The Power Purchase Agreement (PPA) Between Dabhol Power Company and Maharashtra State Electricity Board: *The Structure and its Techno-Economic Implications*

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Introduction

In the debate over techno-economic aspects of the Enron controversy, at every stage, a barrage of new information, arguments, and allegations is being fired by both sides. To help resolve the ensuing confusion, an in-depth study of the original documents is mandatory. Among various documents, the power purchase agreement (PPA) is the heart of any independent power project (IPP). It guarantees market for power produced by the IPP and the tariff at which it would be sold to the purchaser. The PPA creates legal obligation on both the parties to perform the previously accepted tasks in a predetermined manner.

This paper presents an analysis of the PPA between Dabhol Power Company (DPC), the Enron subsidiary handling Dabhol project, and Maharashtra State Electricity Board (MSEB). The analysis is carried out in the techno-economic perspective and does not deal with issues like environmental and legal. The purpose of the analysis is to clarify the structure of the PPA and its techno - economic implications and to make an attempt to evolve a methodology to analyse such issues. Apart from the PPA, the analysis draws information from other publicly available documents and communications with MSEB. The first three sections in this paper elaborate various aspects of the structure of the PPA, while the later four sections deal with the important techno-economic implications.

Since, a lot has been written and talked about the DPC project, a certain level of knowledge of terms and issues is assumed. To limit length and reduce complexity of the paper, the paper is focused only on the first phase of the project with 695 MW capacity and using distillate oil as fuel.

1.0 Salient Facts About the PPA Between DPC and MSEB

This section describes some important facts about DPC and PPA in order to clarify some of the misconceptions:

The DPC plant is a build-own-operate (BOO) type of plant. The PPA between DPC and MSEB was signed on 8th December 1993 and was later amended on 2nd February 1995. The PPA assures DPC that MSEB will buy power from DPC for 20 years and make payments at the negotiated tariff. After expiry of the contract, MSEB has an option of buying the plant from DPC. The method of computing the cost is not fully spelt out in the PPA.

The PPA assures MSEB that DPC will construct this 695 MW (625 MW base and 70 MW peaking) plant in 33 months after the financial closure. The financial closure was effected on 1st March 1995. DPC assures 90% availability of the plant. For calculating tariff, a minimum efficiency of 44.9% for the base load plant and 28.1% for the peaking plant will be considered.

The cost of fuel will be passed on to MSEB. Enron Fuels International has been appointed as the fuel manager, and will be responsible for identifying the least cost fuel supplier. It will be paid $ 2.5 million per year by MSEB, through DPC, for doing this. MSEB can exercise control on this process and DPC will need MSEB's approval for these purchase contracts.

All contracts during the construction period also need to be approved by MSEB. However, MSEB is allowed to object only if plant specifications are materially (from safety or economic point of view) harmful to its interests.

The PPA does not specify capital cost of the project. Change in capital cost (either decrease or increase) will not be passed on to MSEB. But change in costs due to change in customs duty and other taxes will be passed on to MSEB. The new Government of India (GOI) guidelines (which assure 16% return on equity etc.) are not applicable to the DPC project and in this case tariff is based on negotiated values agreed mutually by the DPC and the MSEB. Hence, the economic analysis of the PPA and comparison of DPC's expected profit with that of GOI guidelines become essential.

2.0 Analysis of DPC's Performance Guarantees and Related Penalties.

One of the main planks of pro-Enron argument is a set of various performance guarantees from the DPC and the related penalties it has agreed to pay in case of default. As per the PPA, DPC will pay penalties for the late completion of plant, shortfall in capacity, and efficiency lower than the agreed value. Additional penalties are applicable in case the plant availability falls below 90%. This section lists and analyses these guarantees and related penalties. Table 1 shows the payment by DPC to MSEB and by DPC's contractors to DPC in case of failure to give specified performance. It must be noted that the agreed parameters, when these penalties become applicable are different for DPC and it's contractors.

The implications of these penalties are given in the next few sections.

Table 1: Penalties for DPC and Contractors for failure to meet agreed parameters.

Parameter	DPC pays MSEB	Contractors pay DPC
1) Delay in construction		
a) Upto six months	$ 14,000/day	$ 250,000/day
b) After six months	$ 110,000/day	$ 340,000/day
2) Shortfall in capacity	$ 100/kW	$ 1,892/kW

2.1 Guarantee Against Delay in Construction

DPC assures plant construction within 33 months. If the plant construction is delayed beyond 33 months, for first 6 months of delay, DPC will pay $14,000 /day (Rs 0.64/kW/day) to MSEB. After first 6 months, the penalty will be increased to $ 110,000 /day (Rs 5/kW/day). This is on the lower side of the range (Rs 5 to 7 /kW/day) prescribed by Vanguard Capital, the consultant to Government of India (GOI) (Vanguard Capital, 1994). On the other hand, as per the construction contract signed by DPC with Bechtel and General Electric (called contractor), DPC will receive much larger penalties from the contractor. The contractor assures construction in 33 months, and for the delay up to 6 months, contractor will pay $250,000 /day to DPC and there after $340,000 /day (IDBI, 1994). In effect, DPC will retain nearly, $230,000 per day after paying penalty to MSEB. This sum, of $230,000 is sufficient for DPC to meet the daily interest payment on all debt and allows an additional margin of Rs. 13 lakh per day for other expenditures. In effect, in case of delay, DPC pays nothing from its pocket, neither as interest on loans nor as the much talked about penalties to MSEB. Contractor's willingness to assure such heavy penalties to DPC also indicates that guarantee for constructing such plant in 33 months does not involve a big risk.

2.2 Guarantee Against Shortfall in Capacity

Between DPC and MSEB, the plant will be considered commissioned only if it can operate at a minimum of 80% of the nominal capacity (i.e. 80% of 695 MW = 556 MW). In case, the commissioned capacity is more than 80% of nominal capacity but less than the nominal capacity (695 MW), DPC is allowed to make rectifications in the plant, within 12 months, to raise the capacity up to 695 MW. If it fails to do so even after 12 months, DPC pays $ 100 /kW of capacity shortfall. This is nearly half of the penalty amount ($ 185 to 200 /kW) prescribed by Vanguard Capital in such cases.

As per the PPA (Schedule 1), the capacity being built at Dabhol is not 695 MW but 725 MW (4.4% more than 695). DPC will not accept the plant from its contractor if the capacity is below 695 MW. And the penalties for delayed construction (described above) will apply to the contractor. If plant can produce between 696 MW and 725 MW, DPC will accept the plant, but the contractor will be expected to make modifications in the plant to raise capacity to 725 MW. In this period, DPC will receive Rs 28 /kW/day for the short-fall below 725 MW.

If the contractor fails to deliver 725 MW, DPC gets $ 1,892 per kW of capacity shortage. It can be recalled that DPC pays only $100 per kW as penalty to MSEB (for shortfall below 695 MW). In effect, DPC earns Rs 6 crore per MW of the shortfall (below 725) but pays MSEB only Rs 0.32 crore/MW of shortfall below 695.

If, for example, the final capacity is only 700 MW, then DPC will receive $ 21,860 per day from the contractor and, further, in case of failure of the contractor to upgrade capacity to 725 MW, DPC will also receive $ 47.3 million. However, DPC will not pay anything to MSEB on this account. Rather DPC has an option of selling this additional 5 MW to MSEB as described later. In such cases, DPC make profits and not losses!

2.3 Guarantee for Heat Rate

The GE (General Electric) equipment is said to be very efficient (ET, March 23,95). The GE guarantees DPC a maximum heat rate of 7,460 Btu/kWh[1], called Guaranteed HR, i.e. an efficiency of 45.7%. If the heat rate is more, the contractor will pay DPC $ 121,000 per Btu/kWh of the increase. However, DPC, in turn, promises MSEB a heat rate of 7605 - 145 Btu/kWh higher than what GE has promissed. If the heat rate is lower than 7605, then DPC gets a bonus for this. On the other hand, if the heat rate increases beyond 7605, DPC will absorb the incremental fuel cost. But gets a handsom compensation from the contractor. Thus, by guaranteeing a lower value of HR, DPC assures itself a bonus for its normally expected performance.

DPC may argue that over the years with continuous usage, the plant efficiency drops and the heat rate increases and, hence, DPC's assured maximum heat rate of 7605 for the contract period of 20 years is a reasonable offer. However, if a sharp rise in the heat rate is expected, DPC could have assured an increasing heat rate over the project period instead of the flat one it has assured now.

2.4 Assured Plant Availability

If the plant availability is below 90%, DPC will give a rebate to MSEB. For availability in the range of 86 to 90%, the capacity payments will decrease proportionally. In other words for each percent point decrease, the yearly capacity charges reduce by $ 2.2 million. But if availability is even lower than 86%, the decrease in capacity charge will be at double that rate, i.e. $ 4.4 million per year per percent decrease.

But an availability of 90% for gas turbines is an international norm and not something extraordinary. In addition, according to the DPC's arguments, its actual installed capacity being higher than 695 MW (725 MW), the effective availability it is promising on 725 MW is much lower than 90%, which could be easily achieved. (IDBI, 1994)

To sum up, the said commendable performance being assured by DPC needs to be viewed critically because: (a) In many cases, DPC assures a performance (plant capacity and efficiency for example) that is lower than what is achievable in the worst case. Thus, even if plant performs as expected, DPC automatically gets a bonus for "good" performance; (b) Further, the so-called "stiff penalties" that DPC is said to have promised to MSEB are negligible compared to those it is getting from its contractor. Thus, DPC has thoroughly sheltered itself from any risk burden. Rather, it has manoeuvred itself in such an enviable position that, in many cases, it stands to gain even if it fails to attain the performance standards.

3.0 Tariff Structure

The price of electricity from DPC is often quoted as Rs 2.4 /kWh. Many attempts have been made to compare this price with that of all other projects across the board. Before going into such comparisons, we need to understand that DPC tariff is not one fixed number. Rather, it is highly sensitive to many factors, and is expected to increase at a steep rate in future. For most power projects of SEBs in India, the tariff usually decreases or increases marginally with passage of time (due to increase in fuel and O&M costs) . To understand this crucial difference and its implications, it is essential to carry out a detailed analysis of the two-part tariff structure in the PPA comprising capacity and energy charges.

This tariff structure described in PPA is depicted in a simpler form in figure 1. The numbers in parentheses indicate the share of that component in the total tariff for the base case defined later.

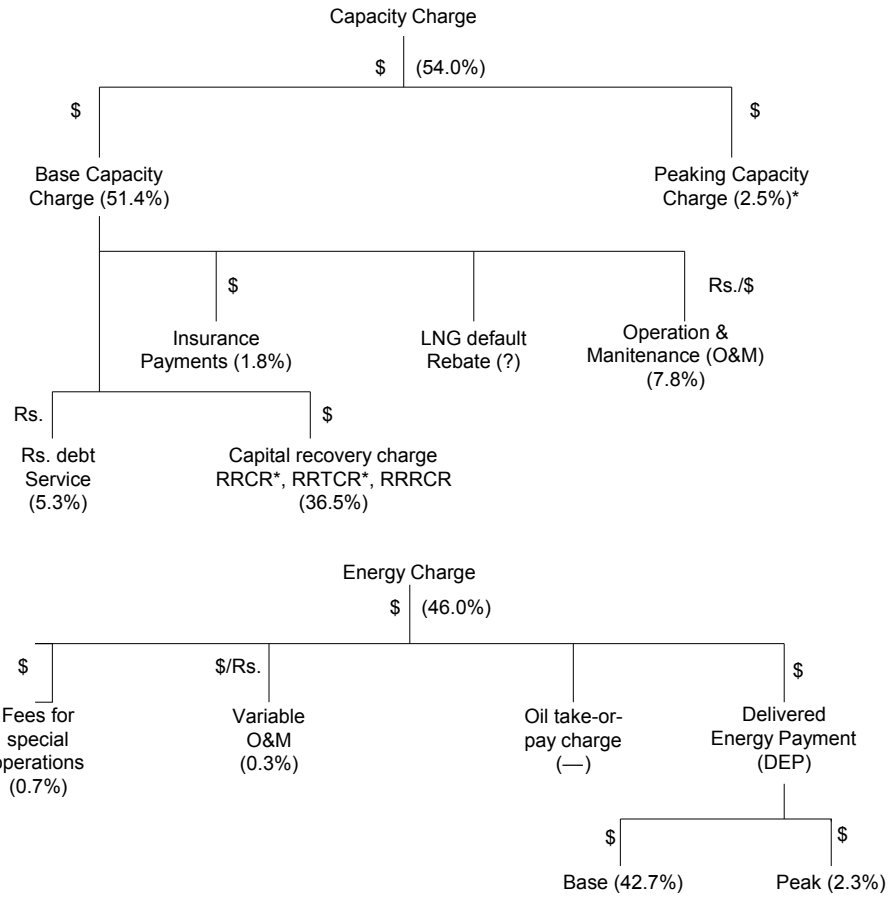
3.1 Capacity charge

3.1.1 Components of Capacity Charge

Capacity charge, the first component of the tariff, can be understood to be similar to 'rent'. It is applicable in full, if plant availability (for generation) of 90% is achieved. However, it should be noted that, it is in no way related to the PLF (which is a measure of the extent to which the plant actually produces electricity).

[1] The heat rates are based on higher heating values and are defined for exportable energy. The heat rate is defined as the fuel required to produce one kWh of electricity therefore higher the heat rate, lower the efficiency.

Figure 1: Structure of DPC tariff



Note : The values in parentheses indicate the share of that component in total payment of Rs. 1299 crore in 1997. This calculation for base case defined in the text assumes 90% PLF of base capacity (625 MW) and 27% PLF of peaking capacity (70 MW)

- $ and Rs. symbols indicate the predominant currency in which payment will be denominated
- * indicates a 4 % back loading (an increase of 4 % p.a.)

Capacity charge includes various fixed charges such as: (i)Capital repayment (denominated in $ and Rs.): This single largest component of capacity charge, includes debt service and return on equity. The debt service of loan in Rupees is separately identified, while the rest of capital repayment is in dollar. The dollar component of capital repayment is back loaded by 4% (increases 4% p.a.); (ii) Fixed operation and maintenance (O&M) charge (in $ and Rs); (iii) Insurance fees (in $): The insurance and O&M payments are indexed to the inflation (US or Indian inflation, as per the denominated currency); and (iv) An undefined quantity of rebate applicable in case of default by LNG (liquefied natural gas) supplier. The LNG default rebate is defined for sharing risk of LNG unavailability, but it was undecided (up till February. 95) when PPA was amended.

3.1.2 Basis for Capacity Charge Calculations

Capacity charge is defined in terms of a combination of Rs. and $ /kW/hr. The 'kW' refers to the kw of 'Rated Plant Capacity', and the 'hr' are 8760 in a year irrespective of the PLF. The capacity rating is done

yearly through a capacity test. Provisions for revising the value of 'Rated Plant Capacity' are specified in the PPA: (i) In case of frequent and serious forced outages, the rated capacity is to be revised through repeated capacity tests; and (ii) The Rated Capacity could be revised voluntarily by DPC, in case of DPC's failure to make full Rated Capacity available for generation for 6 consecutive months, and if DPC sees no chances of improvement in next six months.

The capacity charges will be calculated hourly and paid in monthly instalments. If plant capacity exceeds 695 MW (as expected), MSEB has option, at the beginning of each year, to either buy or reject that extra capacity. If MSEB rejects it for the year, this additional capacity will not be available to MSEB during the year even in case of a dire need. If MSEB decides to buy this additional capacity, MSEB will make corresponding additional capacity payments to DPC. An important point to be noted is that the additional capacity carries same charge as that of the first 695 MW. In fact, this should have been substantially lower, as DPC is installing this additional capacity in the said capital cost of 2912 crore and will not be spending anything more for this purpose.

If the DPC plant runs as expected, the added 9 MW base and 20 MW peaking capacity will fetch DPC an additional revenue of nearly $ 5.8 million /yr. (which would provide an additional 2% return on equity). Power plant capacity derates as time passes, but the possibility of derating by more than 5% is small. And as in the case of heat rate, this could have been accommodated simply by DPC assuring only 695 MW but offering additional capacity, if available, at a nominal charge.

3.1.3 Adjustments to Capacity charges

3.1.3.1 Adjustments Due To the External Factors

The major chunk of DPC's profit accrues from capacity charges. These charges are adjusted for a host of variables, such as, (i) possibility of customs and sales tax exemption, (ii) change in corporate tax (income tax), (iii) $/Rs rate fluctuations, (iv) change in government regulation / law regarding maintaining dividend reserve, (v) any other change in law/regulation that would alter DPC's costs or require DPC to alter its business practices. The charges are adjusted (presumably) to maintain DPC's profits in case of a change in above variables. Some important implications of these adjustments are as follows:

If DPC was granted customs and sales tax exemptions, the capital repayment charge would have reduced by 14.23%. In 1997, this reduction would have been $ 23.9 million. Due to decrease in corporate tax from 57.5% to 46%, the tariff has declined. This decline will materialise only after the 8^{th} year.

While signing PPA, the terms of IDBI loan to DPC were not decided. The calculations assumed interest on Indian loan at 20% p.a. In case the interest rate is actually lower, it would save money, as is the case (IDBI interest rate on DPC loan is 17.5%). This saving is not being passed on to MSEB, but is taken off by DPC and that too in dollars (implying a protection against exchange rate). With the result, that lower the IDBI interest rate, more is the direct profit to DPC.

Ten and half years after commissioning of phase I, the 4% yearly increase in the capital repayment will cease, if GOI does not require DPC to maintain a 'dividend reserve' for paying dividends (i.e. if GOI does not block DPC's money in banks). The capital repayment charge will then start declining at 0.42% p.a. Communication from MSEB indicates that MSEB assumes that such reduction in tariff will be applicable (MSEB, 1995).

But, it is not clear whether the GOI exempted DPC from this reserve or DPC unilaterally decided to provide this concession. This rebate has been considered in our calculations to arrive at the 'conservative' estimate.

3.1.3.2 Availability/Performance Related Adjustments

Before going into the availability rebate and bonus, we need to understand how availability is defined. DPC makes an hourly declaration of available capacity. This 'Declared Capacity' is considered to be actually available (available capacity, AC) unless DPC fails to meet MSEB's hourly supply instructions (called dispatch instructions). If DPC can supply 95% or more than 95% of MSEB's instructions, the generation level achieved is considered to be the 'Available Capacity' (AC). But when supply is below 95%, DPC has to prove that such a shortfall occurred despite its best efforts and was unaware that such situation could occur. If DPC fails to prove this, it is considered as 'False Declaration', and the penalty is to reduce the AC achieved in past few days.

The 'Average Availability' in any period is the ratio of average AC to the rated capacity. In effect, the 'False Declaration' or a supply lower than MSEB's instruction can lead to decreased availability. And if this results in availability lower than the assured, DPC pays a penalty. If this average availability falls

below the target value (i.e. 86 and 92% for monsoon and rest of the year respectively), capacity charges are reduced. The amount of reduction is already discussed in section 2.4.

In the PPA, there is provision for bonus for higher hourly capacity utilisation. The GOI guidelines do not allow such bonus. The DPC-MSEB agreement does not follow GOI guidelines. Bonus is defined for peak hours (16 hours) in the peaking season (8 months). This bonus is for hourly 'capacity utilisation' in excess of target availability (TA) and is defined by a complex equation. The maximum value of this expression, with present clauses, can be 0.2 to 0.5% of the yearly capacity charges. So, the purpose of such a complex equation is unclear.

3.2 Energy Payments

The second component of the two part tariff is the sum of energy charges. This represents the variable charges and is nearly proportional to the PLF. It consist of: (i) Payment for fuel consumed (or deemed to have been consumed) called 'delivered energy payments' (DEP); (ii) Variable O&M charge; (iii) Take-or-pay charges for fuel supplies; and (iv) Special operation fees.

The first part, DEP, is the largest (about 97%) of the energy payments, and is later dealt in detail. The variable O&M charges, which are small, are specified separately in $/kWh and in Rs/kWh, and are indexed to US and Indian inflations respectively. If the fuel purchase agreement between DPC and the fuel supplier is of 'Take-or-Pay' nature and if MSEB does not operate the power plant for sufficient duration so as to consume the 'Minimum Take' quantity of fuel, then the charges to be paid to the fuel supplier will be reimbursed by MSEB. MSEB would approve the fuel purchase agreement. Whether the fuel purchase agreement has been signed and if so, what are its terms is not clear as yet.

3.2.1 Delivered Energy Payments

The delivered energy payment (DEP), i.e. the fuel charge, is separately accounted for the base and peaking capacity. The duration of operation of base and peaking plant are, in turn, decided by MSEB's dispatch instructions.

3.2.1.1 Delivered Energy Payments for Peaking Energy

For the peaking plant of 70 MW, a fixed heat rate of 12,150 Btu/kWh (i.e. 28.1% efficiency) has been agreed. Fuel consumed for peaking operation is simply calculated by multiplying this fixed heat rate with the net energy delivered by the peaking plant. This fuel consumption together with price of fuel gives the DEPpeak:

DEPpeak = Price of fuel x fuel consumed.

3.2.1.2 Delivered Energy Payments for Base Load Plant

For 625 MW base load capacity, a maximum heat rate of 7605 (minimum efficiency of 44.9%) will be considered for the payments to DPC. The expected heat rate is lower as described in section 2.3. After commissioning, heat rate will be tested (TestHR). The heat rate used for calculating fuel consumed, or deemed to have been consumed is called ContractHR and is estimated as follows:

ContractHR = 7605-max [1.03x(3/4)x(GuaranteedHR-TestHR), 0]

where, GuaranteedHR is the heat rate guaranteed by contractors to DPC (7243 Btu/kWh-gross).

This implies that, DPC assures a maximum HR of 7605, but if the operating HR is lower, DPC will not pass the full benefit to MSEB. The 25% of the difference will be passed on to DPC as bonus. In the normal operating situation (GuaranteedHR=TestHR), DPC will get a benefit equivalent to 144 Btu/kWh of base generation. At oil price of $4.63/Btu, this will be Rs. 0.0216/kWh. At 90% PLF, this is nearly $ 3.3 million per year (equivalent to return on equity of 1.24%).

The GE turbines (frame 9FA), that are being used by the DPC, are said to have a 4% higher efficiency than the smaller turbines manufactured by BHEL (frame 9E). However, the savings achieved due to this higher efficiency are taken away by DPC without even acknowledging it as 'bonus'.

Adjustments to Contract Heat Rate : If the operating efficiency of the base load plant changes, DPC can intimate MSEB and the Contract HR will be recalculated through an efficiency test. The Contract HR discussed above, is defined for the full load operation at the system frequency of 50 hz. As operating conditions change from time to time, the Contract HR will be adjusted for load and frequency. This adjested heat rate will be higher, and will be calculated on an hourly basis. This will be used for payment calculations.

3.2.2 Special Operation Fees

In addition to the above charges, MSEB pays fees to DPC for some special operations. The special operation fees include: (i) Fuel management fee of $ 2.5 million per year, increasing at the US rate of inflation. This fee was widely criticised on the grounds that obtaining fuel is part of the plant operation and, hence, should be covered in O&M charges. (ii) Fees in case MSEB unnecessarily undertakes the capacity test. If DPC proves that capacity test was not needed MSEB pays $ 50,000 (iii) Fees for hot and cold starts.

3.2.3. Relation between Hot and Cold Start Fee And PLF

The PPA allows MSEB to shut off one of the two gas turbines of DPC plant. This can reduce plant output by a half. Restarting this GT implies a hot or a cold start (depending on the duration of shut down). The hot start fees (applicable for shutdown of less than 12 hours) are $ 10,429 for 9FA GT and $ 5,015 for steam turbine. Such starts would become regular features, if MSEB uses DPC plant as an intermediate load plant in order to make optimum usage of its own cheap coal plants. In this case, hot and cold start fees would be as much as $ 3 million per year, with some addition to DPC profits. Closing the GT can reduce plant output by half (i.e. by 312.5 MW) making the cost of reducing output equal to Rs 1.07/kW. This cost can be justified only if MSEB saves more than these fees by running its cheaper coal plants. Considering (fuel) cost of coal at Rs. 0.7 /kWh in 1997, and that of DPC at Rs 1.01/kWh, savings will only start accruing if the 9FA turbine is closed for more than 3.5 hours. For medium load operation, closing down one GT should be possible for 9 to 10 hours. In such a case, savings for first 3.5 hours are used up for paying hot start fees, in effect DPC eats away 35 to 45% of the MSEB savings . Thus, even though technically MSEB is allowed to partially back-down the DPC plant, these fees act as a major barrier.

4.0 The Price of Electricity From DPC

The DPC tariff is primarily dependent on three factors: the Rs/$ exchange rate, oil price, and plant load factor (PLF). The change in corporate tax rate, exemption of customs and sales tax and exemption to DPC from maintaining dividend reserve will also affect tariff in a significant way. But, the Indian and US inflation have little direct effect on the tariff.

4.1 Base Case Definition

The most talked about case of 90% PLF, with some additional assumptions, is defined here as the base case. The assumptions are:

i) Inflation rate of 8% p.a. in India and 4% p.a. in USA.
ii) No change in Real oil price. In the last few years, international oil prices have dropped (in real $). But for long term planning, the major international utility planning manuals assume a significant increase in oil prices (increase at 2 to 4% p.a. in real $).
iii) Rs depreciate at 4% p.a. in relation to the US $. Historically Rs has depreciated at a minimum rate of 4.5% p.a. and a maximum of more than 8% p.a.
iv) 90% PLF for base capacity and 27% for peaking capacity,
v) The dividend reserve rebate is applicable from the 11th year, i.e. the capital recovery charges decrease at the rate of 0.42% p.a.

4.2 Estimate of DPC Tariff and Its Components

The DPC tariff is applicable at the door of DPC. MSEB is responsible for transmitting and distributing this power, and will bear the associated costs and losses. For the base case, this tariff in 1997 will be Rs.2.5/kWh, implying a total payment of Rs 1,240 crore ($ 387 million) in 1997. Figure 2 shows total yearly payments by MSEB to DPC for base case scenario and if the oil price (real) decreases at 2% p.a. About 5% of this payment is in Rupees and rest in Dollar terms. The contribution to total tariff from various components is shown in figure 1.

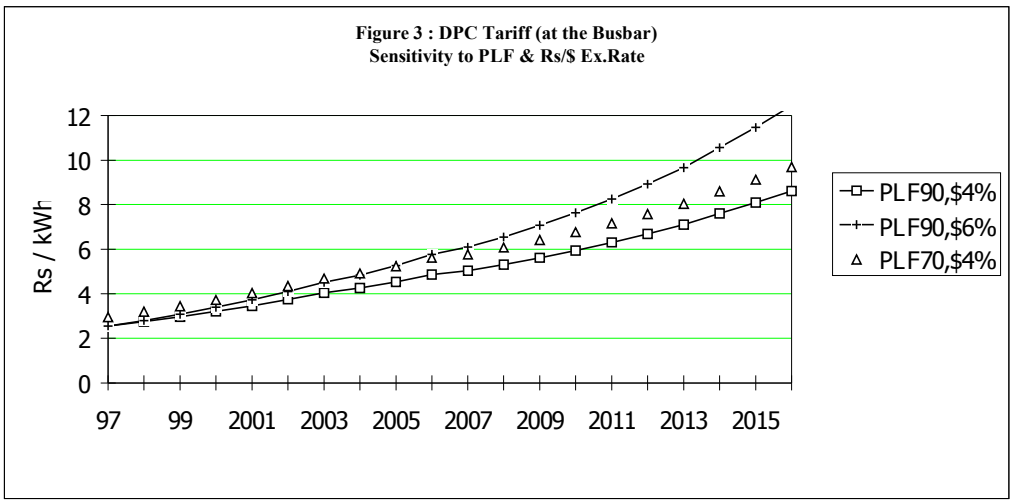
For calculating MSEB's effective cost for supplying DPC's power to average consumer, we need to consider T&D cost, T&D losses, and other expenses incurred by MSEB. T&D losses of 10% is assumed. As a conservative estimate, the total downstream costs of T&D network strengthening, metering, billing etc. is considered at 60 paisa/kWh, (constant for 20 years). The electricity duty levied by Government of Maharashtra (GOM) is expected to be around 25 paisa/kWh in 1997 which is assumed to increase with Indian inflation. Hence, in 1997, the total cost to MSEB for supplying DPC's power to the average consumer would be about Rs 3.57/kWh.

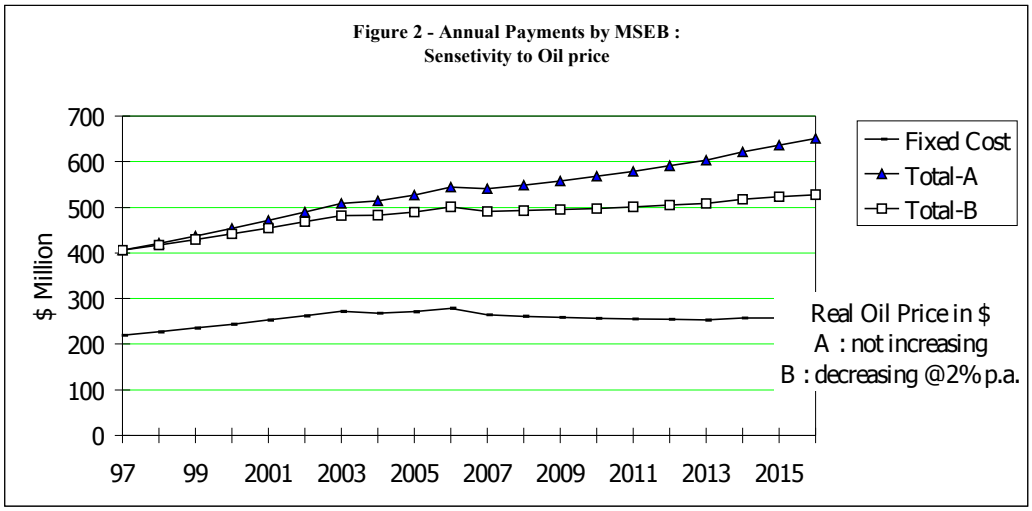
4.3 Sensitivity to PLF and $/Rs. Exchange Rate

In general, the combined cycle gas turbines (CCGT) are not economical for base load operation as their fuel cost (oil in this case) is far more than that of coal plants. This is also true in the case of the DPC 's plant. It is estimated that, barring a transitional period of the next few years, it will be economical for MSEB to use DPC's base capacity at a PLF of 65 to 70%. The peaking plant, of 70 MW, is likely to be used at 27% PLF. The most likely scenario, a PLF of 70% for base and 27% for peaking plant, is taken here as the second case for sensitivity analysis.

Figure 3 shows yearly tariff at DPC busbar for base case (called 90- busbar) and for the second case (called 70-busbar).

It is assumed that the Rs would depreciate at 4% p.a. relative to the US $. If the exchange rate variation is different from this, it will directly affect the tariff as more than 95% of the tariff is denominated in dollars.





4.4 Representative Price of Electricity From DPC

As mentioned earlier, usually the cost of electricity from power plants does not increase throughout its economic life, (except for changes in fuel price) as it does in the case of DPC. The capacity charge in the DPC tariff has an in-built increase of 4% p.a. Hence, it is inappropriate to directly compare the said DPC tariff of Rs 2.4 /kWh, in 1997 with the cost of generation from other projects. Only the tariff over the full life-time of the project can be compared. This life-time (levelised) tariff, for DPC plant is Rs.4.18/kWh, for 70% PLF scenario[2]. This is the most representative price of electricity from DPC, and can be used for comparison. For the base case, this levalised tariff is Rs 3.63/kWh. This tariff is later compared to that of alternative plants.

Table 2 indicates the sensitivity of tariff to the major variables. The values indicate the levelised tariff in nominal Rs. Assumptions are same as those of the base case.

Table 2: Tariff Sensitivity to Oil price, Rs/$ rate and PLF

	90% PLF	**70% PLF**
$ 4%, Oil -2%	3.44	3.99
$ 4%, Oil 0%	3.63*	4.18
$ 6%, Oil 0%	4.06	4.68

Note : $ 4% = $ appreciate w.r.t. Rs @ 4% p.a.
Oil 0% = Real oil price increase is 0% p.a. etc.
* = base case scenario.

5.0 Estimating Profitability of DPC

In this section, DPC's profitability is estimated for the base case specified earlier. The financial assumptions used are specified in the Annexure. DPC's profitability is calculated by deducting the DPC's payments from its revenue as defined below.

Major income for DPC comes from : (i) capital repayment charges (RRCC), Rupee debt repayment (RCR), indirect bonus for heat rate lower than heat rate assured by DPC to MSEB. While the DPC's payments are: (i) debt repayments and (ii) applicable corporate tax.

Figure 4 shows the debt repayment and applicable tax (superimposed on the debt repayment). Difference between these values (which is shaded) shows DPC profits. For a better picture of DPC's profitability, the yearly changing profits are converted to a stream of constant profits (levelised profits). This profit is equivalent to little over 40% of 'return on equity' (as defined by GOI). If the GOI guidelines were adopted DPC would have been allowed to receive a maximum of 31% return on equity.

5.1 IRR Estimation

DPC's profitability in terms of internal rate of return (real, post tax IRR in $) is estimated to be around 28%. This IRR does not include possible hidden profits to DPC such as: (i) through sale of additional capacity to MSEB, (as much as 2% on the equity), (ii) construction profits, as obtained by ENRON in Teesside plant, UK (Enron, 1992) (iii) through use of plant infrastructure for other commercial activities, (iv) Availability bonus, etc.

A report by Vanguard Capital submitted to the GOI says that, after considering the perceived high business risk in India, foreign investors would expect an IRR of about 17 to 21% (post tax, real $). This IRR assumes no hidden benefits. Using this estimate (IRR of 19%), MSEB will be paying $ 200 million extra to DPC over the 20 year period (1996 NPV).

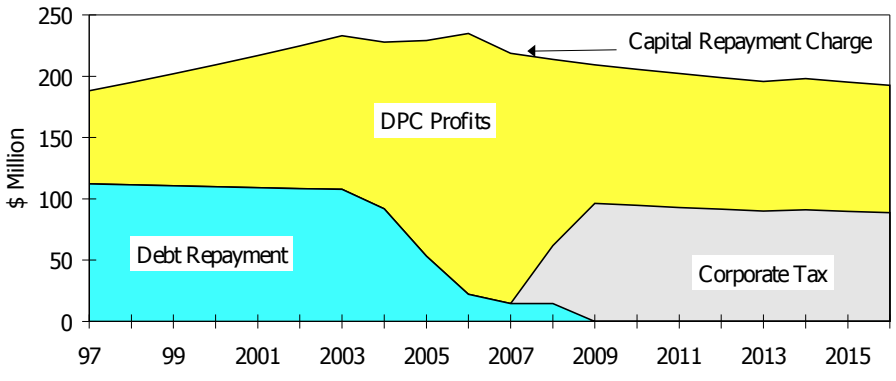
6.0 Whether DPC Project Makes Economic Sense for MSEB

Usually, in India, cost of generation from a new power plant is higher than the existing average tariff. The average tariff reflects the historical average cost of generation. The difference between this average cost of generation from all plants and the higher cost of new plant can be considered as the loss to the SEB owing to this new plant. Usually, the cost of generation from any plant does not increase rapidly. But the average tariff, keeps increasing due to addition of new plants, increasing T&D costs etc. Hence,

[2] Throughout the analysis the levelised costs and the net present values are calculated using a discount rate of 12% p.a.; i.e. nominal discount rate of 17% for US dollar streams and 21% for Rupee streams.

SEBs make losses in the initial years of operation of a power plant. But, with passage of time, the losses decrease and eventually SEBs start making profits from selling power from the said plant.

Figure 4 : Estimation of Direct Profit to DPC.



In this light, MSEB should take up any project only if MSEB expects profit in the life-time of the project. The same logic should have been applied in the case of the DPC proposal. As expected, in this case too MSEB would make huge losses by selling DPC power in the initial 7 to 8 years. Later, if MSEB's tariffs increase adequately, MSEB would start making profits through the sale of DPC power. The concept of net-present-value (NPV), is used to define profitability.

As mentioned earlier, unlike most projects, the DPC tariff is expected to increase rapidly with time. For the base case scenario defined earlier, DPC tariff increases from Rs 2.55/kWh in 1997 to Rs. 8.6 /kWh in 2016. The effective cost of DPC power by the time it reaches the average consumer, would be Rs. 3.6 /kWh and Rs. 11/ kWh for the respective years (a levelised cost of Rs. 4.88/kWh) for the base scenario.

The average tariff of MSEB is expected to be around Rs 2.2/kWh in 1997. Based on this, an estimate could be made of the rate at which MSEB tariff should be increased so that MSEB makes a net profit (a positive NPV) on account of DPC in the lifetime of the project.

For the base-case scenario, it has been estimated that, MSEB can make profits from DPC plant only if it's average tariff increases at a rate higher than 15.5% p.a. (This can be compared to the average tariff increase of MSEB, in last decade, of about 12% p.a.). Hence, DPC project makes economic sense to MSEB only if the average tariff increase is more than 15.5% p.a. for the next two decades. This would result in a tariff of over Rs. 30/kWh in 2016 (an increase of 7.1% p.a. in real terms, and a tariff in 2016 of Rs 8.1/kWh in the constant 1997 Rs.). Even in most favourable case of Rs. depreciation by 2% p.a. and real oil price decrease by 2% p.a. MSEB tariff will have to be increased by over 6% p.a. (real). In this case the tariff by 2016 will be Rs. 6.6/KWh (1997 Rs.) If the increase in tariff is not so sharp, DPC project will result in net losses to the MSEB.

In the likely case (of 70% PLF, no real increase in oil price), MSEB can make profit on DPC project only if MSEB's tariff increases at a rate of 17.25% p.a.!

7.0 How Much in Excess are We Paying

The LNG/oil fired base load plant is not an economical option for the power sector. In fact, the Least cost plan for the state of Maharashtra indicates very substantial savings if we adopt options different from such plants (Sant, Dixit 1994). But for the time being, it is assumed that projects such as DPC are inevitable. This section quantifies the excess payment by MSEB on account of DPC's high capital cost and high profitability.

1) Some experts have argued that a plant similar to that of DPC (inclusive of the infrastructure costs) can be built with much lesser capital. The figures of Rs. 3 to 3.75 crore per MW are claimed and supported by these experts against the estimated capital cost of 4.19 crore /MW of the DPC project.
2) An IRR of 19% is considered as reasonable against the estimated IRR of DPC is over 28% (post tax, real, in US $).

Table 3 shows the excess payments by MSEB, if reduction in capital cost and the IRR is achieved. This is expressed in two ways: (a) the yearly saving in crore Rs. (the levalised savings). This can be compared to the levelised capacity payment of Rs. 950 crore to DPC. and (b) in terms of one time saving (1996 NPV). This can be compared to the capital cost of the project, around Rs 2910 crore.

Table 3: Excess payments by MSEB

Capital cost (Rs. Crore/MW)	**3.0**	**3.75**
Yearly excess payment (Rs. Cr./Yr.)	290	225
One-time excess payment (Rs. Cr.)	1,350	1,050

Note: The reduction in corporate tax for the alternate plant, as compared to that of DPC is ignored.

The levelised tariff for the alternative plant (capital cost of Rs 3.75/MW, and IRR of 19%) is compared with the levelised tariff of DPC, for two assumptions. The values below are in nominal Rs.

Table 4: Comparison of the Levelised Tariff of DPC and the Alternative Plant.

	DPC	**Alternative Plant 3.75 Cr./MW**	**3 Cr./MW**
Base Case PLF 90%	3.63	3.19	3.0
Second Case PLF 70%	4.18	3.62	3.45

Conclusion

This paper demonstrates following important results:

(i) Various performance guarantees from DPC and related penalties it has assured do not constitute any substantial burden on the DPC. On the contrary, DPC would receive bonuses even for its ordinarily expected performance.

(ii) The levelized tariff for DPC's electricity varies from Rs. 3.44 / kWh to Rs. 4.68 / kWh depending upon the changes in oil prices, PLF, and Rs./$ exchange rate.

(iii) DPC's profitability (estimated at a real, post tax, IRR of 28%) is quite high compared to that prescribed by GOI consultants (17% to 21%).

(iv) MSEB ends up paying about Rs. 225 crore extra each year if the effects of higher capital cost and higher profitability are considered.

(v) The DPC project would be viable for MSEB only if MSEB's average tariff keeps increasing at a rate more than 15.5% p.a. for the next two decades. This tariff rise is more than that of the last decade.

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Annexure

Financial assumptions for DPC profitability estimation :

It has been assumed that 5% of DPC equity is brought in the initial year and loan equivalent to 95% of equity (with 12% interest in US $) is brought in the next year. This loan is later replaced by real equity before commissioning.

The financing package of DPC has been assumed as follows; the interest indicated is the effective interest rate, and the term indicates repayment period after construction.

	Million $	Interest % (p.a.)	Term (Yr.)
Total Cost	910.0	—	—
Equity Capital	266.2	—	—
Indian Loan	95.6	17.5%	9.5
US Exim Loan	298.2	8.4%	8.5
OPIC	100.0	10.0%	12.0
Other $ loans	150.0	11.0%	7.5

This article was published in the Economic and Political Weekly (June 17, 1995; Vol XXX, No 24).