Technical Consulting on Assessment of Block Wise Price of Run of Mine Coal for Captive Coal Blocks Offered for Reallocation in India

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Financial Model for Lifetime & Risk Analysis of to be Allocated Coal Blocks

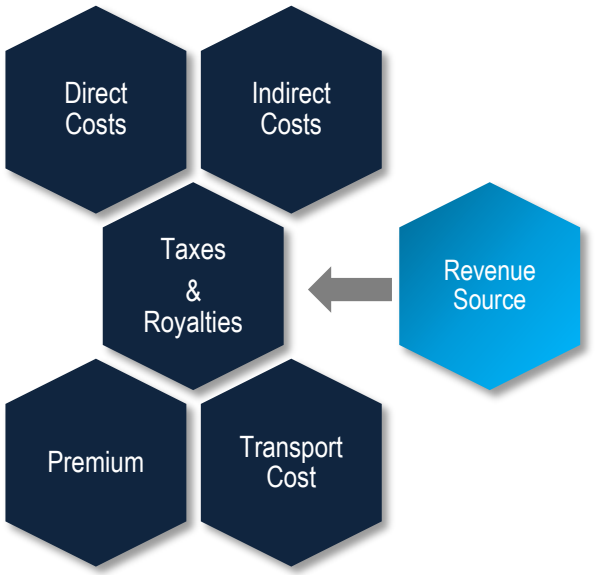
Financial Model of Coal Blocks for Power Sector

The CBV Spreadsheet for Calculating Per Unit Cost of Coal

This section the CBV spreadsheet financial model used to calculate the levelized average cost of coal with intermittent components in case of captive mining as per the end use of coal for the life of mine (LoM). The philosophy and methodology behind levelized cost of coal per unit for life of mine has been detailed along with the discounting factors. It is obvious that only a limited number of parameters can be included in any general model and that a number of factors that have not been taken into account may and do have an influence on the final coal costs. A number of additional specific methodological points, which bear on issues outside the actual calculations of the spreadsheet model used for the calculations of revenue generated and cash flows for respective end use of the coal block i.e. power plant, steel plant and cement plant etc. There are certain intermittent cost components and source of revenue for the coal block which compose the levelized cost of coal per unit which are highlighted as under in Exhibit 01

Exhibit 01: Cost Components for Mining Coal from a Captive Mine

INFOGRAPHIC



Source: enincon research

Further, each cost component have sub-components which are detailed in the following sections with respective heads. Despite the shortcomings in the model the levelized cost of coal production per unit (kg.) would establish to be the most transparent consensus measure for the price valuation of the mine.

The calculation of the levelized cost per kg. of the coal is based on equivalence of the present value of the sum of discounted revenues and the present value of the sum of discounted costs. The LCOC is, in fact, equal to the present value of the sum of discounted costs divided by total production adjusted for its economic time value. Another way of looking at LCOC is that it is equal to the price for output (coal in our case) that would equalize the two discounted cash-flows.

In other words, if the coal price is equal to the levelized average lifetime costs, an investor would precisely break even on the project. This equivalence of coal prices and LCOC is based on two important assumptions:

- ✓ The interest rate ***"r"*** used for discounting both costs and benefits is stable and does not vary during the lifetime of the project under consideration. In keeping with tradition, we have assumed 12 % discount rate.

- ✓ The coal price ***"PCoal"*** is stable and does not change during the lifetime of the project.

The actual equations should clarify these relationships. With annual discounting, the LCOC calculation begins with equation (1) expressing the equality between the present value of the sum of discounted revenues and the present value of the sum of discounted costs. The subscript ***"t"*** denotes the year in which the sale of production or the cost disbursement takes place. All variables are real and thus net of inflation.

On the left-hand side one finds the discounted sum of all benefits and on the right-hand side the discounted sum of all costs. The different variables indicate:

$Coal_t$: *The amount of coal produced in a year* ***"t";***
P_{Coal} : *The constant price of coal ;*
(1+r)^-t: *The discount factor for the year* ***"t";***
Direct $Cost_t$: *Direct Cost for the year* ***"t" (D_c)***
Indirect $Cost_t$: *Indirect Cost for the year* ***"t" (I_c)***
T&R_t : *Taxes & Royalties for the year* ***"t" (T_{rt})***
Transportation $Cost_t$: *Transportation Cost for the year* ***"t" (T_c)***
Coal Block Bidding $Cost_t$: *Coal bidding cost paid as premium over cost of coal*

$$\Sigma_t (P_{Coal} * (1+r)^{-t}) = \Sigma t((D_c + I_c + T_{rt} + T_c + C_b)*(1+r)^{-t}) \quad (1).$$

From (1) it follows that;

$$P_{Coal} = \Sigma t((D_c + I_c + T_{rt} + T_c + C_b)*(1+r)^{-t})) / \Sigma_t ((1+r)^{-t}) \quad (2).$$

which is, of course, equivalent to

"Formula (2)' is the in effect formula which is utilized to calculate the levelized cost of coal (LCOC) for the life of mine (LOM) on the basis of direct costs, indirect costs, taxes & royalties levied, transportation cost and coal block bidding cost"

The appropriateness of dividing each year's output in the denominator by the discount factor (1+r)^t corresponding to any given year needs to be highlighted. The reason is easy to see.

Equation (2)' seems to discount each year's physical value of output measured in **kg** by the exponentially rising time preference factor (1+r)^t. Discounting physical values, however, does not seem to make intuitive sense, since physical units neither change magnitude over time, nor do they pay interest. This intuition, however, needs to be qualified.

While it is true that a **kg of coal** does not pay interest, its only economic function is to produce a revenue stream that does pay interest. From today's point of view, a **kg** produced this year thus does not have the same economic value as does a **kg** produced next year. What
is discounted is the value of output, that is the physical production times its price ***PCoal*** ,in the
above formula, and not output itself. It is only after mathematical transformation that it appears as if physical production was discounted.

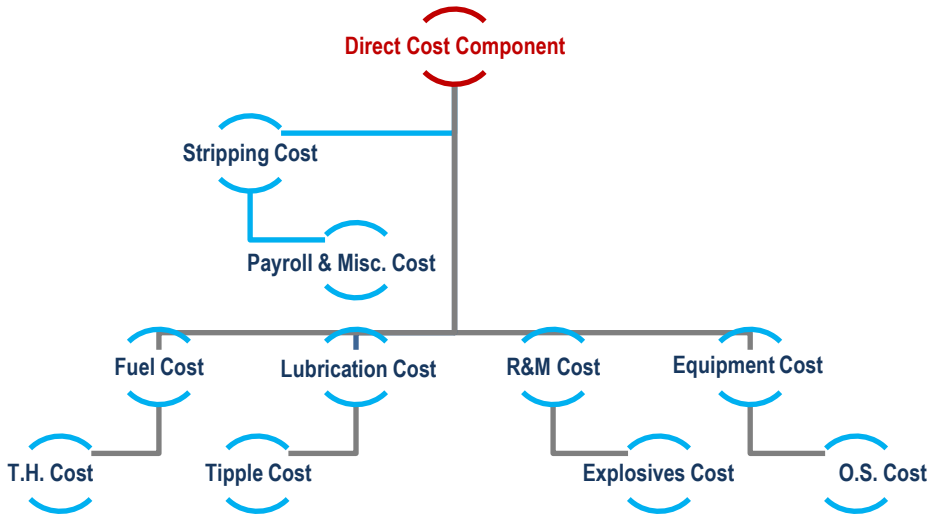
The simple conclusion which can be drawn that the operation that seems to discount physical output is the result of the necessary discounting of the monetary value of output, i.e. its price. This substitution of physical output for its economic value (price) is possible because the nominal, undiscounted price stays the same throughout the operating lifetime of the plant. The correct time value of the annual revenue flow is now obtained by adjusting output rather than price with the correct discount factor. In fact it is not output per se that is discounted but its economic value, which is, of course, standard procedure in cost-benefit accounting. The different cost components which form the part of ***PCoal*** are elaborated in the following sections.

Direct Cost

The direct cost of coal will constitute the major cost component of the price per unit of the coal which on year to year basis and is composed following components as indicated in Exhibit 02.

Exhibit 02:Direct Cost Components for Mining Coal from a Captive Mine

INFOGRAPHIC



Source: enincon research

For the direct cost subscript *"t"* denotes the year in which the sale of production or the cost disbursement takes place. On the left-hand side one finds the discounted sum of all benefits and on the right-hand side the discounted sum of all costs which constitutes direct costs. The different variables indicate:

Coal$_t$: *The amount of coal produced in a year "t";*
(1+r)^-t: *The discount factor for the year "t";*
Direct Cost$_t$: *Direct Cost for the year "t" (D_c)*
Stripping Cost$_t$: *Stripping Cost for the year "t" (S_c)*
Payroll$_t$: *Payroll for the year "t" (P_{rt})*
Fuel Cost$_t$: *Taxes & Royalties for the year "t" (F_c)*
Lubrication Cost$_t$: *Lubrication Cost for the year "t" (L_b)*
R&M Cost$_t$: *R&M Cost for the year "t" (R_m)*
Equipment Cost$_t$: *Equipment Cost for the year "t" (E_c)*
Truck Haulage Cost$_t$: *Truck Haulage Cost for the year "t" (T_h)*
Tipple Cost$_t$: *Tipple Cost for the year "t" (T_p)*
Explosives Cost$_t$: *Explosives Cost for the year "t" (E_x)*
Operating Supplies Cost$_t$: *Operating Supplies Cost for the year "t" (O_s)*
Miscellaneous Cost$_t$: *Miscellaneous Cost for the year "t" (M_c)*

$$\Sigma_t (D_c * (1+r)^{-t}) = \Sigma_t ((S_c + P_{rt} + F_c + L_b + R_m + E_c + T_h + T_p + E_x + O_s + M_c)*(1+r)^{-t}) \quad \textbf{(3).}$$

From (3) it follows that;

$$D_c = \Sigma_t ((S_c + P_{rt} + F_c + L_b + R_m + E_c + T_h + T_p + E_x + O_s + M_c)*(1+r)^{-t}))/\Sigma_t ((1+r)^{-t}) \quad \textbf{(4).}$$

"Formula (4) is the in effect formula which is utilized to calculate the levelized direct cost of coal for the life of mine (LOM) on the basis of different cost components listed above"

The intermittent cost are calculated on normative basis on year on year basis and the levelized against the discount rate as highlighted in the section for LCOC component. Also there are certain assumptions which are adapted to calculate the costs which compose the direct cost. The same is detailed in the sheets of coal block valuations for the respective blocks

Indirect Cost Components

The indirect cost of coal is the smaller component that constitute cost component of the price per unit of the coal which on year to year basis and is composed following components as indicated in Exhibit 03.

Exhibit 03: Indirect Cost Components for Mining Coal from a Captive Mine

INFOGRAPHIC

Source: enincon research

For the indirect cost subscript ***"t"*** denotes the year in which the sale of production or the cost disbursement takes place. On the left-hand side one finds the discounted sum of all benefits and on the right-hand side the discounted sum of all costs which constitutes indirect costs. The different variables indicate:

Coal$_t$: *The amount of coal produced in a year* ***"t";***
(1+r)^-t: *The discount factor for the year* ***"t";***
Indirect Cost$_t$: *Indirect Cost for the year* ***"t" (I_C)***
Development Amortization$_t$: *Development Amortization for the year* ***"t" (D_a)***

Capital Sparest : *Capital Spares for the year* ***"t" (Csp)***
Insurance Sparest : *Insurance Spares for the year* ***"t" (Isp)***

$\Sigma t\ (Ic * (1+r)^{-t}) = \Sigma t\ ((Da + Csp + Isp)*(1+r)^{-t})$ (5).

From (5) it follows that;

$Ic = \Sigma t\ ((Da + Csp + Isp)*(1+r)^{-t}))/\Sigma t\ ((1+r)^{-t})$ (6).

Taxes & Royalties (Trt)

The taxes and royalties component have many smaller components and for a country like India where in general the taxation structure is a concurrent subject with some components applicable for all states and some of them only find application with respect to that state. We have considered following components which would by and large compose the major portion of taxes and royalties and act as governing components:

Exhibit 04: Taxes and Royalties Components for Mining Coal from a Captive Mine

INFOGRAPHIC

Source: enincon research

For the taxes and royalties subscript ***"t"*** denotes the year in which the sale of production or the cost disbursement takes place. On the left-hand side one finds the discounted sum of all benefits and on the right-hand side the discounted sum of all costs which constitutes taxes and royalties costs. The different variables indicate:

Coal$_t$: *The amount of coal produced in a year* ***"t";***
(1+r)^-t: *The discount factor for the year* ***"t";***
Royalty$_t$: *Ad-valorem Royalty for the year* ***"t" (Av)***
Clean Energy Cesst : *Clean Energy Cess for the year* ***"t" (Ces)***
Stowing Cess Dutyt : *Stowing Cess Duty for the year* ***"t" (Scd)***
Excise Dutyt : *Excise Duty for the year* ***"t" (Ed)***
VATt : *VAT for the year* ***"t" (Vat)***

Σt (*TRc* * (1+r)^-t) = Σt ((*Av+Scd+Ed+Vat*)*(1+r)^-t) (7).

From (7) it follows that;

***TRc* = Σt ((*Av+Scd+Ed+Vat*)*(1+r)^-t))/Σt ((1+r)^-t) (8).**

"Formula (8) is the in effect formula which is utilized to calculate the levelized taxes and royalties of coal for the life of mine (LOM) on the basis of different cost components listed above"

Revenue Sourcing for Thermal Power Developers

The revenue source for captive coal block awarded to the thermal power plants as end user would be nothing but the power sales. It is quite difficult to generalize the amount of power sold from one power plant unless we have a log of exact installed capacity which would vary as per each unique project developer. Hence, it was a conscious effort to find out how much of coal is actually burnt achieve one unit of electricity factoring the efficiency of the power plant. The set of assumptions are shared as below in Exhibit 05

Exhibit 05: Set of Assumptions for Revenue Through Power Sales

TABULAR

S.No.	Set of Assumptions for Deriving Revenue
1.	Calorific Value of Coal is assumed between 3700 – 4400 kCal/Kg
2.	Units of Electricity Generated/Tonne of Coal – 1500 kWh
3.	Efficiency of Power Plant – 35%

Source: enincon research

The above Exhibit clearly signifies the role of efficiency of the power plant in terms of actual units of electricity being generated, which in this case reduces the energy content to produce lowered energy in terms of power.

Exhibit 06: Set of Assumptions for Revenue Through Iron and Steel Sales

TABULAR

S.No.	Set of Assumptions for Deriving Revenue
1.	800 kg of Coal utilised to produce 1000 kg of Steel
2.	Price per tonne of steel in India – INR. 40,000/ Tonne

Source: enincon research

Exhibit 07: Set of Assumptions for Revenue Through Cement Sales

TABULAR

S.No	Set of Assumptions for Deriving Revenue
1.	1000 kg of Coal utilised to produce 400 Tonnes of Cement
2.	Price per tonne of Cement in India – INR. 6000/ Tonne

Source: enincon research

Risk Analysis

Sensitivity Analysis for Open Cast Block: Power Sector

This section of the chapter deals with the sensitivity analysis of the captive coal block wherein the mining operations are carried on open cast method. There are three parameters namely operating cost, rate of production and capital expenditure which would govern the output cost of the coal at large and hence are considered most prone to the risks. These factors are put to variance using the discount factor of 12% . For an open cast mine we have considered an example of **Radhikapur (West) Coal Block** which has two components in mining i.e. open cast and under ground both.

For the open cast mine portion we have considered two cases upon which the parameters would be varied as highlighted in Exhibit 08 and Exhibit 09 respectively.

Exhibit 08: Sensitivity of NPV to Certain Parameters @ 12% Discount Rate for OC Operations – Case I

TABULAR

Parameter	Variation
Operating Cost	30% to -40%
Production	-40% to 30%
Capital Expenditure	30% to -40%

Source: enincon research

Apart from the above listed parameters the other LCOC driving parameters like transportation and tax components are not considered because these components apply only post production of the coal and not prior to that.

For the example considered i.e. the **Radhikapur (West) Coal Block** in case of open cast operations the LCOC which comes out for the life of mine is INR. 2.77/kg. Basis the LCOC the mentioned three parameters are varied as per Case I to obtain the variance and hence the sensitivity. The parametric variation as per Case I is depicted in Exhibit 09 for -40% to 30% variance.

*Exhibit 09: Variation in Parameters for Radhikapur West OC Coal Block – Case I**

TABULAR

CASE -I								
Operating Cost	**30%**	**20%**	**10%**	**0%**	**-10%**	**-20%**	**-30%**	**-40%**
INR per Kg	1.93	1.78	1.63	1.48	1.34	1.19	1.04	0.89
Final Price Per Kg (INR)	3.31	3.13	2.95	2.77	2.60	2.42	2.24	2.06
Production	**-40%**	**-30%**	**-20%**	**-10%**	**0%**	**10%**	**20%**	**30%**
MT	63.00	73.50	84.00	94.50	105.00	115.50	126.00	136.50
Final Price Per Kg (INR)	2.00	2.20	2.39	2.58	2.77	2.96	3.15	3.34
CAPEX	**30%**	**20%**	**10%**	**0%**	**-10%**	**-20%**	**-30%**	**-40%**
INR per Kg	0.60	0.55	0.51	0.46	0.42	0.37	0.32	0.28
Final Price Per Kg (INR)	2.91	2.87	2.82	2.77	2.73	2.68	2.64	2.59

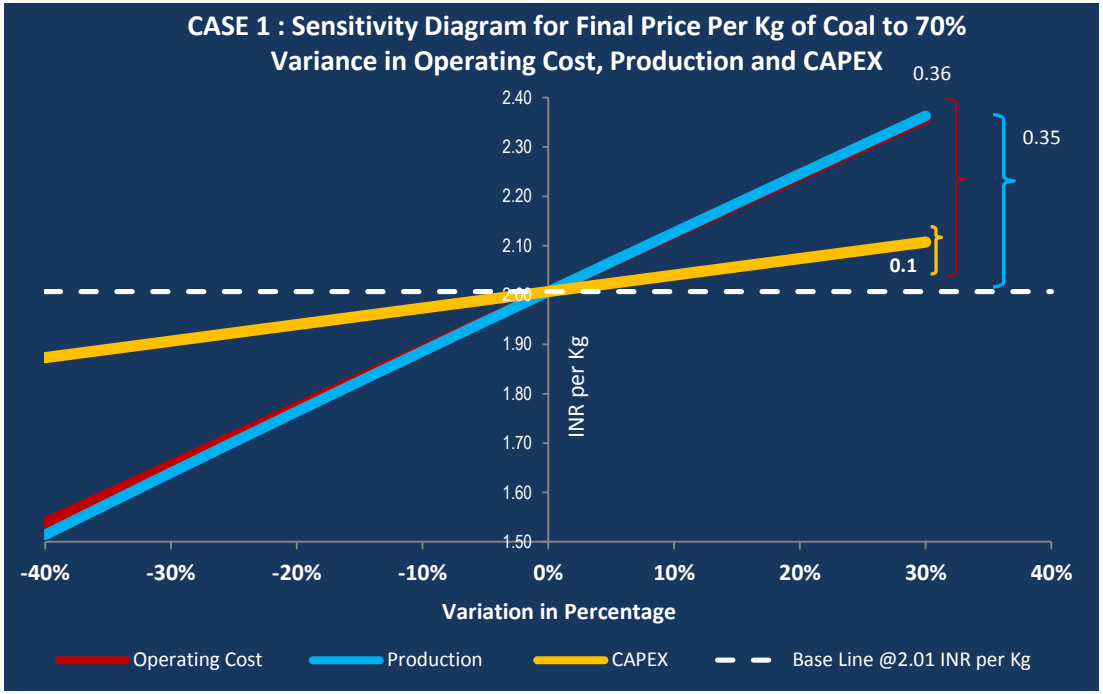
Source: enincon research & analysis

NOTE: All variations are considered for Case I Variation and is according to the calculations depicted in details in Coal block valuation sheet for Radhikapur West OC Block

The degree of variance as depicted in Exhibit 09 in form a spider diagram as per the change in percentage is depicted in Exhibit 10 for the Radhikapur West OC Coal Block.

Exhibit 10 : Spider Diagram Parameters Variation for Radhikapur West OC Coal Block – CASE I

ILLUSTRATIVE



Source: enincon research & analysis

From Exhibit 10 it is evident that the Radhikapur West Coal Block for OC operations is ***maximum sensitive to the operating cost and production with production leading marginally in case of sensitivity.***

Similarly for Case II wherein the variation in parameters is from -10% to 20% is indicated in sections in Exhibit 11 ,Exhibit 12 and Exhibit 13.

Exhibit 11 :Sensitivity of NPV to Certain Parameters @ 12% Discount Rate for OC Operations – Case II

TABULAR

Parameter	Variation
Operating Cost	20% to -10%
Production	-10% to 20%
Capital Expenditure	20% to -10%

Source: enincon research

*Exhibit 12 : Variation in Parameters for Radhikapur West OC Coal Block – Case II**

TABULAR

CASE -II							
Operating Cost	**20%**	**15%**	**10%**	**5%**	**0%**	**-5%**	**-10%**
INR per Kg	1.78	1.71	1.63	1.56	1.48	1.41	1.34
Final Price Per Kg (INR)	3.13	3.04	2.95	2.86	2.77	2.68	2.60
Production	**-10%**	**-5%**	**0%**	**5%**	**10%**	**15%**	**20%**
MT	94.50	99.75	105.00	110.25	115.50	120.75	126.00
Final Price Per Kg (INR)	2.58	2.68	2.77	2.87	2.96	3.06	3.15
CAPEX	**20%**	**15%**	**10%**	**5%**	**0%**	**-5%**	**-10%**
INR per Kg	0.55	0.53	0.51	0.49	0.46	0.44	0.42
Final Price Per Kg (INR)	2.87	2.84	2.82	2.80	2.77	2.75	2.73

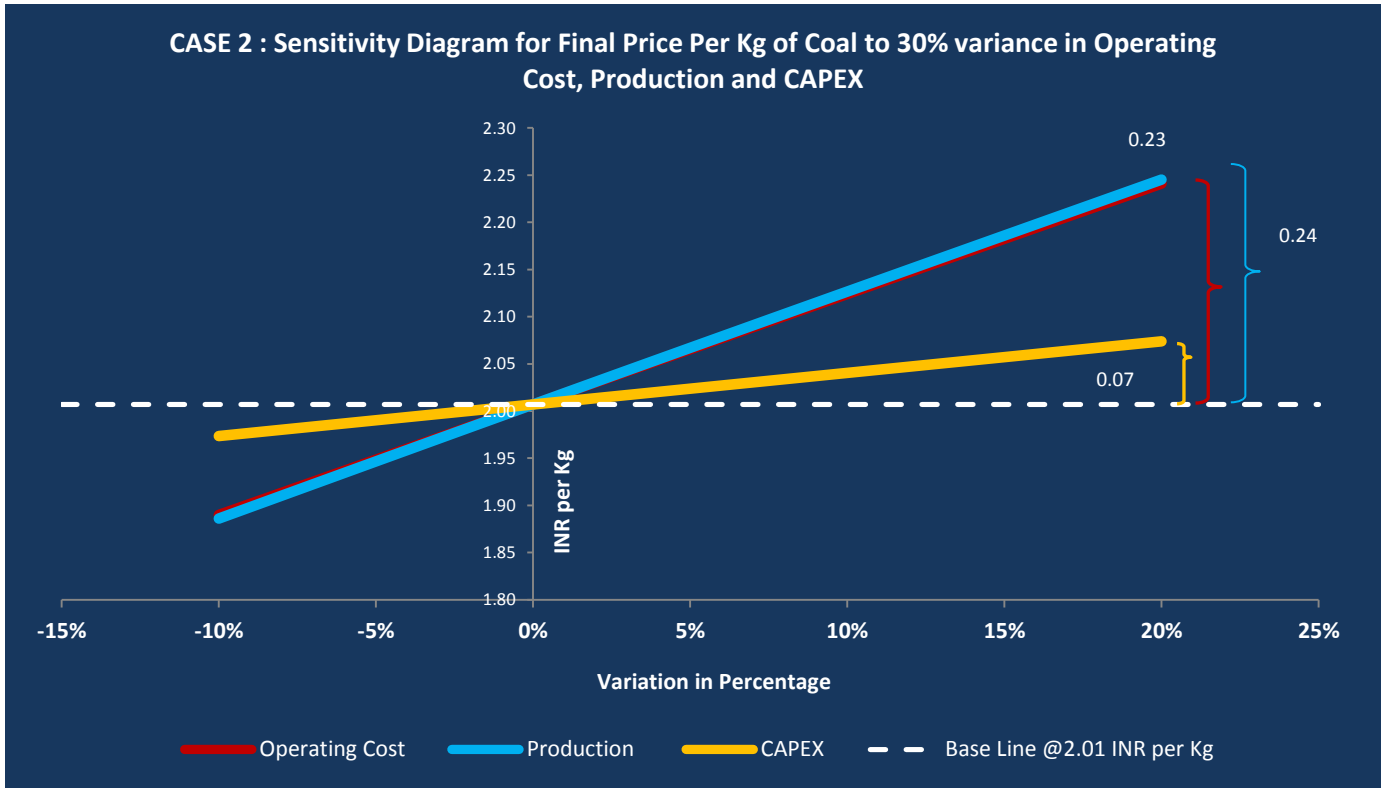
Source: enincon research & analysis

NOTE: All variations are considered for Case I Variation and is according to the calculations depicted in details in Coal block valuation sheet for Radhikapur West OC Block

The degree of variance as depicted in Table 9.4 in form a spider diagram as per the change in percentage is depicted in Exhibit 13 for the Radhikapur West OC Coal Block for Case II.

Exhibit 13 : Spider Diagram Parameters Variation for Radhikapur West OC Coal Block – CASE II

ILLUSTRATIVE



Source: enincon research & analysis