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An Integrated Analysis of a Power Purchase Agreement

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Abstract

A Power Purchase Agreement (PPA) is at the heart of any BOT or BOO type power generation project that is to be undertaken by an Independent Power Producer (IPP). During the past decade privately owned IPPs selling electricity to the power industry has become common place. Such arrangements require some version of a PPA. In this paper we model a multi-currency loan and equity financing package for a 100 MW combined-cycle gas turbine generation plant that is to be built in India. Using this financial model we evaluate a sophisticated power purchase agreement in order to identify the relative importance of each of the variables found in such an agreement. Variables become important if they represent major elements of costs or revenues or are significant sources of risk.

This paper provides an example of the benefits that an integrated financial-economic-stakeholder analysis can bring to the evaluation of a PPA and BOT contracts. The integrated approach allows various scenarios to be compared from different perspectives and points of view. The economic analysis looks at the project's impact on a country's overall economy. The financial analysis of such an infrastructure project checks on the profitability and sustainability of the project over time. Sensitivity and risk analyses are central to the evaluation of this project since they identify the most critical variables and allow a probability distribution of values to be used in the model, rather than a single predicted value. The distributive or stakeholder analysis identifies who would be the major winners and losers if the power plant project were undertaken. This approach enables the partners to the agreement to "test" the sustainability of the contract through the analysis of the project's outcomes under a wide range of situations and combinations of scenarios before the PPA is entered into. The technique of testing contracts for their future sustainability is area of research of potentially great benefit to the parties entering into long term contractual arrangements for public services.

JEL Codes: D61, H43, L94

Keywords: India, electricity, agreement, foreign investment, privatization, appraisal.

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I. INTRODUCTION

The Indian government, in their 1992 five-year development plan stated that the country would need 142,000 MW of power capacity by the year 2005. This would require an additional 48,000 MW of electrical generating capacity to the existing 75,000 MW. In the 1990's the rate of economic growth in India accelerated from near stagnation in 1990-1992 to 6% in 1993-1994, 6.3% in 1994-1995 and 6% in 1995-1996. If the electrical energy demanded is not supplied, this experience of improved economic performance could be put in jeopardy.

In 1992, the government amended India's Electricity Act of 1910 and opened the electricity sector to privatization and foreign investment. An incentive package was enacted in 1993 to provide a five year tax holiday for new projects in the power sector and a guaranteed 16% return on foreign investment. Additionally, the protracted project approval system was substantially revised. In January 1996, the government announced new guidelines governing how India's state-run electricity boards should evaluate their power projects through competitive bidding. Even though the states have the responsibility for negotiating their own power deals, they are likely to follow the new guidelines, as the federal power ministry's approval is required for all new projects.

The state of Sendara Pradesh[2] requires substantial additions to its present power generating capacity to meet the power demands of its growing industry, agriculture and other sectors. For the period 1998-2000, the shortfalls in peak capacity are 1,471 MW, 2,035 MW and 2,263 MW. The state is experiencing an acute shortage of power to a point where there has been

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frequent power failures as well as demand cuts on high-voltage industrial customers and restrictions on low-voltage businesses and residential customers during peak hours. This trend has to be reversed to satisfy the unrestricted demand of power and to provide adequate reserves for periodic overhauls and emergency outages. The Sendara Pradesh State Electricity Board (SPSEB) has already identified a number of industrial projects that have been stalled at various stages of implementation due to power shortages. For a large part of the state, the supply of adequate electricity is an immediate requirement for industrial development and for improving the living conditions of the people. By the year 2000, the State of Sendara Pradesh is expected to face a deficit of 2,263 MW in peak power availability. The Government of Sendara Pradesh is encouraging several private power developers to participate in the construction of new power plants within the shortest possible time.

As a result of this policy, a Memorandum of Understanding (MOU) was signed between the Government of Sendara Pradesh, Sendara Pradesh State Electricity Board (SPSEB), Industrial Power Supply Private Limited (IPS) and Edison-Madison Electric Company Private Limited . IPS and Edison-Madison are hereby collectively known as Sendara Pradesh Power Partners Private Limited (SPPL), which is a joint stock company with equity participation, registered by IPS and Edison-Madison to develop, finance, build, operate and transfer an approximately 100 MW power plant on an exclusive basis under the terms of the MOU.

The purpose of this paper is to build an intergrated financial, economic, and stakeholder model of this project and to use this case to illustrate the use of this set of tools for the assessment of the specific outcomes and risks for such arrangements.

[2] In order to preserve the confidentiality of the project, the names of the state and the various interested parties have been changed.

II. PROJECT DESCRIPTION

A. Project Objectives and Scope

The plant will be located at the site of an old decommissioned 10 MW coal-fired thermal power station. The new facility is designed to provide approximately 106 MW of capacity at the generator terminals.

The SPPL Power Project includes the following components:

(1) Construction in about 18 months of a Naphtha-based open/cogeneration/combined cycle generation plant of 100-140 MW capacity.

(2) Refurbishment and renovation of the railway siding for use of transportation of residual fuel oil or naphtha and other distillates. Appropriate logistical arrangements to be made for ensuring a continuous and reliable supply of fuel to the project.

(3) Ground water is available at a depth of about 150 ft and it can be presumed that minimum consumption requirement for closed cycle cooling arrangement can be met from the deep borewells.

(4) Demolition and clearance of existing plants, buildings, and machinery on the site.

(5) For feeding the power from proposed station to the grid, the existing 132 kV switchyard has to be extended with additional step-up transformers and outgoing feeders.

(6) Measures are to be undertaken to mitigate the project's impact on the environment.

B. Project Cost and Financing

The total cost of the project in 1995 US dollars is estimated at US$100.654 million, with the traded component of costs equal to US$49.263 million (Table 1). The cost estimates are based on actual prices obtained through international competitive bidding. The cost estimates provide for both physical and price contingencies.

Domestic banks and the World Bank will finance the project through two loans of US$35.23 million each at 6.48% and 5.34% percent real rate of interest, respectively. SPPL’s private partners will provide the balance of US$31.2 million with equity.

Table 1: Project Cost (million 1995 US$)

	Non-traded	Traded	Total
Land	0.194		0.194
Civil Works	2.079		2.079
Mechanical Works	18.473	44.965	63.438
Electrical Works	0.797	1.952	2.749
Miscellaneous	1.839	2.346	4.185
Development Cost	4.000		4.000
Financial Charges	5.553		5.553
Interest During Construction	12.832		12.832
Pre-operative Expenses	1.471		1.471
Vehicle, Office, Apparatus	0.529		0.529
SUB-TOTAL	47.767		97.030
Contingency for EPC	3.624		3.624
TOTAL	**51.391**	**49.263**	**100.654**

Table 2: Project Financing (million 1995 US$)

Domestic Banks	35.229
World Bank	35.229
Sendara Pradesh Power Partners Private Limited	15.400
Foreign Partner	14.796
TOTAL FINANCING	**100.654**

Table 3: Annual Financing (million rupees, nominal prices adjusted for inflation)

	Year 1	Year 2	Total
Domestic Equity (m. Rs)	291.2	243.7	534.9
Foreign Equity (m. Rs)	279.8	234.2	513.9
Foreign Equity (m. $)	8.2	6.6	14.8
Domestic Loan (m. Rs)	666.1	557.5	1,223.6
Foreign Loan (m. Rs)	666.1	557.5	1,223.6
Foreign Loan (m. $)	19.6	15.6	35.2
Total (m Rs)	1,903.1	1,592.9	3,496.0

C. Project Life

The project life, according to the PPA, is set at 17 years after the start of operations, although the design life of the power plant is 25 years.

D. Project Implementation and Management

The project will be implemented by SPPL, which will contract management services in the first years, until local employees are able to manage the project. SPSEB will regulate its activities and purchase its output.

III. THE POWER PURCHASE AGREEMENT

The PPA signed between SPPL and SPSEB is a fixed rate of return (ROE) type that specifies how SPPL will be paid for the electricity to be delivered by the SPPL plant for a period of 17 years after which the plant will be transferred to SPSEB at a negotiated transfer price. This type of contract is not unique to India, but has become one of the standard format contracts used internationally. The PPA consists of four major payment categories: (i) fixed charge payment, (ii) variable charge payment, (iii) incentive payment, and (iv) transfer price.

A. Fixed Charge Payment

For a PPA of the fixed-ROE (fixed Rate Of Return) type, the fixed charge payment is usually the most important category of the major payment categories. This fixed charge payment category includes the following payments:

(1) Interest on Debt,
(2) Depreciation Payment,
(3) Return on Equity,
(4) Interest on Working Capital,
(5) O&M and Insurance Expenses[3],
(6) Taxes on Income,
(7) Special Appropriation.

Except for the fifth and sixth items, these payments are the major vehicle from which the IPP will recover its investment costs plus a return on its equity. Based on the actual design of the PPA, the IPP partners may actually earn more or less than the fixed ROE explicitly specified in

[3] Whether O&M plus insurance truly reflects the actual costs could have a significant impact of the project NPVs.

the agreement.[4] A power purchase agreement (the PPA) signed between an electric utility or a state electricity board and an IPP is usually based on a fixed return on equity. Accordingly, the IPP is guaranteed a fixed return, 16% in India, on the partners' equity. Whether this 16% ROE is a real or a nominal rate of return is usually not specified in a PPA. It is nevertheless a common practice to treat it as a nominal ROE. The real ROE will therefore depend on the rate of inflation experienced during the duration of the contract[5].

The definition of all the items listed above are all reasonably transparent except for the depreciation payment and special appropriation components. The depreciation payment is defined as:

$$\text{Depreciation Payment Per Period} = \frac{\text{Investment Cost} \times (1 - \text{Residual Value Ratio})}{\text{Number of Depreciation Periods}},$$

or

$$\text{DP} = \frac{\text{C} \times (1 - \text{RVR})}{\text{n}}. \qquad (1)$$

The residual value ratio (RVR) is the portion of the investment cost that will not be depreciated. This undepreciated portion is supposed to be recouped by the transfer price at the consummation of the contract. The annual depreciation payment per period is a function of RVR and the number years over which the depreciation payments are made (n). If the RVR and n are low, the depreciation payment is "front-end-loaded". This can increase the project's NPV from the IPP point of view.

Whenever the repayment of the principals of the loans obtained by the project exceeds the depreciation payment, the utility is required to pay a "special appropriation" whose amount is

[4] The ROE specified in the PPA is only part of a payment package as noted in the fixed charge payments. It may differ significantly from the actual return on equity that the IPP partners would get.

[5] If a domestic inflation of 8% were expected, as in our base case for India, then the underlying real ROE in rupees would be 7.41%. But if the rate of inflation were 3% as is assigned for the U.S., the underlying real ROE would be 12.62% on dollar-dominated equity financing.

equal to the difference between the two. Depending on how the loans are structured, this item can have a significant impact on the project's, the utility's and the equity holders' NPVs.

The combination of the depreciation and the special appropriation payments are subjected to two further restrictions: (1) the accumulated sum of the depreciation and the special appropriation payments is not to exceed (1-RVR)*total investment cost, and (2) that after all debts are repaid, the total fixed charge for each period will be reduced by an amount, which will be referred to as "Fixed Charge Adjustment I" in our case study, equal to:

$$\text{Fixed Charge Adjustment I} = \text{Prime Rate} \times \left(\begin{array}{c} \text{Accumulated sum of the depreciation} \\ \text{special appropriation payments - total debt} \end{array} \right) \quad (2)$$

[6]

In other words, the prime interest rate will be paid to the electricity board on any payments it has made to the IPP in excess of the amount of debt financing less the residual value. In the event that the calculated plant load factor (CPLF) is less than the Normative Plant Load Factor (NPLF), the total fixed charge payment will be reduced by an amount equal to the following:

$$\text{Fixed Carge Adjustment II} = \text{Fixed Charge Payment} \times \left(\frac{1 - \text{CPLF}}{\text{NPLF}} \right), \text{if CPLF} < \text{NPLF} \quad (3)$$

[7]

[6] The Depreciation and Special Appropriation payments are restricted by, for example, the following statement from one of the PPAs. " `Depreciation' shall mean the depreciation on the assets of the Project based on the Capital Cost at the rates specified by the Government of India as of the date of this Agreement under the Electricity Laws; provided, however, that the allowance for depreciation shall be zero from and after the date on which the aggregate of all payments for Depreciation and Special Appropriation equals 90% of the Capital Cost, provided further, however, that with respect to each Billing Period after the Billing period in which the Debt is due to be fully repaid in accordance with the Debt Amortization Schedules, the applicable Fixed Charge Payment shall be further reduced by an amount equal to the interest (calculated at the prime lending rate of the State Bank of India) on the amount by which the aggregate amount of Depreciation and Special Appropriation provided for pursuant to this Appendix D exceeds the aggregate amount of Debt referred to in the Financing Plan." If the Depreciation and Special Appropriation payments are not restricted by the preceding conditions, they will result in excessive over-repayment of the total investment cost.

[7] CPLF is defined as (actual energy delivered + deemed generation)/(capacity*hours of period). Normative PLF is supposedly the average PLF for a specific plant operates under normal conditions. In India, however, NPLF is specified by the Indian Government PPA directives. See also Incentive Payment below.

B. Variable Charge Payment

The variable charge payment is a payment for the fuel costs actually incurred by the plant.[8]

C. Incentive Payment

Inventive payment is defined as:

$$\text{Inventive Payment} = \text{Equity} \times .007 \times (\text{CPLF} - .6849) \times 100 \times \left(\frac{n}{365} \right), \text{ if CPLF} > .6849, \qquad (4)$$

where n is the number of days in the Billing Period, 68.49 is the Normative PLF (NPLF)[9] and .007 (.7 of 1%) is the incentive points. Both the NPLF and the incentive points are negotiated values, with the values shown here being those specific to this contract.

IV. APPRAISAL OF THE SPPL PROJECT FROM DIFFERENT POINTS OF VIEW

It is customary to look at a project from the different perspectives - total investment, equity owner, and economic. This approach can be applied to any project. The different stakeholder points of view - the utility versus the IPP, which are explained below, apply only to specific situations such as the present case of a PPA which is also part of a BOT agreement.

A. The Utility (SPSEB) Point of View

Traditionally, the most important mandate of a utility is to provide reliable power at the lowest cost. This role has more or less been fulfilled by the traditional utilities when they are regulated and managed properly. Recent changes have altered some of the attributes of this traditional mandate. These changes have arisen because of the introduction of privatization and

[8] How to provide incentives for the IPP to minimize fuel costs is crucial but often omitted in most PPAs.

[9] Normative PLF is the PLF expected for the plant under normal conditions. It is to be agreed by the Utility and the IPP.

competition with the intent to widen financing capability and reduce costs. The latter is often referred to as "deregulation". Another important change is the rapid growth of many developing countries, which has led to a shortage of public funds to meet the expanding demand for basic infrastructure such as transportation, communications, electricity, and others. The combination of privatization, competition and the shortage of investment funds has led to the introduction of many BOT projects as a substitute for the traditional publicly funded projects in these sectors.

The biggest attraction of a BOT deal to a utility, through the signing of a PPA, is the avoidance of having to raise the funds to finance generation capacity. However, from the point of view of a utility, or any buyer of electricity, reliable power at a reasonable price remains one of the most important criteria. An investment appraisal is one way to ascertain if the price paid for the electricity is reasonable. For example, the utility would like to know what is the ROE that would satisfy the IPP and at the same time not give the IPP a return that is significantly greater than the minimum required to attract an IPP with the needed skills and resources. It also needs to know what is the true rate of return to the IPP[10], or alternatively what is the impact of the key negotiation variables on the financial NPV.

For a fixed-ROE PPA, there are many specifications and variables that have to be negotiated between the two parties. Among the many contract items, the key variables are the ROE, the capital cost, the normative plant load factor (NPLF), the incentive points, the depreciation payment scheme, the calculation of O&M plus insurance payment, the special appropriation, and the variable charge payment.

When the utility is also a parastatal enterprise such as the SPSEB, various parts of the agreement may be benefited from public guarantees or subsidies. The investment appraisal should also consider the economic costs and benefits of the project even though the financial viability and constraints may be the overriding concerns.

[10] The true rate of return to the IPP is the real rate of discount at which the real financial NPV is equal to zero.

B. The IPP (SPPL) Point Of View

From the IPP's point of view, the true financial return of the project is its main concern. Hence an IPP will use the results of the financial analysis to set its minimum-return positions while striving for the maximum return in its negotiations with the utility. The financial return of the IPP may accrue to the IPP through revenues other than the guaranteed rate of return on the initial equity. For example, a change in either the investment or fuel costs that accrue either directly or indirectly to the IPP may be more important in the determination of the final profitability of the project than several points on the negotiated ROE in the PPA.

C. The Economic and Public Agency Point of view

As mentioned above, when the utility is also a parastatal enterprise, it must consider the economic costs and benefits as well as the distributive aspects of the project.

Public agencies such as the state development agencies and international development banks will be concerned with not only the economic benefits and sustainability of the project but social goals as well. Here the economic value of electricity, the externalities of the project and the distributive impacts of the project come into play.

D. Importance of Proper Evaluation and Transparency of the Contract

For an agreement to be successfully executed after the negotiation, it is important that both sides properly evaluate the agreement such that, to the extent possible, no major omissions are left out of the agreement. On the other hand, a high degree of transparency of the contract, achieved through adequate accessment of the contract by both sides and through elimination of the "black-box" areas of the contract, tends to promote mutual trust and prevent recrimination arising between the parties. In the area of contracting for such public services, incomplete evaluations and the lack of transparency of the implications of the contract terms have been two of the primary sources of contract risk. Evaluation of the outcomes of projects from the points of view of the various stakeholders for ranges of input variables that reflect real world experience, is a helpful way to assess the risk of damaging project outcomes that might arise in the future.

V. FINANCIAL ANALYSIS

The financial analysis of this power project is conducted here from both the SPSEB's and the SPPL's points of view. The parameters used to develop the cash flow statements in the base case are detailed in the accompanying spreadsheets.[11]

A. Financial Benefits and Costs

1. The SPSEB Point of view

From the SPSEB point of view, the financial benefits of the project are the revenues derived from the sale of the electricity to its customers. The financial costs of the projects are the payments it must pay to SPPL as defined by the PPA[12] and the additional transmission, distribution and operating costs[13] incurred by the utility in delivering power to its customers. Part of the payments will be in foreign currency.

2. The SPPL Point of view

From the SPPL point of view, the financial benefits of the project are the PPA payments it receives from SPSEB. The financial costs to the IPP or SPPL are the financing costs, fuel and the operating costs of the project.

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[11] A detailed set of Excel spreadsheets for this project can be obtained from the authors.
[12] Part of the payments will be in foreign currency.
[13] Including transmission and distribution losses.

B. Methodology

1. Perspectives

The financial analysis of the project is conducted from the points of view of the IPP and the utility, and from both the total investment and equity holder's perspective[14]. Unlike the total investment perspective, the equity holder's perspective includes in the cash flow profile of the project the loans and the costs of borrowing. The pro-forma cash flow statements are first developed in nominal terms in order to take into account the effects of inflation, on such variables as the amount of taxes due. The cash flow items are then deflated to arrive at their real values. Finally, the real net cash flows are discounted by the overall real cost of equity capital to find the net present value of the project.

2. Depreciation Payment

Depreciation payments, as specified in the PPA, is to be paid by the utility to the IPP every year during the course of the project. But if the depreciation payments are front-end-loaded, the IPP will have reclaimed their equity, through these payments, very early in the project. After the IPP's equity is reclaimed, according to the contract, the utility must still pay for the ROE on the initial amount of equity every year throughout the project life. This could result in over-compensation to the IPP.[15]

Note that this so called "depreciation payment" scheme is divorced from the depreciation allowances estimated for tax purposes. To avoid confusion it would be better to call these payments "PPA depreciation repayments".

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[14] It is worth noting that the different points of view represents the standard project evaluation's way of analyzing a project which can be applied to any project. The different perspectives mentioned above apply only to specific situations such as the present case of a PPA which is also a BOT agreement.

[15] An alternative is to use the depreciation payment to retire the outstanding equity. But if the depreciation scheme is front-end-loaded, the IPP's equity will be retired very early and the IPP will no longer receive ROE payments for the most part of the project life. This may leave very little incentive for the IPP to continue to care for the project.

3. Special Appropriation

As noted above, even though the total of the depreciation and special appropriation payments are limited to (1-Residual Value Ratio)*100 % of total investment cost[16], because the special appropriation is defined as the amount equal to loan repayments less depreciation, this will further contribute to the front-end-loading of the repayment of the capital cost.[17] This front-end-loaded repayment in combination with the continuation of a fixed "Return On Equity" payment during the entire project life can result in the actual rate of return to the IPP much higher than the PPA's stated fixed rate of return (contract ROE). Special appropriation, front-end-loading, and return on equity payments contribute much to the divorce between the contract ROE and the actual rate of return to the IPP. Furthermore, if the Residual Value Ratio is too low, it further contributes to the overcompensation of capital cost.

4. Financial Interests and PPA Negotiation

Three parties are involved in this project: the utility, the IPP, and a development bank which will provide part of the loans. All of the above are interested in the financial analysis of the project in a different way. The IPP or SPPL would like to know if the project is sustainable and profitable and how much the utility would gain or lose from this project. The utility or SPSEB will want to know whether the project is sustainable as an independent operation by the IPP and what is the financial implications - a financial gain or drain - to SPSEB. As a development agency, the development bank would like to know the economic implications of the project, as a lending institution it also wants to know whether the project is sustainable and has the ability to repay its loans. Both the utility and the IPP would also like to know the other party's financial positions in order to formulate their own negotiation strategy.

C. Cash Flows and Results

The financial cash flow statements for the project are presented in Tables 4, 5, 6 and 7.

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[16] See discussion in III. The Power Purchase Agreement, A. Fixed Charge Payment.

[17] Whether loan repayments - interest and principle – will be greater than the PPA depreciation payments, depends on the size and the terms of the loans. If the size of the loans is large and the terms are short, loan repayments will exceed the PPA depreciation repayments.

1. Utility Point of view

From Table 4 we see that, based on an average selling price of 2.8 Rs/kWh, the financial (equity) NPV of the project from the utility's point of view is –18.03 million rupees (expressed in 1995 prices and evaluated as of 1995).[18] The negative NPV is due to the "below-cost" electric tariffs.

From a strictly financial perspective, the utility is losing money on the SPPL deal due to the utility's own tariff policy or the restrictions on tariffs mandated by the government. But because the project is operated by an IPP which is making a positive financial NPV[19] and a rather high rate of return, there is no danger that the project will fail, provided that the PPA will be honored by both sides and that interim financing can be obtained to finance the negative net cash flows that occurs in several years over the project life. This is, however, an extremely strong assumption as the utility might be so financially weak that it can not fulfill its obligations under the contract.

The operating environment of the utility taken here does not assume that the utility would otherwise have supplied the power through the expansion of its own generation capacity. If this option were available, then the evaluation of the project from the utility's point of view would require a comparison of the cost of the IPP generation with the financial cost of its own generation. In India at this time this option generally is not available to the State Electricity Boards. They simply can not obtain the financing necessary to provide sufficient capacity themselves. Hence, to assess the financial impact on the State Electricity Board, we are restricted to comparing the revenue it receives from additional electricity sales with the cost of the power it purchases from the IPP.

2. IPP Point of view

From Table 5 we see that the financial NPV of the project to the IPP (equity perspective) is 476.09 million Rs yielding a real rate of return of 32.19%.[20] The actual real rate of return

[18] Using a real discount rate of 12%.

[19] While the financing of the deficit years are not specifically included in the spreadsheet, it is assumed that these short term financing can be obtained from the banks at interest rates not significantly different than the equity owners' discount rate, or that it can be financed by the equity holders themselves.

[20] Annex 22, Financial Cash Flow (Equity).

(ROR) is 29.16% (42.40% nominal) for the domestic IPP partner and 34.98% (39.03% nominal) for the foreign partner. This positive NPV is due largely to the Special Appropriation and ROE payments noted above.[21] The financial NPV to the domestic IPP partner is 232.43 million rupees (Table 6)[22], and 237.39 million (US$3.02 million) rupees to the foreign IPP partner (Table 7).[23]

To the IPP, it is doubtlessly a profitable project as long as the PPA is honored by the utility.

[21] See the Methodology section above.
[22] Using a real discount rate of 12%, Annex 25.
[23] Using a real discount rate of 16%, Annex 26.

Table 4: Financial Cash Flow from the Utility Point of View

(expressed in 1995 prices)

Year	NPV	0	1	2	3	4	5	6	7	18
Revenue*			911	1,847	1,847	1,847	1,847	1,847	1,847	0
PV of Future Benefits			0	0	0	0	0	0	0	1,710
Bulk Power Cost			802	1,458	1,450	1,424	1,907	1,893	1,954	0
Transfer Price			0	0	0	0	0	0	0	1,710
Transmission, Distribution and Operating Cost			177	326	295	268	243	220	200	0
Change In Working Capital			156	175	29	29	29	29	29	(288)
Net Cash flow			(224)	(112)	72	125	(333)	(296)	(336)	288

NPV @ 10.00% = (18.03) **IRR = -4.63%**

Table 5: Financial Real Cash Flow Statement from the IPP Point of View

(expressed in 1995 prices)

Year	0	1	2	3	4	5	6	7	18
Receipts									
Sales	-	801.52	1,457.78	1,449.90	1,423.97	1,907.31	1,893.08	1,953.79	-
Change in Accounts Receivable	-	(63.87)	(189.05)	(122.17)	(31.01)	(28.17)	(104.79)	(36.37)	285.88
Transfer Price	-	-	-	-	-	-	-	-	1,710.01
Liquidation Values									
Land	-	-	-	-	-	-	-	-	-
Civil Work	-	-	-	-	-	-	-	-	-
Mechanical Work	-	-	-	-	-	-	-	-	-
Electrical Work	-	-	-	-	-	-	-	-	-
Other EPC	-	-	-	-	-	-	-	-	-
Other Investments	-	-	-	-	-	-	-	-	-
Loan	1,305.44	1,005.72	-	-	-	-	-	-	-
Loan for Working Capital	52.06	234.97	344.35	343.04	338.71	419.27	416.90	427.02	-
Total Inflows	**1,357.50**	**1,978.34**	**1,613.07**	**1,670.77**	**1,731.68**	**2,298.41**	**2,205.19**	**2,344.44**	**1,995.89**
Expenditures									
Investment Costs									
Land	6.60	-	-	-	-	-	-	-	-
EPC Cost									
Civil Works	70.70	-	-	-	-	-	-	-	-
Mechanical Works	1,027.66	1,027.66	-	-	-	-	-	-	-
Electrical Works	44.54	44.54	-	-	-	-	-	-	-
Miscellaneous	68.28	68.28	-	-	-	-	-	-	-
Development Cost	136.00	-	-	-	-	-	-	-	-
Financial Charges	93.00	93.00	-	-	-	-	-	-	-
Interest During Construction	289.44	142.56	-	-	-	-	-	-	-
Pre-operative Expenses	50.00	-	-	-	-	-	-	-	-
Vehicle, Office, Apparatus	18.00	-	-	-	-	-	-	-	-
Contingency for EPC	60.70	60.70	-	-	-	-	-	-	-
Cost Overrun	-	-	-	-	-	-	-	-	-
Operation Costs									
Fixed Costs									
O & M Expenses	-	35.08	70.16	70.16	70.16	70.16	70.16	70.16	-
Salaries	-	6.19	12.38	12.38	12.38	12.38	12.38	12.38	-
Variable Costs									
Naphtha	-	482.20	977.80	977.80	977.80	977.80	977.80	977.80	-
Change in Accounts Payable	-	(40.18)	(45.04)	(7.58)	(7.58)	(7.58)	(7.58)	(7.58)	73.90
Change in Cash Balance	-	3.44	3.76	0.64	0.64	0.64	0.64	0.64	(6.24)
Loan Repayment									
Interest	-	-	-	-	-	343.05	281.69	223.04	-
Principal	-	-	-	-	-	276.59	293.48	311.40	-
Loan for Working Capital									
Interest	-	9.66	43.61	63.91	63.67	62.87	77.82	77.38	-
Principal	-	47.22	213.12	312.32	311.13	307.21	380.27	378.12	-
Income Tax	-	-	-	-	-	-	26.26	138.20	-
Total Outflows	**1,864.92**	**1,980.35**	**1,275.79**	**1,429.63**	**1,428.20**	**2,043.12**	**2,112.92**	**2,181.54**	**67.67**
Net Cash Flow	**(507.42)**	**(2.00)**	**337.28**	**241.13**	**303.48**	**255.29**	**92.27**	**162.89**	**1,928.23**

NPV @ 13.96% = 476.09 IRR = 32.19%

Table 6: Financial Cash Flow Statement from the Domestic IPP Partner Point of View

	NPV	0	1	2	3	4	5	6	7	8	9	10	11	18
Net Cash Flow		-259	-2	168	117	147	121	36	71	54	-119	-6	-6	983

NPV @ 12.00% = 232.43 **IRR =29.16%**

Table 7: Financial Cash Flow Statement from the Foreign IPP Partner Point of View

	NPV	0	1	2	3	4	5	6	7	8	9	10	11	18
Net Cash Flow (m. Rs)		-249	0	169	124	156	134	56	92	77	-88	22	23	945

NPV @ 16.00% = 237.39 **IRR=26.09%**

VI. SENSITIVITY AND RISK ANALYSES OF FINANCIAL APPRAISAL

A. Sensitivity Analysis

A sensitivity analysis is conducted to determine the impact of changes in the key variables on the financial NPVs of the project. Such a sensitivity analysis will tell if the project can survive significant changes in variables like inflation, fuel prices and cost overruns, which are not controlled by either party. A sensitivity analysis will also allow each party to know how changes in those key variables that are to be negotiated through the Power Purchase Agreement may influence the outcome of the project. Tables 8 through 25 show the effect of such changes on the financial NPVs of the project.

The NPVs are calculated as of 1995 and expressed in terms of the 1995 price level. *Unless otherwise stated all NPV values reported below will be given in millions of rupees.*

1. Selling Price of Electricity

Table 8: Effect Of Electricity Selling Price On The Financial NPV From The Utility's Point Of View

Average Real Electricity Selling Price	NPV (million Rs)
2.4	(1,952)
2.6	(985)
2.8	(18)
3.0	949
3.1	1,433
3.2	1,916
3.3	2,400
3.4	2,884
3.5	3,367
3.6	3,851
3.7	4,334

Using a real discount rate of 10%, the utility will break even when the tariff to its customers is set at 2.8037 Rs/kWh. At the present tariff of 2.8 Rs/kWh, the utility will lose money on the deal.

2. Domestic Inflation

Table 9: Effect of domestic inflation on the Financial NPV from the Equity point of view

Domestic Inflation	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)	NPV Utility (million Rs)
3%	774	474	314	(1,001)
4%	721	431	300	(806)
5%	671	391	287	(635)
6%	625	354	275	(484)
7%	584	320	264	(351)
8%	547	290	255	(233)
9%	513	263	247	(130)
10.25%	476	232	237	(18)
11%	456	216	233	40
12%	432	196	227	111
13%	408	176	221	176
14%	386	158	216	233
15%	367	142	211	284
16%	350	128	207	328
17%	334	115	204	371

Because the 16% contract ROE is a fixed nominal rate, regardless of inflation, higher rates of domestic inflation means that the real rate of return paid to the IPP falls, hence reducing its NPV while increasing the NPV of the utility.

3. Foreign and Domestic Inflation

Impact on Domestic Equity Holder

Table 10: Effect of inflation on the NPV from the Domestic Equity Holder's Point of View with variable loan interest rates.

(in million Rs)		Domestic Inflation						
		8%	10.25%	12%	14%	16%	17%	18%
Foreign Inflation	1%	270	212	174	137	107	93	81
	2%	280	223	185	148	117	104	92
	3%	290	232	196	158	128	115	103
	4%	299	242	205	168	137	124	112
	5%	308	250	214	178	147	133	121
	6%	316	258	222	186	155	142	130
	7%	324	266	229	194	163	150	138
	8%	332	273	236	201	171	158	146

As mentioned above, higher domestic inflation leads to a smaller real fixed ROE payment by the utility to the IPP causing both the IPP's NPV as well as the domestic partner's NPV to fall. With an increase in foreign inflation, the value of the foreign loan decreases in rupee terms because for the same domestic inflation there is less devaluation of the rupee. The IPP will have less debt (principal) to repay relative to the amount of depreciation plus special appropriation they receive. This will increase the domestic partner's NPV. The decrease in foreign debt repayment outflow due to a lower rate of devaluation of the rupee is partially offset by the decrease in the "PPA Payment" by the utility to the IPP. In addition, the total "PPA Payment" is reduced and the interest on foreign loans and the income tax components of the interest on the contractual working capital decrease.

- In summary, the decrease in foreign principal payments (outflow) decreases the amount of special appropriation (inflow), which causes the total "PPA Payment" to decrease, thereby decreasing the interest expenses for working capital and income taxes even further. However, the decrease in special appropriation (from the lower rate of depreciation) is not enough to offset the lower principal payments. Therefore, even though the inflows decrease, the outflows decrease even more, so the NPV increases from the point of view of the domestic equity holder.

Impact on Foreign Equity Holder

Table 11: Effect of inflation on the NPV from the Foreign Equity Holder's Point of View with variable loan interest rates.

		Domestic Inflation							
(in million Rs)		4%	6%	8%	10.25%	12%	14%	16%	18%
	1%	327	301	281	264	252	241	232	226
	2%	313	287	267	250	239	228	219	213
Foreign	3%	300	275	255	237	227	216	207	201
Inflation	4%	289	264	244	226	216	205	196	190
	5%	279	254	234	216	206	195	187	181
	6%	269	245	225	207	196	187	178	172
	7%	260	237	216	199	188	179	170	164
	8%	252	229	209	191	180	171	163	157

The foreign equity holder receives his return in US dollars. Higher domestic inflation rates lower the real fixed ROE payment to the IPP, reducing the NPV values of both domestic and foreign equity holders. A higher foreign inflation rate raises the value of rupees and lowers the dollar value of the foreign partner's rupee incomes, hence reducing his NPV as well. Therefore, the foreign equity holder is affected negatively by an increase in the inflation rate of either India or the US.

4. Fixed Nominal ROE of PPA

Table 12: Effect Of The Contract Nominal ROE On The IPP's Financial NPV[24]

Contract ROE	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)
7%	53	34	19
8%	100	56	44
9%	147	78	68
10%	194	100	92
12%	288	144	140
14%	382	188	189
16%	476	232	237
18%	570	277	286
20%	664	321	334

The local partner will break even at 5.46% contract ROE; the foreign partner will break even at 6.2%. The sensitivity analysis also shows that the higher the specified ROE in the contract the higher the net present values of the project will be to each of the IPP owners.

[24] Assumes an average 8% inflation in India and 3% foreign (US) inflation over the life of the project, the real discount rate for the project is 13.96%, for the local partner 12%, and for the foreign partner 16%.

5. Real Discount Rate

Real Discount Rate's Impact on Domestic Equity Holder

Table 13: Effect Of Real Discount Rate On The Financial NPV From The Domestic Equity Holder's Point Of View

Nominal Discount Rate	Real Discount Rate	NPV (million Rs)
21.28%	10.00%	293
23.49%	12.00%	232
25.69%	14.00%	184
32.31%	20.00%	86
37.82%	25.00%	33
42.23%	29.00%	1
42.45%	29.20%	0
43.33%	30.00%	-6
44.43%	31.00%	-13
45.54%	32.00%	-19

The discount rates at which the domestic partners' NPV becomes zero are the actual rates of return on their equity. Assuming an 8% rate of inflation, the actual real ROE to the domestic equity holder is 29.2% yielding a nominal return of 42.45%. Again, this shows that actual returns to the equity holders can deviate greatly to the contract's fixed ROE.

Real Discount Rate's Impact on Foreign Equity Holder

Table 14: Effect Of Real Discount Rate On The Financial NPV From The Foreign Equity Holder's Point Of View

Nominal Discount Rate	Real Discount Rate	NPV (million Rs)	NPV (million US$)
17.42%	14.00%	290	3.90
19.48%	16.00%	237	3.02
25.66%	22.00%	127	1.02
26.69%	23.00%	113	0.75
27.72%	24.00%	100	0.49
28.75%	25.00%	88	0.25
29.78%	26.00%	77	0.02
30.81%	27.00%	66	(0.20)
31.84%	28.00%	56	(0.41)

The actual real ROE to foreign equity holder is 26.0%. This implies a 29.78% nominal ROE assuming a 3% rate of foreign inflation.

6. Incentive Points

Table 15: Effect Of The Incentive Points On The Project's Financial NPV

Incentive Points	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)	NPV Utility (million Rs)
0.0%	225	93	124	379
0.1%	261	113	140	323
0.5%	404	192	205	96
0.7%	476	232	237	(18)
1.0%	584	292	286	(188)
1.5%	763	392	367	(472)
2.0%	943	492	447	(745)
2.5%	1,122	592	528	(1,009)
3.0%	1,302	692	609	(1,273)
3.5%	1,481	792	690	(1,536)
4.0%	1,661	891	770	(1,800)

The incentive points can substantially affect the NPV of different concerns. Since it is beneficial for the utility to provide adequate incentive for the IPP to keep the power plant in good conditions and maintain a high plant load factor, incentive points should therefore not be used by the utility as a major bargaining point.

7. Normative PLF

Table 16: Effect Of The Normative PLF On The Project's Financial NPV

Normative PLF	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)	NPV Utility (million Rs)
60.00%	692	353	335	(359)
65.00%	565	282	277	(158)
68.49%	476	232	237	(18)
70.00%	438	211	220	43
72.00%	387	183	197	124
74.00%	336	154	174	205
76.00%	285	126	151	284
78.00%	234	98	129	364
80.00%	225	93	124	379
82.00%	225	93	124	379

The IPP receives an incentive payment only when the CPLF, based on actual generation plus deemed generation, exceeds the Normative PLF. When the CPLF is less than the

Normative PLF, assuming IPP bears the responsibility, the fixed charge payment to the IPP will be reduced proportionally. This explains why the project's and the IPP partners' break even points are quite sensitive to the Normative PLF.

8. Actual Plant Load Factor

Impact on the IPP's NPV

Table 17: Effect Of Actual Plant Load Factor on the Project's Financial NPV

Actual Plant Load Factor	NPV Project (IPP Responsible) (million Rs)	NPV Project (Utility Responsible) (million Rs)
65%	284	450
70%	458	458
75%	465	465
80%	472	472
83%	476	476
85%	479	479
90%	486	486

If the IPP is not responsible for the low actual energy delivered (low actual plant load factor), a change in the Actual PLF will have little effect on the incentive payment but will affect the operating costs and the utility's interest payment on working capital. Hence the IPP's NPV is not very sensitive to it. But if the low Actual PLF is due to the IPP or the plant's fault, the PPA payment to the IPP will be reduced proportionally[25] and hence the IPP's NPV is highly sensitive to it. This is also known as the production or commercial risk of the IPP.

[25] (Actual PLF)/(~~Benchmark~~Normative PLF).

Impact on The Utility's NPV

Table 18: Effect Of Actual Plant Load Factor on the Utility's Financial NPV

Actual Plant Load Factor	NPV Utility (IPP Responsible) (million Rs)	NPV Utility (Utility Responsible) (million Rs)
65%	(588)	(869)
70%	(633)	(633)
75%	(396)	(396)
80%	(160)	(160)
83%	(18)	(18)
85%	77	77
90%	313	313

If the lower Actual PLF is due to the utility's failure to take the power, it is very detrimental to the utility who must pay for the plant. This is the demand risk of the utility. But if the low Actual PLF is due to the IPP or the plant's fault, the PPA's fixed charge payment as well as the variable charge payment to the IPP will be reduced proportionally, hence the utility's financial loss is actually reduced. On the other hand, if the utility's tariff is high enough such that the utility has a positive NPV, the situation will be reversed - the utility's NPV decreases as the Actual PLF declines.

Impact on the Utility's Break Even Tariff

Table 19: Actual Plant Load Factor and the Utility's Break Even Tariff

		Tariff (Net of Tax)				
		2.8	2.9	3.0	3.1	3.2
Actual Plant Load Factor	70%	(633)	(225)	183	591	999
	75%	(396)	41	478	915	1,352
	80%	(160)	306	772	1,239	1,705
	83%	(18)	466	949	1,433	1,916
	85%	77	572	1,067	1,562	2,058
	90%	313	837	1,362	1,886	2,410
	95%	549	1,103	1,656	2,210	2,763

If the Actual PLF is 83%, the utility needs a 2.8037 Rs/kWh tariff to break even. As the Actual PLF becomes higher, the break-even tariff gets lower. Given the Actual PLF, the utility's financial position depends ultimately on the utility's tariff policy.

9. Residual Value Ratio

Table 20: Effect Of The Residual Value Ratio On The Project's Financial NPV

Residual Value Ratio	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)	NPV Utility (million Rs)
0.0	549	273	270	(134)
0.1	476	232	237	(18)
0.2	399	190	203	104
0.3	318	144	166	233
0.4	236	99	130	361
0.5	145	48	89	502
0.6	52	(3)	47	645
0.7	(50)	(59)	1	801

The [(1-Residual Value Ratio) * (Investment Cost)] value decides the total amount of depreciation and special appropriation payments. The higher the (1-Residual Value Ratio) value (or the lower the Residual Value Ratio) the higher the total amount of depreciation and special appropriation payments. The Residual Value Ratio therefore strongly affects the rate of return to the project and the IPP partners.[26]

10. Cost Overruns

Table 21: Effect Of Cost Overrun On The Project's Financial NPV

Cost Overrun	NPV Project IPP Responsible	NPV Project Utility Responsible	NPV Utility IPP Responsible	NPV Utility Utility Responsible
-20%	806	(187)	(18)	713
-10%	641	144	(18)	349
0%	476	476	(18)	(18)
10%	311	808	(18)	(384)
20%	146	1,139	(18)	(749)
30%	(18)	1,471	(18)	(1,106)
40%	(183)	1,803	(18)	(1,454)
50%	(348)	2,134	(18)	(1,803)

[26] This ratio is more reasonable if it is set to near the {1-(project life/economic life) } value so that the real present value of the undepreciated book value of the investment is closer to the real transfer price of the plant, assuming that the real transfer price will be close to the residual value estimated by {(economic life – project life)/economic life}*initial investment cost.

If the IPP is responsible for cost overruns, cost overruns will have a significant negative effect on the IPP's NPV. If the utility is to bear the cost overruns, the greater the cost overruns, the higher the IPP's NPV will be. Because of the "fixed-return" nature of the PPA, a higher-capital-cost project tends to benefit the IPP. This also tends to provide an incentive for the IPP to have a more capital intensive project. This fact is also reflected in the utility's NPV which worsens as cost overruns are heightened. The responsibility for cost overruns is therefore one of the critical elements in a fixed-ROE type PPA.

11. Fuel Cost

Table 22: Effect Of Fuel Cost On The Project's Financial NPV

Fuel Cost	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)	NPV Utility (million Rs)
-20%	452	220	226	1,581
-10%	464	226	232	781
0%	476	232	237	(18)
10%	488	238	243	(817)
20%	500	245	249	(1,617)
30%	512	251	255	(2,416)

Since all fuel costs will be passed on to the utility, higher fuel costs will have very little impact on the IPP partners but are highly detrimental to the utility. It also is an area where if the IPP can inflate the cost of fuel through non-arm's length practices, it can gain substantial revenues at the expense of the utility.

12. Actual Fuel Cost Factor

Table 23: Effect of IPP's Actual Fuel Cost Factor on the Project Financial NPV

Fuel Cost	NPV Project (million Rs)	NPV Local Partner (million Rs)	NPV Foreign Partner (million Rs)	NPV Utility (million Rs)
80%	1,638	897	746	(18)
90%	1,057	565	492	(18)
100%	476	232	237	(18)
110%	(105)	(100)	(17)	(18)
120%	(686)	(433)	(272)	(18)
130%	(1,267)	(765)	(526)	(18)

The PPA's variable charge payments are fixed in terms of electricity heat rate and fuel calorific value specified in the PPA. If the IPP can manage to achieve lower heat rate or higher fuel calorific value or both, it can save on the fuel costs, while the utility continues to pay the contract amount based on the predefined heat rate and calorific value. Lower actual fuel costs (relative to the contract fuel costs) will greatly benefit the IPP but not the utility. A better formulation of the fuel cost formula is to include an incentive for the IPP to lower the fuel costs and a mechanism to pass on part of the savings to the utility.

13. Real Loan Rates

Real Loan Rates' Impact on the IPP

Table 24: Effect of Real Loan Rates on the Project's Financial NPV From Equity Holder's Point of View (in million Rs)

		Real Domestic Debt Interest Rate				
		5.0%	6.5%	8.0%	10.0%	12.0%
Real Foreign Debt Interest Rate	3.0%	506	493	479	460	437
	4.0%	499	486	472	453	430
	5.3%	489	476	462	443	420
	6.0%	484	471	457	438	415
	7.0%	467	454	440	421	398
	8.0%	459	446	433	413	390
	9.0%	461	448	434	415	392

Because interest during the grace period is accrued to the principal, an increase in the real rate of interest on both the domestic and the foreign loan rate will increase the total loan principal to be repaid. The increase in interest payments will be automatically compensated for by changes in the PPA payment paid to the IPP, since these are part of the fixed charge payment. The increase in principal repayments will cause the special appropriation to be higher in the earlier years, but lower in the later years because this payment is limited to the point when the IPP recovers its initial investment. Therefore, the net present value of the special appropriation will be higher. However, this increase in special appropriation is not enough to compensate for the increase in the present value of the principal repayments. As a result, an increase in the real interest rate on any of the loans will reduce the project's financial NPV.

Real Loan Rates' Impact on the Utility

Table 25: Effect of Real Loan Rates on the Project's Financial NPV From Utility's Point of View (in million Rs)

		Real Domestic Debt Interest Rate				
		5.0%	6.5%	8.0%	10.0%	12.0%
	3.0%	153	93	25	(71)	(175)
	4.0%	108	48	(20)	(116)	(220)
Real Foreign Debt Interest Rate	5.3%	43	(18)	(85)	(182)	(285)
	6.0%	8	(53)	(120)	(217)	(320)
	7.0%	(24)	(84)	(152)	(248)	(352)
	8.0%	(84)	(144)	(211)	(308)	(411)
	9.0%	(172)	(233)	(300)	(397)	(500)
	10.0%	(216)	(276)	(344)	(440)	(544)

From the utility's point of view, a power purchase agreement can be treated either as a simple bulk power purchase from an outside IPP or as a financing deal. For a fixed-ROE type PPA (vis-à-vis a fixed kWh price PPA), it is more representative to take the latter view. As a financing deal, both the true rate of return on equity and the loan rates are important. As shown in Table 24, the real domestic loan rate has a smaller impact on the project NPV from the equity holder's point of view because the loan interest is paid by the utility.[27] In contrast, higher loan rates, both domestic and foreign, cause the utility's NPV to deteriorate substantially (Table 25).

[27] The small impact from real foreign loan rate is deal to the slow increase in real exchange rate.

B. Conclusions – Sensitivity Analysis

The sensitivity analysis based on such a financial model allows us to evaluate the relative impact of each of the variables contained in a power purchase agreement. It is clear that the actual plant load factor is a key variable from the point of view of the utility. If it falls, and it is the utility's responsibility, it will cause the NPV of the utility to fall dramatically. It also is very costly to the IPP if it is the party responsible for the low plant factor. Depending on whose responsibility is the cost overruns, they can have serious impact on either parties' NPV. The fixed nominal ROE of the PPA (the contract ROE) can substantially affect the final NPVs, even though it does not exclusively determine the actual rate of return to the IPP. The actual fuel costs of the plant and the real exchange rate are risk variables outside the control of the utility. They can nevertheless have an important impact on the utility when it undertakes this project with this type of PPA.

C. Risk Analysis

The assumptions and probability distributions for the various risk variables used in the risk analysis are summarized in Table 26. Details of these assumptions are given in Appendix I.

Table 26: Specification of Risk Variables

Risk Variable	Probability Distribution	Base Case Value	Range Value	Probability
1. Inflation Rate Disturbance	Step (Independent Yearly)	0%	-(50-100%) -(30-50%) -(10-30%) -(0-10%) 0-10% 10-30% 30-50% 50-100%	14% 14% 10% 12% 12% 10% 14% 14%
2. Real Exchange Rate Disturbance	Step (Independent, yearly)	0%	-20% to -10% 0% to -10% 0% to 10% 10% to 20% 20% to 30% 30% to 50%	30% 32% 10% 15% 12% 1%
3. Annual Fuel Cost Disturbance	Normal (Independent, yearly)	0%	-40% to -30% -30% to -20% -20% to -10% -10% to 0%%	4% 13% 25% 16%

			0% to10% 10% to 20% 20% to-30% 30% to 40%	8% 8% 13% 13%
4. Investment Cost Overrun Factor	Step	0%	-10% to 0 0% +10% 10% to 20% 20% to 30%	67% 20% 9% 4%
5. Actual Plant Load Factor	Normal	70%	55% to 85%	Mean 70%, Standard Deviation 5%
6. Transfer Price Factor	Normal	1.0	0.5 to 1.5	Mean 1.0 Standard Deviation 0.2

D. Results - Risk Analysis of Financial Outcomes

The results of the risk analysis are summarized in Table 27.

Table 27: Results of Financial Risk Analysis (Million Rupees, Real)

	Financial NPV - Equity
Base Case	476.09
Risk Analysis	
Expected Value	485.50
Maximum Value	849.16
Minimum Value	(165.26)
Standard Deviation	153.89
Probability Of Negative NPV	8%

Given this power purchase agreement, we find that the range of net present values for the IPP equity holders is from 849 million rupees to negative 165 million rupees with an expected value of 486 million rupees. The probability of a negative NPV is a modest 8%. The negative NPV is due largely to the risk of cost overruns.

The assumption that the utility will actually fulfill its side of the contract obligations is critical to the above risk analysis. In fact, this assumption is the most important risk factor facing the IPP. The other variables examined in the above analysis are associated with the design and structure of the contract and the variables affecting the inputs and outputs of the project, but the political and financial ability of the utility to deliver on its commitments can not be modeled in the same manner.

VII. ECONOMIC ANALYSIS

A power project providing shortage power will have an impact on the consumers directly affected by the power shortages and indirectly on the state economy by eliminating the deterrence to potential domestic and foreign investment in the state. We shall refer to the potential demand for electricity in the state discouraged by the power shortages as the "deterred demand".

A. Methodology

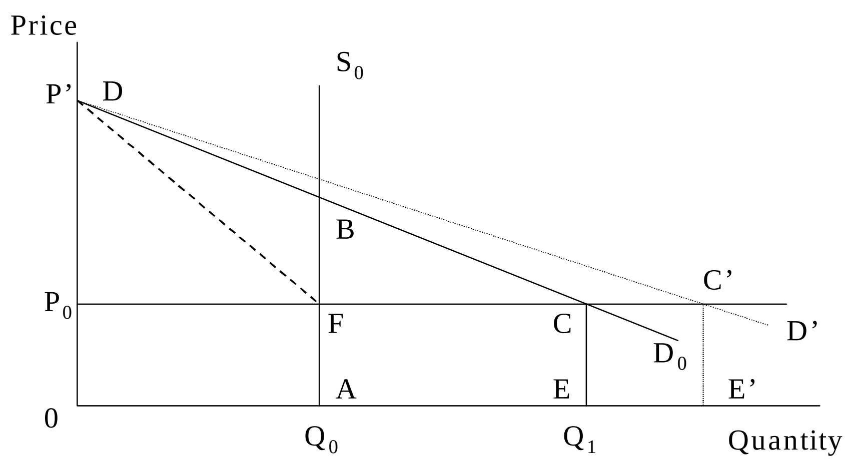
Value Of Electricity With Power Shortages

When a power shortage situation arises and persists for some time, some firms and residential customers may decide to install their own generators. Some would decide to conduct their business without electricity while others may simply cut back some of their activities that require electricity. Furthermore, some firms which otherwise would have located in the country or state may decide not to come. We shall refer to the potential demand for electricity in the state discouraged by the power shortages as the "deterred demand".

The direct benefits of providing electricity to the customers are measured by their willingness to pay for the power. In addition to the direct benefits accruing as a result of elimination of power shortages to those affected customers, there will be the added benefits due to reduction in the deterred demand. Because of the lack of a good measure of the quantity of deterred demand, these benefits are not included in this study. They nevertheless are an important consideration.

In Figure 1, the supply of power by the existing system is fixed at the level Q_0 in year 0, represented by the vertical supply curve, Q_0S_0. Based on the demand curve DD_0, the demand for power would have been Q_1 at the prevailing tariff of P_0 at year 0. But because of the fixed supply at Q_0, a power shortage of AE persists. The valuation of electricity currently provided is given by the area 0DFA. The valuation of the entire demand (served and unserved), Q_1, is given by the area ODCE. If the power shortage is *evenly distributed among all customers* through a rotating blackout, the valuation of the "unserved energy" or shortage power is given by the area AFDCE. After the deterred demand is added, the new demand curve is represented by the line DC'D'.

Figure 1: Demand and Valuation of Electricity with Rotating Power Shortages



The highest value a customer is willing to pay can be estimated by the cost of the alternative power supply available to this customer, which usually means own-generation with a small gasoline or diesel electricity generator. For a rural farmer, the fuel cost of running a diesel water pump may provide an estimate of the highest level of willingness to pay. For rural residential usage, the cost of using a kerosene stove may be used.[28]

[28] For example see World Bank, 1996.

Table 28: Own-Generation Cost In India*

Customer Class	1996 Rs/kWh
COMMERCIAL (Diesel generation)	4.00
INDUSTRIAL (Diesel generation)	3.22
FARMER (Diesel pump replacement)	3.77
RESIDENTIAL (Kerosene replacement)	10.00

* Based on the financial costs of generation or fuel replacement, World Bank Report, 14298-IN, 1996, for Orissa state of India.

For the own-generated power to have the same degree of reliability as the power obtained from the electric utility, the own-generation will have to be backed up by another generator. The maximum willingness to pay for the shortage energy (P') with an accepted level of reliability can thus be estimated by the cost of own-generation plus the cost of maintaining a reserve generator. Assuming the capacity cost (cost of generator) takes up k% of the *total* self-generation cost, the maximum willingness to pay will be (1+k) times the own-generation cost with no backup.

Let the quantity of the shortage energy (AE) be S (kWhs), the gross of tax price of electricity be P_0 in year 0, and the cost of own-generation or alternative supply be G_0. The highest willingness to pay for shortage power is therefore

$$\text{Maximum WTP} = P' = (1+k) \times G_0 \tag{5}$$

We have

$$\text{Area 0DCE} = \frac{[P_t + (1+k) \times G_0] \times (Q_0 + S)}{2}\text{, and} \tag{6}$$

$$\text{Area 0DFA} = \frac{[P_t + (1+k) \times G_0] \times Q_0}{2} \tag{7}$$

The valuation of the "unserved energy" is given by the area

$$\text{AFDCE} = \text{0DCE - 0DFA} = \frac{S \times [P_t + (1+k) \times G_0]}{2} \tag{8}$$

Equation (8) can be rewritten as

$$WTP_s \times S = \frac{S \times \left[P_t + (1+k) \times G_0\right]}{2} \qquad (9)$$

where WTP_S is the average willingness to pay per unit of shortage power, S is the quantity of shortage power, P_t is the prevailing gross of tax price of electricity in year t, P_0 is the gross of tax price of electricity in year 0 when the alternative power cost is estimated or power price at the beginning of the project, k is the capacity cost as a percentage of the alternative power supply cost, and G_0 is an estimation of the alternative power cost.

From equation (9), the average willingness to pay per unit of shortage power is given by the maximum willingness to pay plus the prevailing tariff in year t divided by 2, or

$$\text{Average WTP} = \frac{P_t + P'}{2} \qquad (10)$$

For this study, the calculation of the average willingness to pay is given in Table 29.

Table 29: Own-Generation Costs, Average Tariff, and Willingness To Pay in India (1996 Prices)

Own-generation Cost (Rs/kWh)	3.500
Average Power Price (Gross of Tax, Rs/kWh)	2.912
Capacity Cost as Share of Total Generation Cost* (k)	0.258
Maximum Willingness To Pay (Rs/kWh)	4.404
Average Willingness To Pay in Year 0 (Rs/kWh)	3.658

It is important to note that the maximum willingness to pay will not be affected by the changes in electricity tariffs over time. For this study, the maximum real willingness to pay is assumed to stay constant in real terms at its year 0 (1996 in this case) level. The average willingness to pay for each year of the project is calculated as the average of the maximum willingness to pay and the prevailing real tariff.

B. Project Benefits and Costs

The statements of economic benefits and costs for the project are shown in Table 30. The economic cost of capital for India used to discount the statements of economic benefits and costs is estimated to be 10.86%.

C. Results

The economic appraisal of the SPPL project is based on the total investment real cash flow from the IPP point of view adjusted for the economic costs and values of all the items and discounted at the economic discount rate.

The economic NPV of the project is 5,042 million Rs. It should be noted that the incremental economic NPV for the project is understated as the benefits from the elimination of the deterred demand are not included.

Table 30: Economic Cash Flow Statement

Year		CF	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	NPV																				
Receipts																					
Sales	**17,242**		0	1,189	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	2,410	0
Change in Accounts Receivable	**(439)**	1.000	0	(64)	(189)	(122)	(31)	(28)	(105)	(36)	(47)	(38)	9	(4)	(29)	(30)	(30)	(29)	(28)	(17)	286
Transfer Price	**267**	1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,710
Liquidation Values	**0**		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Land	**0**	1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Civil Work	**0**	0.836	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mechanical Work	**0**	0.900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electrical Work	**0**	0.900	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other EPC	**0**	1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other Investments	**0**	1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Inflows	**17,070**		**0**	**1,125**	**2,221**	**2,288**	**2,379**	**2,382**	**2,305**	**2,374**	**2,363**	**2,372**	**2,419**	**2,406**	**2,381**	**2,380**	**2,380**	**2,381**	**2,382**	**2,393**	**1,996**
Expenditures																					
Investment Costs																					
Land	**7**	1.000	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
EPC Cost																					
Civil Works	**59**	0.836	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mechanical Works	**1,759**	0.900	925	925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Electrical Works	**76**	0.900	40	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Miscellaneous	**117**	0.900	61	61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Development Cost	**136**	1.000	136	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Financial Charges																					
Pre-operative Expenses	**45**	0.900	45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vehicle, Office, Apparatus	**16**	0.900	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency for EPC	**104**	0.900	55	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cost Overrun	**0**	1.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Operation Costs																					
Fixed Costs																					
O & M Expenses	**433**	0.861	0	30	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	0
Salaries	**85**	0.955	0	6	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	0
Variable Costs																					
Naphtha	**6,711**	0.959	0	463	938	938	938	938	938	938	938	938	938	938	938	938	938	938	938	938	0
Change in Accounts Payable	**(106)**	1.000	0	(40)	(45)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	(8)	74
Change in Cash Balance	**9**	1.000	0	3	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	(6)
Income Tax	**0**	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transmission & Distribution Costs	**2,578**	0.911	0	178	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	0
Total Outflows	**12,028**		**1,344**	**1,720**	**1,329**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**1,364**	**68**
Net Cash Flow	**5,042**		**(1,344)**	**(596)**	**892**	**924**	**1,015**	**1,018**	**942**	**1,010**	**999**	**1,009**	**1,055**	**1,042**	**1,018**	**1,017**	**1,017**	**1,018**	**1,018**	**1,030**	**1,928**

Economic NPV @ EOCK 10.86% = 5,042 **Financial NPV @ EOCK = 418**

VIII. SENSITIVITY AND RISK ANALYSES OF ECONOMIC APPRAISAL

A. Sensitivity Analysis

A sensitivity analysis is conducted on the economic NPV of the project. The variables tested are similar to those for the financial sensitivity analysis except for those contract items that would not affect the economic value of the project. The sensitivity of the economic NPV to the own-generated power cost is added . The results of the sensitivity analysis are given below.

1. Domestic Inflation

Table 31: Effect Of Domestic Inflation On The Project's Economic NPV

Domestic Inflation	NPV Economic (million Rs)
6%	3,310
8%	4,046
10.25%	5,042
12%	5,962
14%	7,210
16%	8,709
18%	10,516

A higher rate of domestic inflation will increase the economic NPV only slightly.

2. Real Exchange Rate

Real Exchange Rate's Impact on Economic NPV

Table 32: Effect Of Average Real Exchange Rate On Economic NPV

Appreciation / Depreciation Factor	NPV Economic (million Rs)
80%	6,693
90%	5,867
100%	5,042
110%	4,217
120%	3,392
130%	2,567

The economic NPV is highly sensitive to real exchange rate. A real devaluation of the exchange rate will cause the economic NPV to fall because of the greater cost of fuel (naphtha) price, which is based on the import price of fuel, and the higher repayment of the foreign loans.

3. Fuel Cost

Table 33: Effect Of Fuel Cost On The Project's Economic NPV

Fuel Cost	NPV Economic (million Rs)
-20%	6,433
-10%	5,737
0%	5,042
10%	4,347
20%	3,652
30%	2,957

Economic NPV is quite sensitive to fuel costs: the higher the real fuel cost the lower is the economic NPV.

4. Cost Overruns

Table 34: Effect Of Cost Overrun On The Project's Economic NPV

Cost Overrun	NPV Project (million Rs)
-20%	5,375
-10%	5,209
0%	5,042
10%	4,876
20%	4,709
30%	4,543

The economic NPV is sensitive to cost overruns but the likely cost overruns will be small relative to the size of the economic NPV.

5. Actual Plant Load Factor

Table 35: Effect Of Actual Plant Load Factor on the Project's Economic NPV

Actual Plant Load Factor	NPV Economic (IPP Responsible) (million Rs)	NPV Economic (Utility Responsible) (million Rs)
40%	1,091	1,047
50%	2,007	1,976
60%	2,920	2,905
70%	3,834	3,834
83%	5,042	5,042
90%	5,693	5,693
100%	6,622	6,622

The economic NPV is very sensitive to Actual Plant Load Factor but remains in the positive range. This is because the economic value of the electricity of the project is high relative to the cost of the project.

6. Own-Generation Cost

Table 36: Effect Of Own-Generation Cost Factor On The Project's Economic NPV

Own-Generation Cost Factor	NPV Economic (million Rs)
0.800	1,585
1.000	3,314
1.200	5,042
1.400	6,771
1.600	8,500
1.800	10,228

The economic NPV is very sensitive to the own-generation cost factor[29], which determines the maximum willingness to pay for electricity. The lower the own-generation cost factor means the lower is the willingness to pay for power and hence the lower is the economic

[29] The own-generation cost factor is defined as a multiplier of the own-generation cost for use in the sensitivity analysis.

NPV. However, the economic NPV remains within the positive range despite the wide range of the own-generation cost factor values.

B. Risk Analysis

Risk analysis was also applied to test how the economic return of the project responds to possible changes in inflation, exchange rate, fuel cost, cost overruns, actual plant load factor, and own-generation cost. The range limits and probability distributions of the risk variables are shown in Table 37.

Table 37: Range Values and Probability Distributions of Risk Variables

Risk Variable	Probability Distribution	Base Case Value	Range Value	Probability
1. Inflation Rate Disturbance	Step (Independent Yearly)	0%	-(50-100%) -(30-50%) -(10-30%) -(0-10%) 0-10% 10-30% 30-50% 50-100%	14% 14% 10% 12% 12% 10% 14% 14%
2. Real Exchange Rate Disturbance	Step (Independent, yearly)	0%	-20% to -10% 0% to -10% 0% to 10% 10% to 20% 20% to 30% 30% to 50%	30% 32% 10% 15% 12% 1%
3. Annual Fuel Cost Disturbance	Normal (Independent, yearly)	0%	-40% to -30% -30% to -20% -20% to -10% -10% to 0%% 0% to10% 10% to 20% 20% to-30% 30% to 40%	4% 13% 25% 16% 8% 8% 13% 13%
4. Investment Cost Overrun Factor	Step	0%	-10% to 0 0% +10% 10% to 20% 20% to 30%	67% 20% 9% 4%
5. Actual Plant Load Factor	Normal	70%	55% to 85%	Mean 70%, Standard Deviation 5%
6. Own-Generation Cost	Normal	0%	-25% to 25%	Mean 0, Standard Deviation 5%

Own-Generation Cost

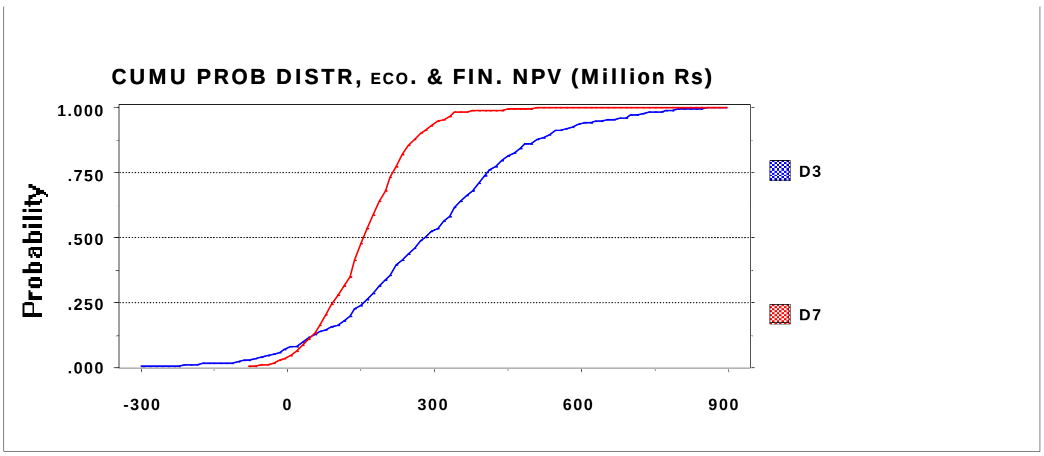
The economic value of shortage power depends on the estimate of own-generation cost of the cost of alternative power supply. The own-generation cost factor is used to adjust the own-generation cost up or down within a range of plus and minus 25% from its base-case value. A normal distribution with a mean of zero and a standard deviation of 5% is assumed for the own-generation cost.

Table 38: Risk Analysis Results: Economic NPV (million rupees)

	Base Case Value	Mean value	Standard deviation	Minimum value	Maximum value	Probability of negative return
Economic NPV	5,042	5,027	1,352	(672)	10,456	0.0%

The risk analysis (Table 38 and Figure 2) reveals that the expected value of economic NPV is quite substantial at 5,027 million rupees with no probability that it will be negative.

Figure 2: Cumulative Probability Distribution of Financial (IPP) and Economic NPV



IX. STAKEHOLDER ANALYSIS

A project generates externalities when its economic benefits and costs are different from its respective financial flows. The purpose of distributive analysis is to establish who is gaining or loosing from the implementation of the project.

The steps followed in distributive analysis are:

i) identification of externalities item by item by subtracting the financial from the economic flows,

ii) reduction of each item's flow of externality into a single figure by computing the net present value of each stream at the economic discount rate,

iii) allocation of externalities to various affected stakeholder groups in the economy.

A. Distribution of Externalities

The net present value, at the economic cost of capital, of the externalities generated by the project amounts to 7,202 million rupees. The analysis of the allocation of externalities, presented in Table 39, shows that the electricity consumers, government, IPP partners and workers would gain if the project were implemented. The utility would be the only loser in this project.

Table 39: Distribution Of Externalities

	NPV (million Rs)
Government	1,192
Consumers	5,931
Utility	(69)
IPP Domestic Partner	265
IPP Foreign Partner	398
Workers	78
Total	7,796

The electricity consumers would gain 5,931 million rupees which is a measurement of the willingness to pay by the consumers less the gross of tax power prices. The government would have a positive externality of about 1,192 million rupees due mainly to the taxes and duties on imported equipment and fuel. The workers would have a modest externality gain of 78 million rupees because of their employment by the project. The utility would lose 69 million rupees due to its “below-cost” tariff policy. The domestic partner of the IPP would gain 265 million rupees while the foreign partner would gain 398 million rupees.[30]

X. CONCLUSIONS

The main conclusions resulting from a detailed financial, economic, risk and distributive analyses of the project are the following:

1) The proposed project is an attractive project from the IPP point of view.

2) From the utility’s point of view, the proposed project is a mixed blessing. The utility will get the new power generation capacity it needs but it will also mean a further drain on its financial resources if the electric tariffs can’t be raised to cover the utility’s costs. The utility is caught between its duty to provide electricity to the citizens of the country and a further financial loss. Note that it is the financial difficulties of the utility that led to the solicitation of BOT projects in the first place. While a lower cost PPA or BOT deal will help, the government policy on electric tariff is ultimately responsible for the project’s financial impact on the utility in this case.

3) The main variables that affect the project's financial feasibility are the electric tariff, actual plant load factor and project cost. The risk analysis shows that the financial NPV from the IPP point of view has a relatively small chance (8%) of being negative, while the economic NPV has no probability (0%)of becoming negative. Of course, the primary risk of such a project is whether the State Electricity Board will be able to fulfill the terms of the agreement it is signing.

4) In terms of the distributive impact, the big winners will be the electricity consumers, the economy (the added production and employment by the commercial and industrial customers), the local and foreign IPP partners, and the government tax department.

[30] Externalities to the IPP partners are calculated as the extra return the partners in addition to the normal return which the IPP partners normally get from their best alternative projects. The externalities are equal to the financial NPVs of the partners evaluated at the economic discount rate.

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APPENDIX I RISK VARIABLES AND ASSUMPTIONS

Table 40: Assumptions of Risk Variables

Risk Variable	Probability Distribution	Base Case Value	Range Value	Probability
1. Inflation Rate Disturbance	Step (Independent Yearly)	0%	-(50-100%) -(30-50%) -(10-30%) -(0-10%) 0-10% 10-30% 30-50% 50-100%	14% 14% 10% 12% 12% 10% 14% 14%
2. Exchange Rate Disturbance	Step (Independent, yearly)	0%	-20% to -10% 0% to -10% 0% to 10% 10% to 20% 20% to 30% 30% to 50%	30% 32% 10% 15% 12% 1%
3. Annual Fuel Cost Disturbance	Step (Independent, yearly)	0%	-40% to -30% -30% to -20% -20% to -10% -10% to 0%% 0% to10% 10% to 20% 20% to-30% 30% to 40%	4% 13% 25% 17% 8% 8% 13% 13%
4. Investment Cost Overrun Factor	Step	0%	-10% to 0 0% +10% 10% to 20% 20% to 30%	67% 20% 9% 4%
5. Actual Plant Load Factor	Normal	70%	55% to 85%	Mean 70%, Standard Deviation 5%
6. Transfer Price Factor	Normal	1.0	0.5 to 1.5	Mean 1.0 Standard Deviation 0.2

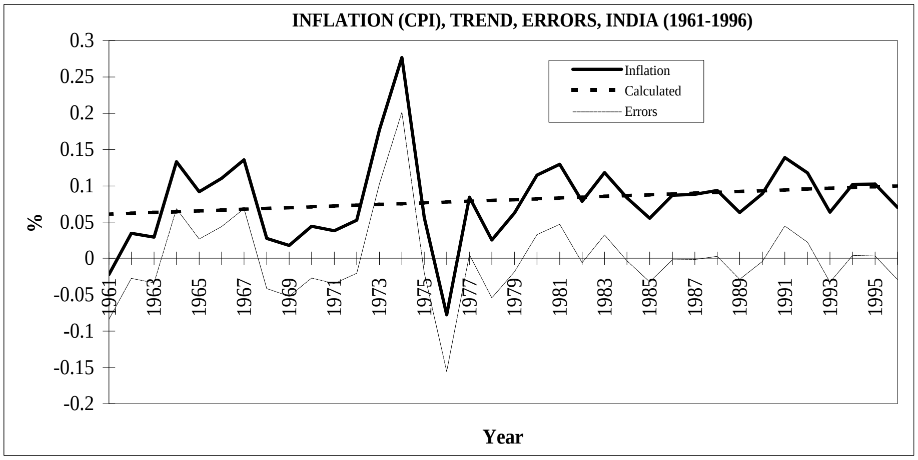
1. Inflation

The long-term general levels of inflation and exchange rate depend on the monetary, fiscal and trade policy of the government. The year to year changes of these inflation and exchange rate may be viewed as the combination of (1) the long-term general level with some uncertain fluctuations and (2) more random short-term influences. Making long range annual inflation and exchange rate forecasts must subject to both of these uncertainties. The country's political environment, government policy and international forces can not be predicted with precision. To the extent that we can in general assume that the general inflation and exchange rate levels can be more or less managed and that our present understanding of the economy is sufficient to control the economy within certain limits, the future general level of inflation and exchange rate may be restricted to a narrowed and more or less predictable range over time.

The inflation and exchange rate assumptions or forecasts used in project appraisal are submitted therefore to two risks: (1) the "general level risk" which has a narrower range of fluctuation and is more stable and "predictable", and (2) the "annual variation risk" which has a wider range of fluctuation due to more random factors.

As Figure 3 demonstrates, inflation in India fluctuates around the range of 5% to 15% . When a trend line is fitted to the annual rates of inflation for the 1961 to 1996 period, the trend line shows a moderate long-term upward trend – the long-term general level. When annual inflation rates are compared with the trend values, the "actual minus trend" values or the "annual disturbances" show remarkable symmetry around the trend line.

Figure 3: Inflation, Trend and Annual Disturbances in India



The probability distribution of the disturbances or errors based on historical data is given in Table 41.

Table 41: Probability Distribution for Annual Disturbances of Inflation

% Error (disturbances)	Frequency	Probability
-(50-100%)	6	17%
-(30-50%)	6	17%
-(10-30%)	4	11%
-(0-10%)	5	14%
0-10%	4	11%
10-30%	1	3%
30-50%	4	11%
50-100%	6	17%
Total	36	100%

A slightly modified probability distribution which will give a mean of 0% error is given in Table 42 and used in the risk analysis.

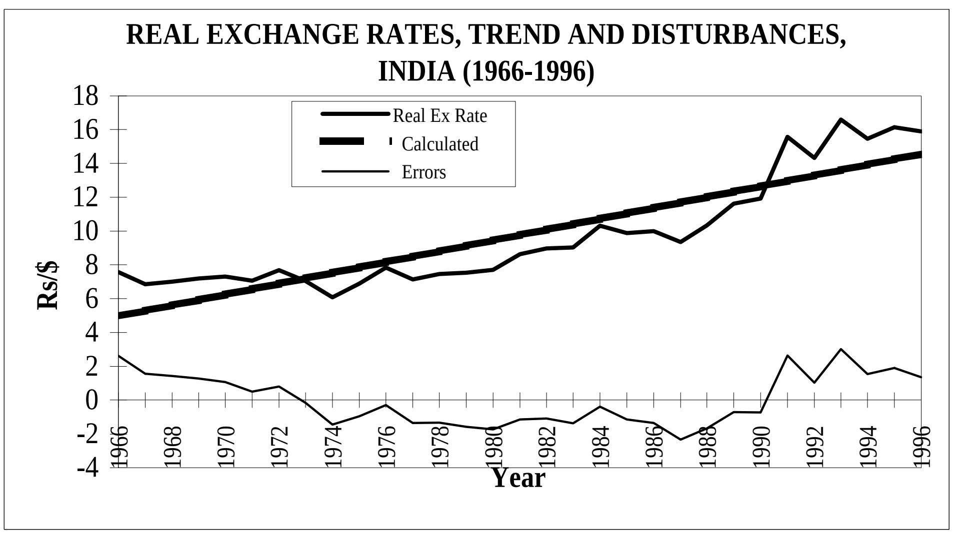
Table 42: Probability Distribution for Annual Disturbances of Inflation Used In Study

% Error (disturbances)	Probability
-(50-100%)	14%
-(30-50%)	14%
-(10-30%)	10%
-(0-10%)	12%
0-10%	12%
10-30%	10%
30-50%	14%
50-100%	14%
Total	100%

2. Foreign Exchange

Foreign exchange rates in India exhibits a slow rising trend (Figure 4). When a trend line is fitted to the annual rates of inflation for the 1966 to 1996 period, the trend line also shows a moderate long-term upward trend. [31] The "annual disturbances" indicate some symmetry around the trend line.

Figure 4: Real Exchange Rate, Trend and Annual Disturbances in India



[31] Real Exchange Rate = - 624.39 + 0.3201* Year $R^2 = 0.786$
(10.18) (10.34)

The probability distribution of the disturbances or errors based on historical data is given in Table 43.

Table 43: Probability Distribution for Annual Disturbances of Real Exchange Rate

% Error	Frequency	Probability
-20% to -10%	12	39%
0% to -10%	6	19%
0% to 10%	3	10%
10% to 20%	5	16%
20% to 30%	4	13%
3'0% to 50%	1	3%
Total	31	100%

The following probability distribution slightly modified to give a zero mean is used in the risk analysis.

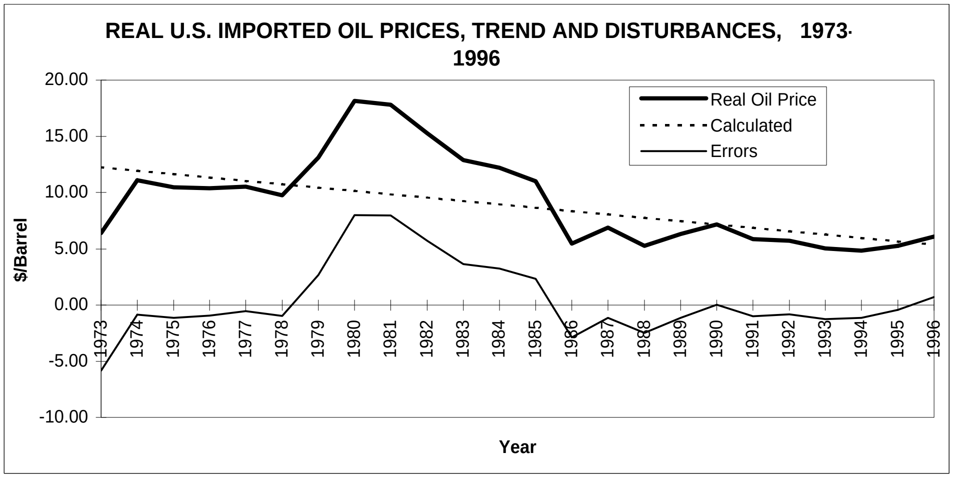
Table 44: Probability Distribution for Annual Disturbances of Real Exchange Rate Used in Study

% Error	Probability
-20% to -10%	30%
0% to -10%	32%
0% to 10%	10%
10% to 20%	15%
20% to 30%	12%
30% to 50%	1%
Total	100%

3. Fuel Cost

While the market power of OPEC cartel would seem to exert decisive influences on world oil prices at times, the true long-term forces that determine oil prices are really the demand and supply of oil. As can be seen in Figure 6 of world oil prices and their annual changes, the first oil price hike of 1974 is caused by the OPEC cartel, the second hike is caused by the Arab oil embargo, and a small hike in 1989 is due to the Middle-East war.

Figure 5: Real U.S. Import Oil Price, Trend, and Disturbances, 1973-1996



Following each price hike, the demand for oil adjusted and the oil price declined and stabilized. The long cycles of oil prices tend to reflect a recurrent pattern: " incident/price hike – demand adjustment – price decline – incident/price hike – demand adjustment …" Basically, the long run oil price level is determined mainly by demand and the availability of oil and production costs. The yearly ups and downs in oil prices are heavily affected by unpredictable near-random incidents such as wars in the Middle-East, OPEC decisions and weather conditions.

Over the 1975 to 1997 period, the changes in average nominal U.S. import price of crude oil has a mean growth rate of 9.4% and a standard deviation of 28.7%. The average compound growth rate of oil prices from 1975 to 1997 is 3.2%. While the nominal oil prices exhibit a small upward trend around 3% per year, the real oil prices shows no long term trend - the average compound growth rate of real oil prices from 1975 to 1996 is –0.23%.[32] Based on this historical background, a long-term growth rate of 0% for real oil prices is assumed in this study. Based on the actual values, the probability distribution of the % errors used in the study is given in Table 46.

[32] The mean growth rate of real oil prices is 2.6% with a standard deviation of 24.9%.

Table 45: Probability Distribution for Annual Disturbances of Real Oil Price

% Error	Frequency	Probability
-40 to -30	1	4%
-30 to -20	2	8%
-20 to -10	6	25%
-10 to 0	6	25%
0 to-10	1	4%
10 to 20	1	4%
20 to-30	3	13%
30 to 40	4	17%
Total	24	100%

Table 46: Probability Distribution for Annual Disturbances of Real Oil Price Used in Study

% Error	Probability
-40% to -30%	4%
-30% to -20%	13%
-20% to -10%	25%
-10% to 0%%	17%
0% to10%	8%
10% to 20%	8%
20% to-30%	13%
30% to 40%	13%
Total	100%

4. Investment Cost Overrun

Construction cost overruns are more or less expected in large capital projects. The scale of cost overruns varies from country to country, project to project and construction firm to construction firm. A step distribution given in Table 40, Assumptions of Risk Variables, above is used to represent the uncertainty of cost overruns.

5. Actual Plant Load Factor/Technical Risk

The actual energy delivered to the interconnection point depends on the plant's design and construction standards, and the IPP's capability and willingness to maintain and repair the plant and keep it in good running conditions. It also depends on the ability of the utility to take delivery of the power.[33] On the other hand, the expected demand for power or the demand

[33] This is submitted to system and transmission constraints.

projection made by the utility may not be realized.[34] This will also affect the actual plant load factor. Actual Plant Load Factor may therefore affected by random factors. A normal distribution which is given in Table 40 is therefore used.

6. Transfer Price

The transfer price of the power plant upon the consummation of the contract depends on the conditions of the plant at the time, the valuation of the plant by an independent evaluator, and the outcome of negotiation between the utility and the IPP. The final outcome is uncertain. A normal distribution given in Table 40 is used to represent this uncertainty.

APPENDIX II NOTES ON POWER PURCHASE AGREEMENT

The power purchase agreement (the PPA) signed between the Sendara Pradesh State Electricity Board (SPSEB) and Sendara Pradesh Power Partners Private Limited (SPPL) is based on a fixed return on equity (fixed ROE). Accordingly, SPPL is guaranteed a 16% return on the partners' equity. Whether this 16% ROE is real or nominal is usually not specified in a PPA. It is nevertheless a common practice to treat it as a nominal ROE. The real ROE will therefore depend on the rate of inflation. For example, if a domestic inflation of 8% were expected, as in our base case, then the underlying real ROE would be 7.41%. But if a domestic inflation of 3% were considered, the underlying real ROE would be 12.62%.

The contract ROE is only used as part of the PPA payment formula to calculate the fixed charge payment, it may or may not represent the true rate of return (ROR) to the IPP as the total fixed charge payment also includes a horde of other variables and formula as will be explained below. To determine the true ROR to the domestic and foreign equity owners we will have to look at their separate cash flow.

[34] This is the demand side quantity risk or demand risk.

The PPA payment formula consists basically of three parts: the fixed charge payment, the variable charge payment and the incentive payment.

A. Fixed Charge Payment

The fixed charge payment is the main component of the PPA through which the IPP recovers its capital investment costs as well as any other fixed charges. As noted in the discussions in the main text and the sensitivity analysis of this study, the timing of various payments (front-end-loading) can greatly affect the NPVs of the project. So is the possibility of overcompensation - items such as depreciation payment, special appropriation and transfer price can over compensate the investment cost, that is, the accumulated sum of these three items may exceed the initial investment cost. In principle, since the fixed charge payment has already included a payment on debt interest and a payment on the return on equity, the three items should be strictly for the recapturing of the initial investment cost plus a proper return to the IPP partners. This is an area that is quite often not clarified in most PPAs. Furthermore, the special appropriation formula used in this study causes the depreciation plus special appropriation payments to be highly front-end-loaded, resulting in 90%[35] of the investment cost being recaptured very early while the ROE payment continues through out the project life. Because of the timing and structuring of the various items of the fixed charge payment, the actual rate of return received by the IPP partners can only be determined through a proper cash flow analysis.

The different components of the fixed charge payment are:

Interest on Debt:

This is the interest portion of the loan repayments of the project.

Depreciation:

Depreciation payment is where the IPP are supposed to recover the investment costs or the principal of their loans plus their equity investment. The exact computation is given by the formula below.

[35] This percentage depends on the Residual Value Ratio.

Depreciation Payment ={ (Investment Cost) * (1 - Residual Value Ratio) }/(Number of Depreciation Periods)

The Depreciation Payment is subjected to a restriction explained in *Special Appropriation* below.

Return on Equity:

Each year, the utility will pay the IPP a fixed percentage, 16% in our case, on the total amount of the initial equity. For foreign equity, the return on equity is based on the 16% return on the initial dollar value of the foreign equity, repaid in Rupees based on the most recent exchange rate.

Interest on Working Capital:

The utility will pay the IPP for the interest on short-term loans taken out by the project to finance the working capital necessary for the operating of the project. Working capital includes fuel cost for one month, thirty days of fuel stock, one month of O & M expenses, and accounts receivable equal two months of average billing.[36]

O & M and Insurance Expenses:

Operations and maintenance plus insurance expenses are assumed to be equal to 2.5% of capital cost adjusted each year for inflation. The actual O&M plus insurance of SPPL may be more or less than this presumed amount. In practice, this is an item that should be verified by the utility. [37]

Taxes on Income:

Corporate income taxes paid by SPPL are also covered by the utility. This is a feature to ensure a net of tax ROE to the equity holders.[38]

Special Appropriation:

Special Appropriation is a payment made by the utility to the IPP whenever the depreciation payment is less than the loan repayment subjected to the restriction that the

[36] These items may change from case to case and may be negotiable. Two months of average billing is the amount of receivable based on the quarterly billing period.

[37] In this study, the O&M plus insurance in the project cash flow is nevertheless assumed to be the same as the amount specified in the contract.

accumulated sum of the special appropriation payments plus depreciation payments must not exceed the investment cost less the residual value reservation. Once the accumulated sum reaches the value equal to [(1-Residual Value Ratio)*Investment Cost], both the depreciation and the special appropriation payments are reduced to zero.[39]

B. Variable Charge Payment

The variable charge payment compensates SPPL for the fuel cost, which is the main variable input used in the generation of electricity. The variable charge payment formula is simply a computational formula. While the formula itself may or may not be negotiable, it is essential to be able to verify such values as heat rate of electricity and calorific value of fuel. The following are the components of the variable charge payment computation formula:

Actual Energy (AE_m):

Metered at the Interconnection Point, it does not include the auxiliary consumption used to run the plant.

Fuel Cost (RFC_m):

Fuel cost per kilogram in local currency, gross of tax, transportation, handling and insurance costs.

Unit Heat Rate (UHR_u):

Unit Heat Rate (UHR_u) in kilocalories per kilowatt-hour for a unit u, is the number of BTUs required to produce one kilowatt hour of electricity. In our base case, the UHR is assumed to be 2,000 kilocalories per kilowatt-hour.

Gross Calorific Value of Fuel ($GCVF_u$):

Gross Calorific Value of Fuel in kilocalories per kilogram. In our base case, the GCVF is assumed to be 11,200 kilocalories per kilogram.

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[38] In this study, however, there is a five-year tax holiday, followed by five additional years with a corporate income tax rate of 30% before the actual 46% rate comes into place.

[39] See main document for more details.

Auxiliary Consumption (AC):

The auxiliary power consumption by the plant is defined as a percentage of the total amount of electricity generated.

Variable Charge Payment:

Variable Charge Payment = $[(RFC_m / GCVF_u) * UHR_u * AE_m] / (1-AC)$

C. Incentive Payment

This is a component of the PPA subject to negotiations. The incentive payment is based on the "above average performance of the plant". The various components of the incentive payment formula are as follow:

Normative PLF:

The Normative PLF (NPLF) is the typical PLF for a given type of power plant according to the operating conditions in that particular country and location. In our base case, the NPLF is set at 68.49% which is specified by the Indian Government PPA directives.

Calculated PLF in billing period:

The calculated PLF in a billing period is defined as:

CPLF = (actual energy + deemed generation) / (installed capacity * number of hours in the billing period).

Deemed Generation:

It is the amount of energy that the plant is capable of generating, which is not delivered to the buyer for various reasons. It is defined as:

Deemed Generation = (declared availability * hours in period) – actual energy metered.

Declared Availability:

It is the generating capacity of the plant notified by the IPP to the buyer utility from time to time. It is expressed in megawatts net of auxiliary consumption. Misdeclaration is subject to penalty in order to discourage frauds. The penalty formula for misdeclaration may vary from case to case. For example it may be defined as "For the misdeclared billing period, Declared Availability shall be immediately reduced for the seven days after discovery, any payable amount related to the Billing Period should be reduced or returned accordingly." Or it may be defined as "Hand back the recent availability payments, or alternatively, the IPP will in the future receive incentive payments only for availability that has been demonstrated by actually produced output."

Incentive Points:

This is one of negotiable variables on the PPA payment. It is defined as a percentage (of equity value). Our base case assumes that the incentive points is 0.7%.

Incentive Payment:

The incentive payment is calculated by the following formula:

Incentive Payment = Equity * (Calculated PLF – Normative PLF) * 0.7% * (days in billing period/365)

D. Concluding Note

Because of the complexity of a PPA, it is impossible to know the true rate of return of the project to the IPP partners without going through a thorough NPV cash flow analysis. The first challenge to the evaluation of a PPA is therefore finding the true rate of return. The remaining challenge is to determine a proper rate of return which corresponds to the risks of the project and is acceptable to all parties of the BOT deal.