

## Abstract

Field Development Strategy and Risk assessment of Area under Discovered Small Field: A perspective from Tapti-Daman Block

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### 1.1: Introduction:

The Government formulated a Discovered Small Field Policy with the objective to bring the discovered small fields to production at the earliest to augment the domestic production of Petroleum. The Government decided to extend the said policy for fast-track monetization of un monetized small fields/ discoveries of Oil and Natural Gas Corporation Limited (ONGC), Oil India Limited (OIL) under nomination regime and relinquished discoveries under Production Sharing Contract (PSC) regime.

Till date three DSF bid rounds happened and bids were invited through international competitive bidding and 65 contract areas. Thus, it is crucial to determine the economic life of the project for a fast track and effective monetization of these fields.

In this paper illustrates to develop the discovered small field of awarded DSF block around Mid-South Tapti Field (Figure-1). The study area is located in the Tapti-Daman block of Bombay Offshore Basin with a water depth of 14-24 m bathymetry. So far three wells have been drilled in the area, out of which one well NMT-A proved to be Gas bearing in Mahuva Formation, while the other wells are dry.

In above scenario, the Techno economic viability of the project is a paramount importance for fast-track monetization of discovery under DSF policies. It is also a prudent to analyses the discovery and associated risk of the study area by using Monte Carlo simulation for volumetric calculation, Investment/ production Profile, Discounted Cash Flow Analysis, Economic Indicator, Risk & Uncertainty with Fiscal Regime.

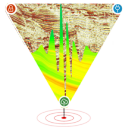
**Key words:** DSF, Monte Carlo analysis, DCF, Economic Indicator (IRR, NPV & EMV), Quester, X-Port and PoS.

### 1.2: Conceived Methodologies:

1.2.1: Volumetric Analysis: NMT-A has flowed gas and condensate from one object with  $Q_{gas}$  @ 84,800 m<sup>3</sup>/d,  $Q_{cond}$  @ 100 BPD through 1/4" choke.

Probabilistic method: Commonly, the probabilistic method is implemented using Monte Carlo analysis. In this case, the user defines the uncertainty distributions of the input parameters and the relationship (correlations) between them, and the technique derives an output distribution Guidelines for Application of the Petroleum Resources Management System. Thus, the resultant volumetric method was employed around prospect NMT-A (Figure.2) to derive the gas in-place estimation and its distribution by using Monte Carlo soft-wares. Log motif against Object-I is depicted in Figure-3 by using Petrel. Inferred Sand deposition in these areas are offshore bars and channels. The pay Sand is composed of fine to medium grained non-laminated sand unit deposited under an overall deltaic regime. Porosity observed in the reservoir section is in the range of 14-20%. The gas pool is found within the Mahuva Formation around well NMT-A. The pay sands are in the form of lenticular bodies trending NE-SW. The entrapment is strati-structural in nature. Mahuva pay top encountered in NMT-A at 2011 m against well depth of 2800 m. Building an economic (Investment profile, cash flow and fiscal) model of the project by using standard workflow (Figure.4) for estimating the economic value and return on investment and finally, identifying and quantifying the economic risks. The following reservoir parameters were used to generate volumetric through Crystal Ball software (Table-1).

Parameter	Minimum	Most Likely	Maximum
Area (Sq. Km)	6.85	9.35	11.85
Net Pay (m)	9.46	9.535	9.61
Porosity (%)	20	21	22



Gas Saturation (%)	60	65	70
FVF or Bg	0.005		
Recovery Factor (Oil/Gas)	60	60	60

**Table 1: Parameters considered for volume estimation**

After Monte Carlo simulation the ultimate reserve of Gas was derived as 1.46 BCM/ 51.58 BCF against the IGIP of 2.43 BCM (Figure 5-8).

### 1.2.2: Discounted cash flow (DCF):

Cash flow is simply the cash received and the cash expended over a defined period of time. Net cash flow is simply the cash received less the cash expended during a period.

**Net cash flow = Cash received - Cash expended**

The derivation of the future net cash flow of an investment is essential if we are to determine whether that investment is economically viable.

In petroleum economics, the DCF (Discounted Cash Flow) formula is commonly used to evaluate the economics of oil and gas projects. It helps estimate the net present value (NPV) of the project based on expected cash flows. The DCF formula used in petroleum economics is like the general formula mentioned earlier, but it incorporates specific considerations for the oil and gas industry.

Here is a general representation of the DCF formula in petroleum economics:

$$DCF = \sum [(P - C - T) / (1 + r)^t]$$

Where:

DCF represents the discounted cash flow or net present value.

P represents the projected future petroleum revenues.

C represents the projected future operating costs.

T represents the projected future taxes.

r represents the discount rate.

t represents the time period.

In the present project Investment and production profile of NMT-A prospect was generated by help of Quester 2022 Q3 version (Figure. 9 & 10). The project is expected to earn revenue from 2027 till 2042.

### 1.2.3: Economic Indicators:

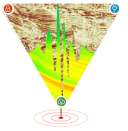
Economic Indicators are devices which reduce a net cash flow projection to single numbers so that we do not need to deal with a stream of money amounts stretching out from now into the future. The Economic Indicator was enumerated through X-Port software & key findings are mentioned below.

- a) **Internal Rate of Return:** It is a trial-and-error type of calculation in which the NPV of a series of cash flows is determined for several selected discount rates until the rate is found that yields a NPV of zero. IRR arrived around at 18.44 % for NMT-A.
- b) **Net Present Value:** The equivalent value today of a sum of money received or spent sometime in the future is its present value ('PV'). The present value of net cash flow occurring at some point in the future is referred to as the net present value ('NPV') of that future cash flow. NPV at 12% came around \$ 17.83 MM.
- c) **Expected Monetary Value:** The expected monetary value of an outcome is obtained by multiplying the probability of occurrence of the outcome and the conditional value (or worth) that is received if the outcome occurred, where the values received are expressed as monetary profits or losses. Expected monetary value enumerated 11.02 MM\$ @ 5%  

$$EMV = (Pg * NPV \text{ of Project}) - (1-Pg) * NPV \text{ of Risk Money of Project}$$

Where EMV = Expected Monetary value, Pg = Probability of Geological Success

- d) **Probability of Success:** The mathematical expression for geological risk or geological probability (i.e., PoS, e.g., [1]) for hydrocarbon systems is presented in Equation (Ref.: *Geological Risk Calculation*



*through PoS: Applied to Radioactive Waste Disposal in Pre-Neogene Basement in the North Croatia, 29.06.2020)*

$$\text{PoS} = p(t) \cdot p(r) \cdot p(m) \cdot p(\text{sr}) \cdot p(\text{CHp})$$

PoS - geological probability of success (%);

p(t)- probability of potential traps (%);

p(r) - probability of reservoir characteristics (%);

p(m) - the probability of hydrocarbon migration (%);

p(sr)- the probability of the existence of source rocks (%);

p(CHp)- the probability of hydrocarbon preservation (%).

**The discovery probability of NMT-A prospect derived of 0.32.**

### 1.3: Conclusion:

- **Economic analysis has been carried out considering prevailing APM terms like: Royalty @ 10% of well head value and Corporate IT @ 25.17%. Risk money is exploratory well cost MMS 6.86 (after IT rebate). Gas price considered for 1st 2 years USD 6.77/Mcf and for subsequent 5 years USD 5/Mcf with 1\$ escalation after each block of 5 years. Project yielded Lifecycle cost of 179.85 MMS with project life of 19 years.**
- **IRR yielded 18.44% with NPV came around 17.83 MMS @ 12%. Expected monetary value enumerated 22.21 MMS @ 0% and 11.02 MMS @ 5% (Table-2).**
- **Sensitivity also arrived by comparing cash flow with parameters of Gas Price, OPEX and Capex, wherein Gas Price variation is the most sensitive (Fig.10)**
- **This paper illustrates traditional measures of profitability, the parameters used by the decision makers to order, accept, reject or compare investment proposals under attractive terms of DSF policy.**

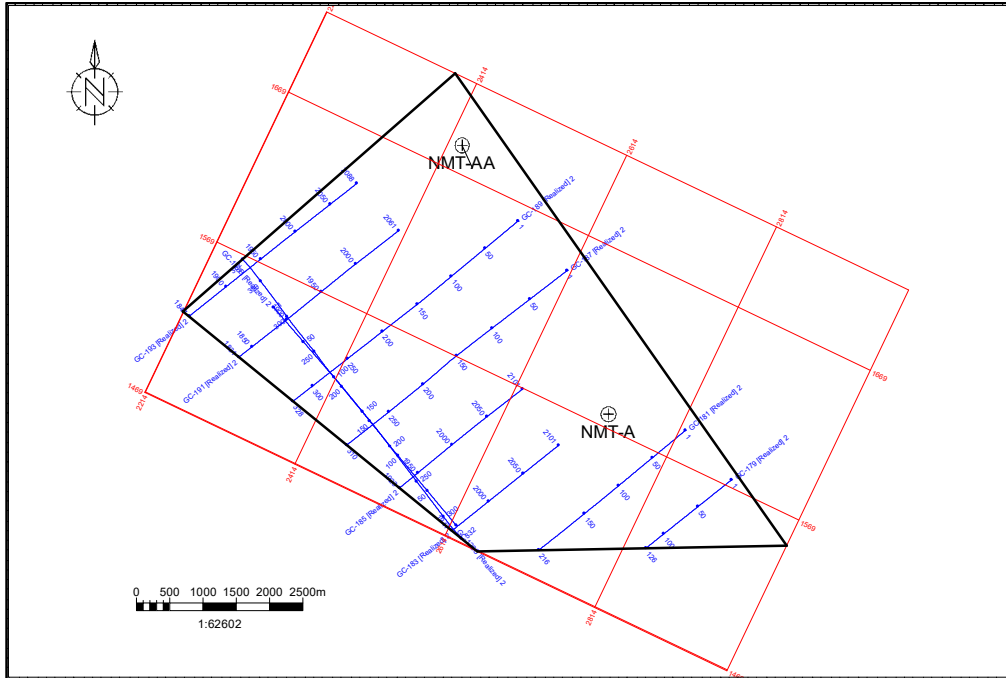
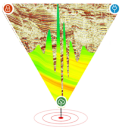


Figure 1: Base Map of the Study Area

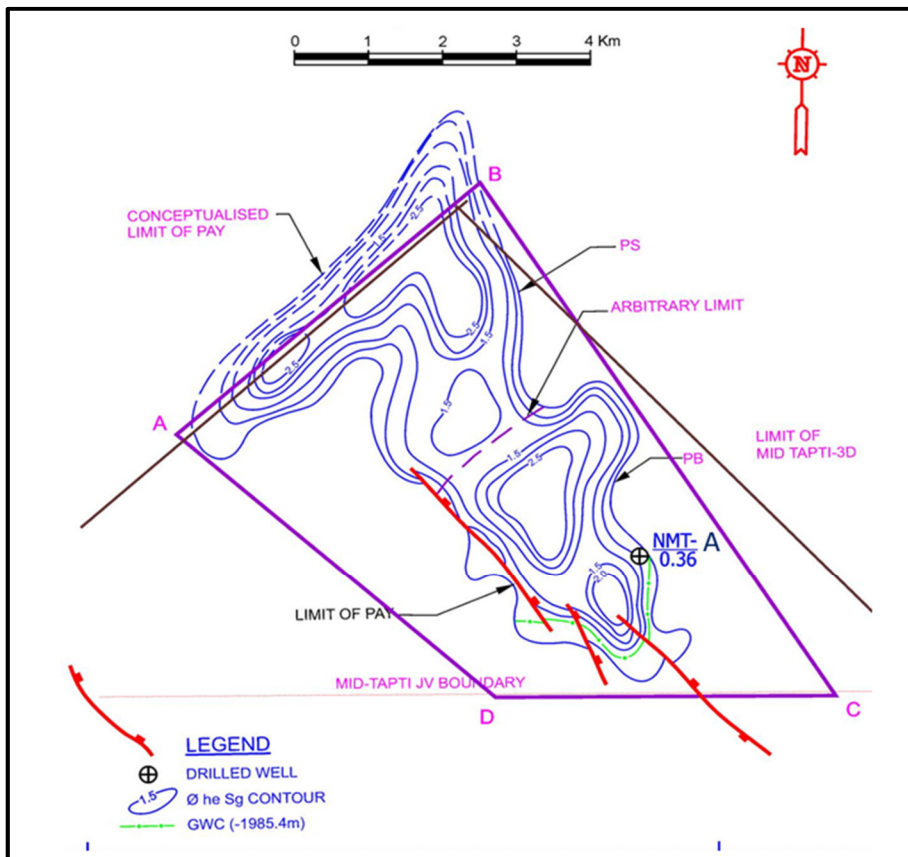
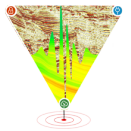


Figure 2: PHI-HE-SG MAP OF NMT FIELD



SPG 2023

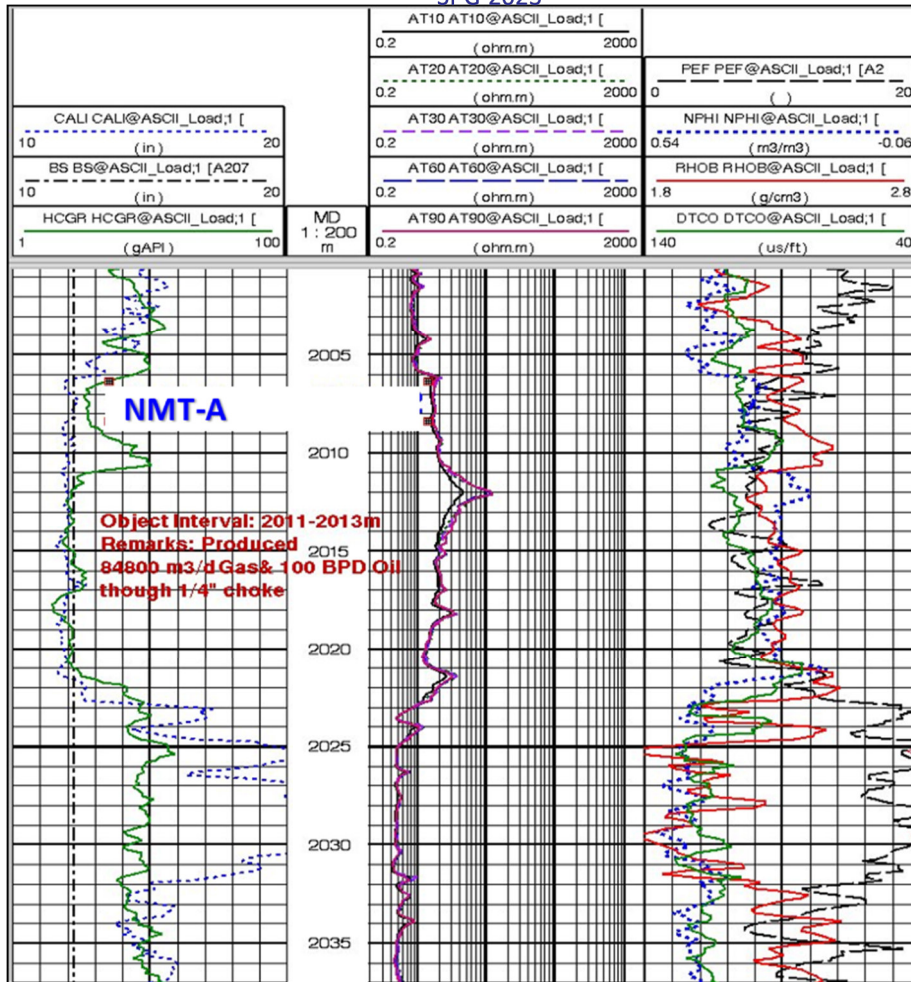


Figure 3: Log Motif of Tested Object of Well NMT-A

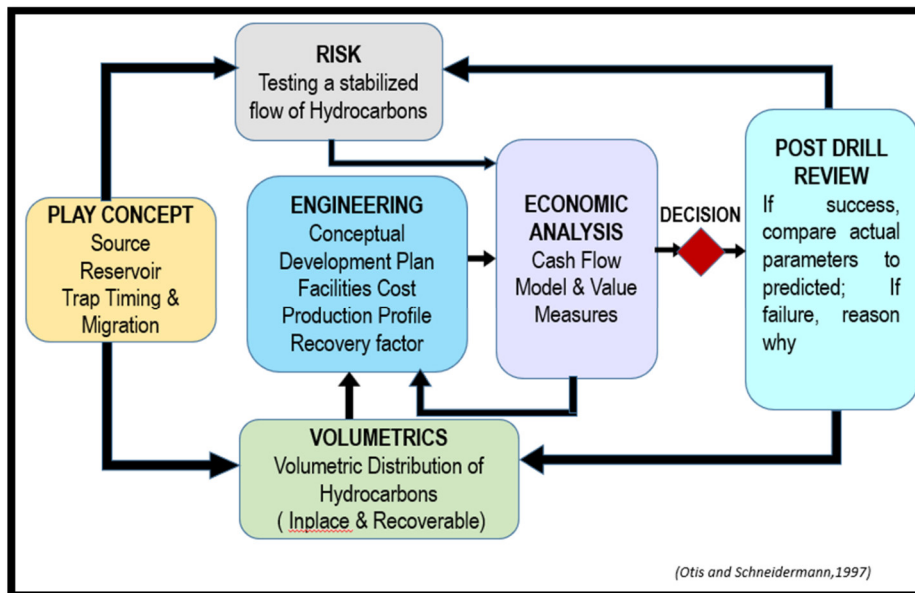


Figure-4. Prospect with Key Workflow

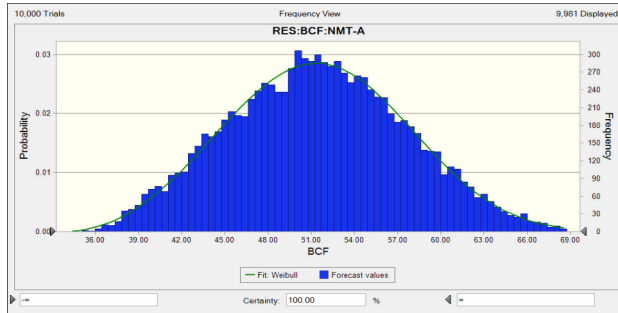
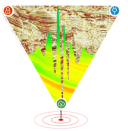


Figure 5: Probability distribution of Recoverable Reserves

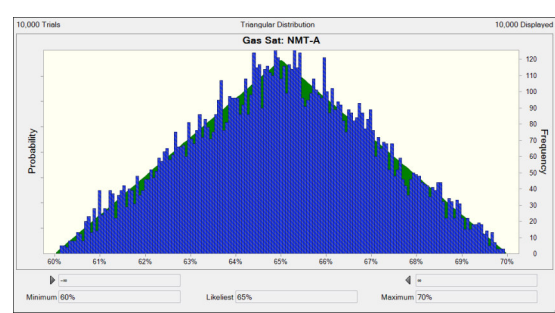


Figure 6: Probability distribution of Gas Saturation

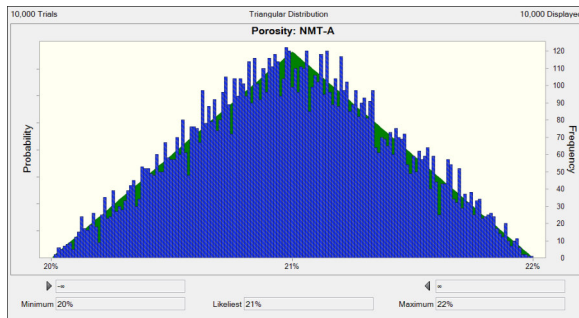


Figure 7: Probability distribution of Porosity.

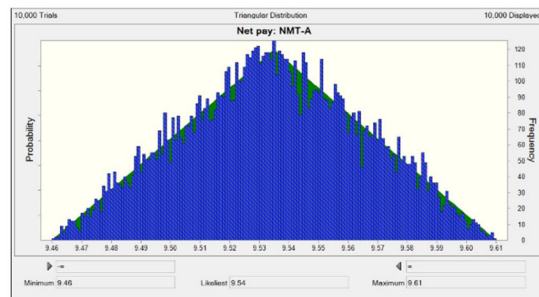


Figure 8: Probability distribution of Porosity

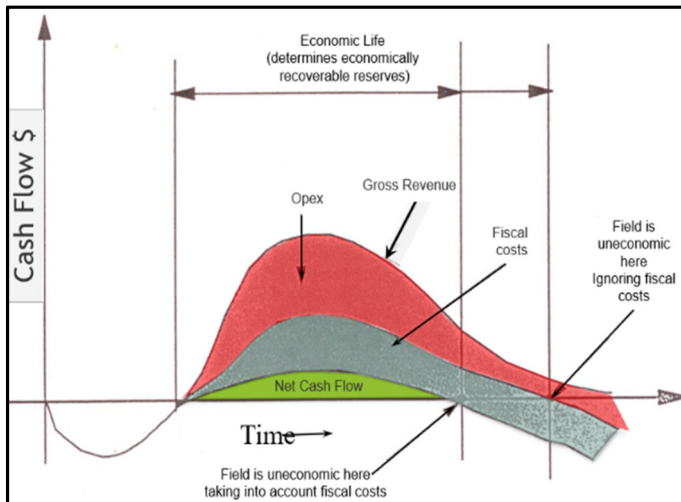


Figure 9: Economic Life of the Project.

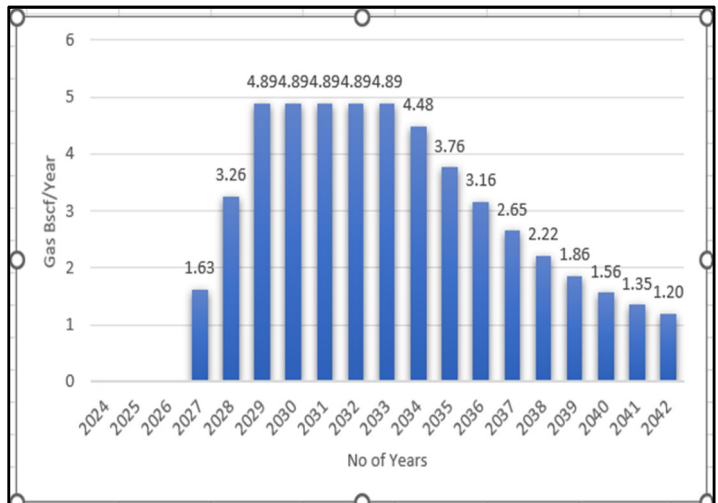
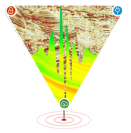


Figure.10: Production profile generated through Questor for NMT-A



<b>Block</b>		<b>KSTD</b>
<b>Prospects</b>		<b>NMT-A</b>
<b>Hydrocarbon Type</b>		<b>Gas</b>
<b>Price Scenario</b>	\$ / Mcf	<b>6.77</b>
Total Reserves	Bcf	51.58
<b>Estimated Expenditure</b>		
Operating Expenses	MM \$	105.63
Exploration Capital	MM \$	9.80
Development Capital	MM \$	64.41
Other Capital	MM \$	0.00
<b>Life Cycle Cost</b>	<b>MM \$</b>	<b>179.85</b>
Unit Operating Expenses	\$ / Mcf	2.05
Unit Exploration Capital	\$ / Mcf	0.19
Unit Development Capital	\$ / Mcf	1.25
<b>Unit Life Cycle Cost</b>	<b>\$ / Mcf</b>	<b>3.49</b>
Producing Life	Years	16.00
Project Life	Years	19.00
<b>Economic Indicators</b>		
<b>After Tax Rate Of Return</b>	<b>%</b>	<b>18.44</b>
<b>NPV@ 0%</b>	MM \$	84.99
<b>NPV@ 5%</b>	MM \$	50.01
<b>NPV@ 8%</b>	MM \$	34.17
<b>NPV@ 10%</b>	MM \$	25.39
<b>NPV@ 12%</b>	MM \$	<b>17.83</b>
<b>EMV@ 0%</b>	MM \$	22.21
<b>EMV@ 5%</b>	<b>MM \$</b>	<b>11.02</b>
<b>Risk Money</b>	MM \$	<b>6.86 (After IT rebate)</b>
<b>Cumulative Discovery Probability (Pg)</b>	<b>%</b>	<b>32.00</b>

Table 2: Enumerated Expenditure & Economic Indicators of NMT-A

Base Case		Sensitivity														
ACTIVITYNAME	PARAM_NAME	DISCRATE	@ -30	@ -20	@ -10	@ 10	@ 20	@ 30	@ 0	IRR@ -30	IRR@ -20	IRR@ -10	IRR@ 10	IRR@ 20	IRR@ 30	IRR@ 0
NETCASHFLOW	GASPRICES	0	19.0345	41.0377	63.0214	106.9327	128.8602	150.769	84.9864	6.6847	11.4278	15.1909	21.3478	24.0137	26.4917	18.4379
NETCASHFLOW	OPEX	0	108.701	100.7961	92.8913	77.0816	69.1767	61.2719	84.9864	20.5921	19.9001	19.1832	17.66	16.8443	15.9837	18.4379
NETCASHFLOW	TCAPEX	0	101.9237	96.2779	90.6322	79.3407	73.6949	68.0491	84.9864	27.2191	23.7971	20.9152	16.2734	14.3569	12.6412	18.4379

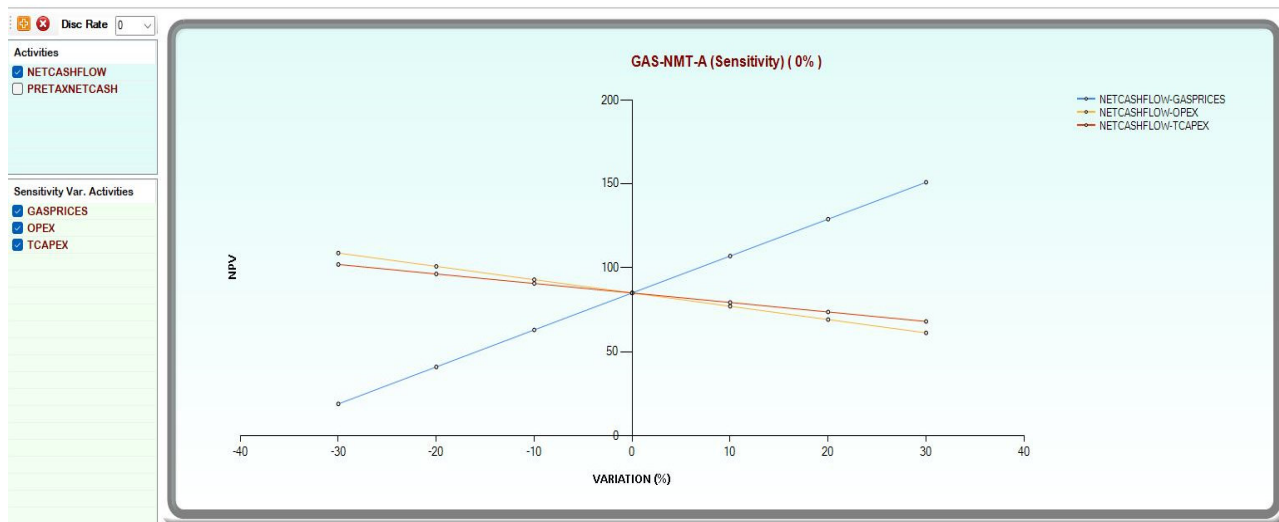
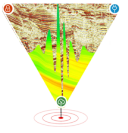


Figure. 11: Sensitivity analysis of NMT-A prospect.



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