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Using an Economic Model for Assessing High-Risk Exploration Project, M and B PSC Assets, in Sumatra, Indonesia

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In 2022 and the next few years, Energi Mega Persada will conduct the exploration projects campaign in several producing blocks including M and B to seek some potential upside for adding company book reserves. This exploration will consist of geological and geophysical seismic, acquisition, processing, and drilling. It's estimated to spend a large capital investment so it's needed justified economic modeling.

High-risk projects including exploration are projects that are full of uncertainty and randomness, so the approach to the economic model is not enough with a predictable deterministic model, but also requires a stochastic model approach that takes into account the random factor. In the economic model that will be made, of course, it will consider risk in decision making, so to make it easier, a decision tree path is made

M and B are assets that already have steady cash flow. In principle, the two blocks can finance all of their operating activities and set aside cash reserves for investment activities. But how much financial strength is there to pay for exploration activities and how to choose an exploration project that has a positive impact on the company needs to be looked at further and again the difference between the two types of PSC, namely M which uses gross split and B which uses cost recovery also has an effect on economic calculations.

Economic modeling, both deterministic and stochastic, which are in principle opposite, has been used to view the project prospect in Energi Mega Persada, so that the project can be understood better, and can sort out projects that are economically disadvantaged.

Keyword**(s):** Economic model, deterministic, random number, PSC

1 Background

M and B PSC are work areas that have scattered fields, located in the province of Riau, Sumatra Indonesia (**Figure 1**). The fields that currently producing are mature enough and in a downward trend. M PSC produces 5,000 bopd of oil while B produces 90 mmscfd of gas. To replace the reserves that continue to be produced, Energi Mega Persada will conduct an exploration campaign to find the potential upside in new green fields.

As M PSC began exploring the eastern area on a different island from the main island by continuing to reopen data for wildcat wells, and old 2D seismic, the exploration team also carried out 3D and reviewed the volume of hydrocarbons in the area for re-entry. Meanwhile, B is also actively carrying out similar work, namely seismic and exploration drilling in new fields which have smaller structures (**Figure 1).**

1.1 The PSC Economic

In Indonesia, the current PSC economy is divided into 2, namely cost recovery and gross split. Cost recovery is a contract system where all expenditures from the project both for operations and investment will be returned directly before profit sharing, while the gross split is revenue sharing is done at the beginning, while all expenses will be borne by the contractor (**Figure 2**)

In the contract document (PSC) there will be terms that contain rights and obligations in economic calculations such as Profit split, Tax, DMO, Bonus (Signature, Production), ASR obligations, Firm Commitment, etc

The main difference between the two systems above is that cost recovery is profit sharing while the gross split is revenue sharing. Gross split can be more attractive if the split obtained by the contractor can be greater than the cost recovery.

1.2 The Economic Model

There are 2 types used in modeling, namely deterministic and stochastic. The deterministic model emphasizes the exact outcome of a given input, the opposite stochastic model, uses inputs and predicts outputs taking into account probability and randomness.

Examples are NPV and EMV, the NPV (net present value) is a product of a deterministic model with inputs such as price, and both costs and sales profiles. It will produce discounted cash flow and NPV.

Meanwhile, the EMV (expected monetary value) is a product of the stochastic model, where in principle EMV is the NPV multiplied by the chance of success of the project.

The NPV is quantitative where the larger the NPV means the greater of valuation, and the EMV is qualitative means the projects with only positive EMV are eligible to be included in the shortlist

2 Data and Method

We need to collect data such as

a) actual and accrual data: gross revenue, prices (oil and gas) received, sales volume (gas and oil), costs that arise from both operations and investments, real cashflow in the current year
b) sales projections (gas sales or oil sales)
c) oil price projection agreed upon by management
d) gas price by the gas sale and purchase agreement or gas price projection if there is no price agreement with the buyer
e) Planned operating and investment costs for the duration of the PSC contract
f) Fiscal terms are those in the PSC documents (**Figure 3**).

All the necessary data is collected, so we can start creating a template for the deterministic model (**Figures 4 & 5**). The outputs are the project of NPV, IRR, payback time, and sensitivity analysis.

3 Results and discussion

M and B PSC have almost the same project, namely exploration, fortunately, both blocks already have production fields so they have steady cashflow, for exploration projects that do not have cash-in guarantees it is impossible to apply for loans to outside parties, the financing is from the block's equity, but its capabilities are still limited. so that the economics of the project does not stand alone but will be combined with other fields in a block so that the ability to finance is more visible.

For the process of making the deterministic economic template described above and further of a high-risk exploration project where the chances of not finding hydrocarbons are high, in addition to the deterministic model, it is also necessary to add a stochastic model approach so that the economic analysis is more complete and more justifiable (**Figure-5**).

After the deterministic model has been created, and there is no change in input assumptions, the next step is to create a stochastic economic model. This stochastic model uses a deterministic model template that will be modified so that it takes into account the probability of success or failure as described in the decision tree (**Figure-6**)

in stochastic modeling, the first step is to make a tree diagram for decision-making, the diagram will be equipped with a probability of success, then in each tree branch there will be a decision node, chance node, and outcome (**Figure-6**)

From the tree, it can be calculated that from each branch there will be a chance and decision, then the outcome will be collected in the population depending on how many sample outcomes are desired, for example, 1000 samples. The more sample outcomes, the dense the distribution pattern in the population will be.

The outcome distribution pattern from the calculation in the stochastic model generally follows the natural distribution as is true in statistics. Meanwhile, for the inputs that appear, the randomness will also follow the existing distribution pattern, where the characters are closest, there are discrete for sales and price of oil and gas profiles and triangular for operating dan capital expenditures (**Figure-7**)

From the distribution above, a plot will be made that describes the distribution output with samples that have been sorted from small to large, which will generally be in the form of an S-Curve. This S-Curve can provide information about

- The expected monetary value (EMV) which is the average of the output, the NPV
- What is the highest project valuation if it is successful or if it fails?
- How much value is lost
- What is the percentage chance of making money from the positive NPV

in the case of M or B PSC, as an illustration of the decision tree analysis is an exploration drilling project (**Figure-6**).

- As decision node 1 is drill and discovery, there will be a sales profile and operating costs, selling price, and the outcome is the NPV of the new field
- decision node 2, if the drill turns out to be dry, then the activity will stop and how much money has been spent will be lost, the outcome is a negative NPV

From this tree diagram, iteration calculations will be carried out to obtain a project NPV with a random number whose pattern of emergence follows a certain distribution pattern (**Figure-7**), for example, iterations until 1,000, then all NPVs are collected and the Curve is made so that the plot between the NPVs and the cumulative probability will illustrate project EMV (**Figure-8**).

4 Conclusion

- M and B PSC are promoting exploration programs in new fields that have the potential to find hydrocarbons. Both blocks are producing so that economically it can be modeled because there is already cash flow.
- The exploration program has a high risk, so the economic model is not only developed with a deterministic model but also a stochastic model to complete the justification given the uncertainty risk.
- The economic evaluation of both gross split and cost recovery are different in the concept of deterministic calculation flow. The same applies to the stochastic model.

5 References

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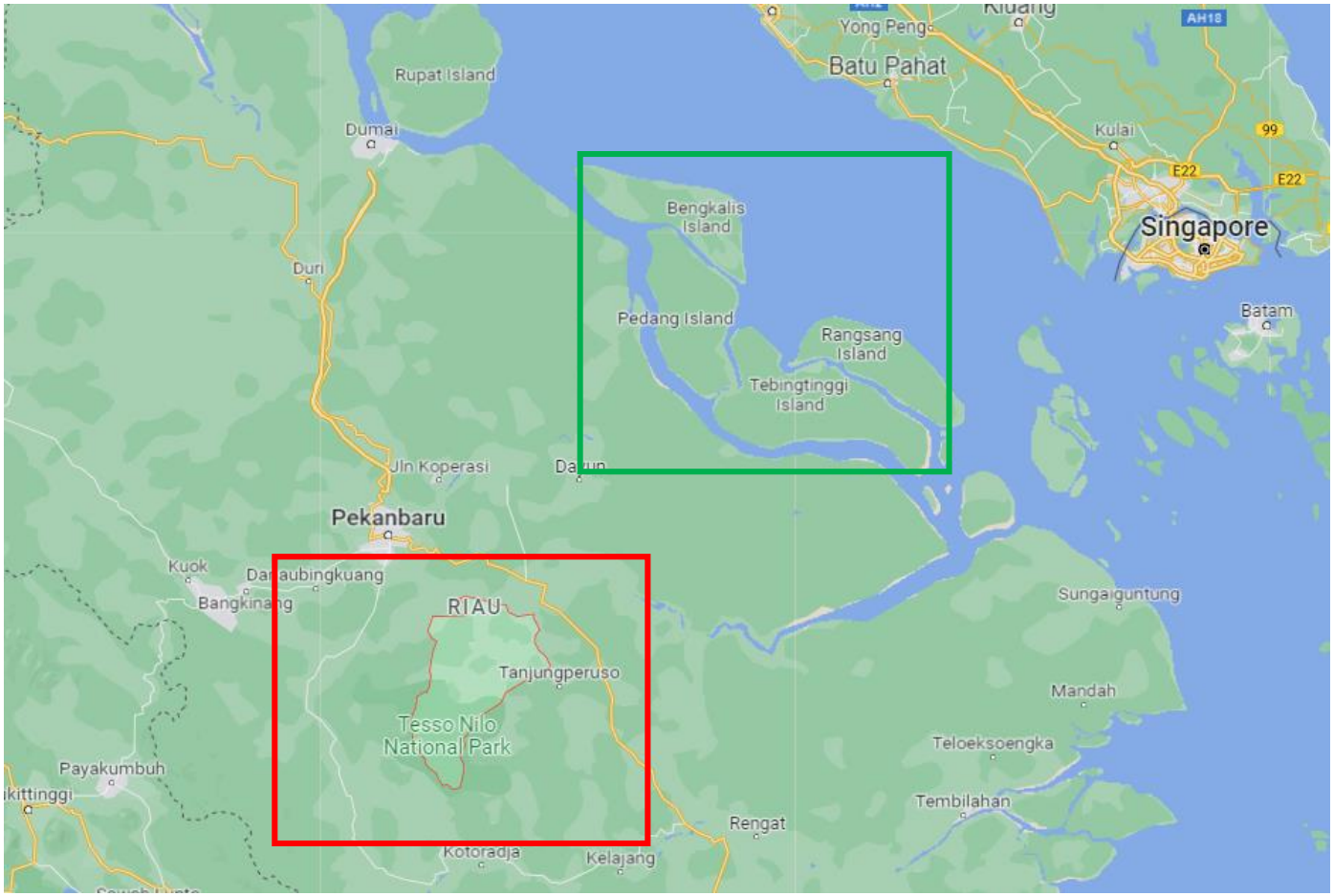


Figure 1 .

M PSC (green box) on the east coast of the island of Sumatra, Riau, Indonesia, Exploration and development activities are currently focused in the southeast of the area, on Tebing Tinggi Island, south of Main island, Padang island, B PSC (red box) is located in the center of Sumatra, close to the provincial capital of Riau, Pekanbaru, precisely in Palalawan district

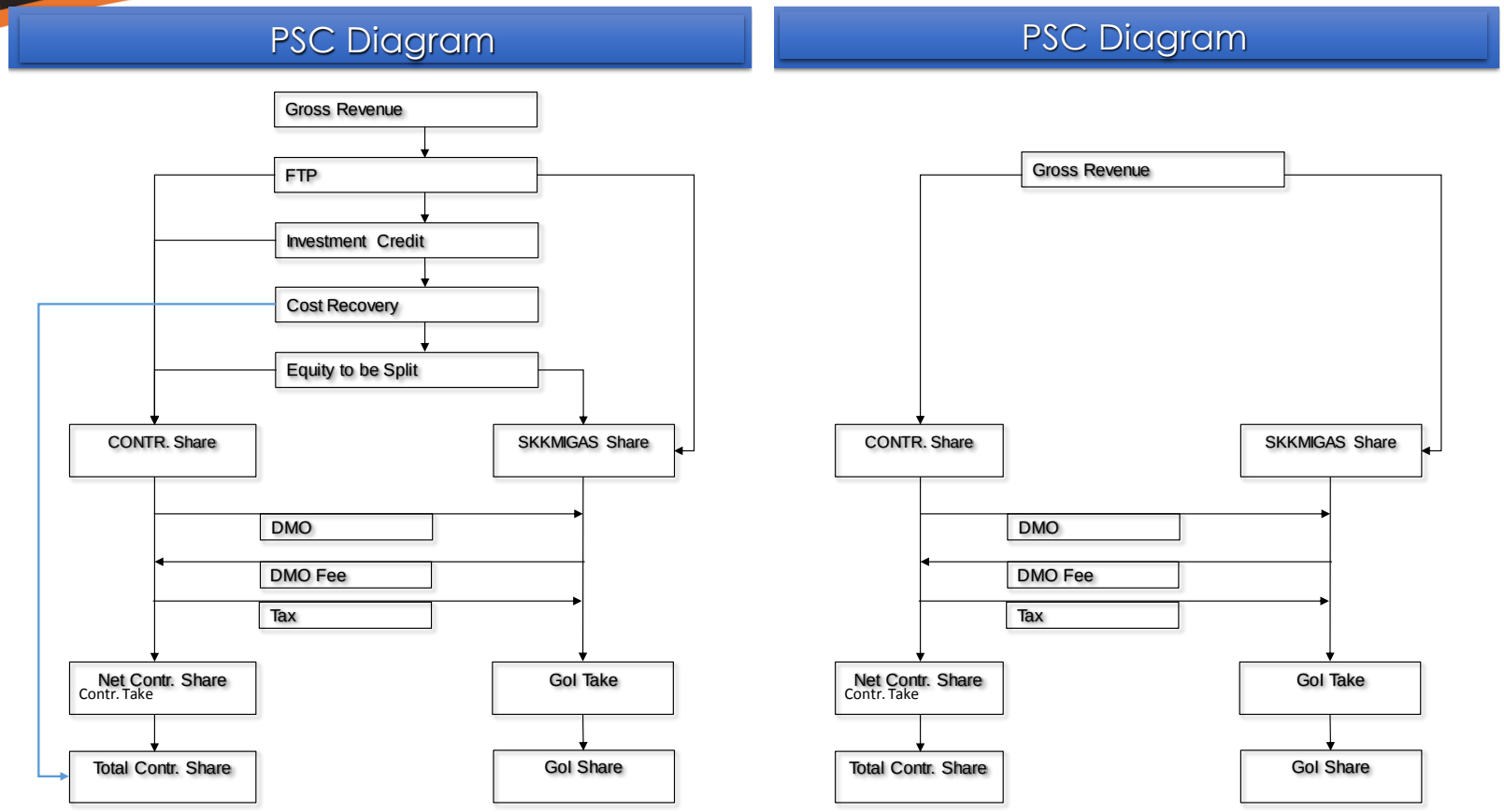


Figure 2. showing comparation between PSC cost recovery (left) and gross split (Right) schema

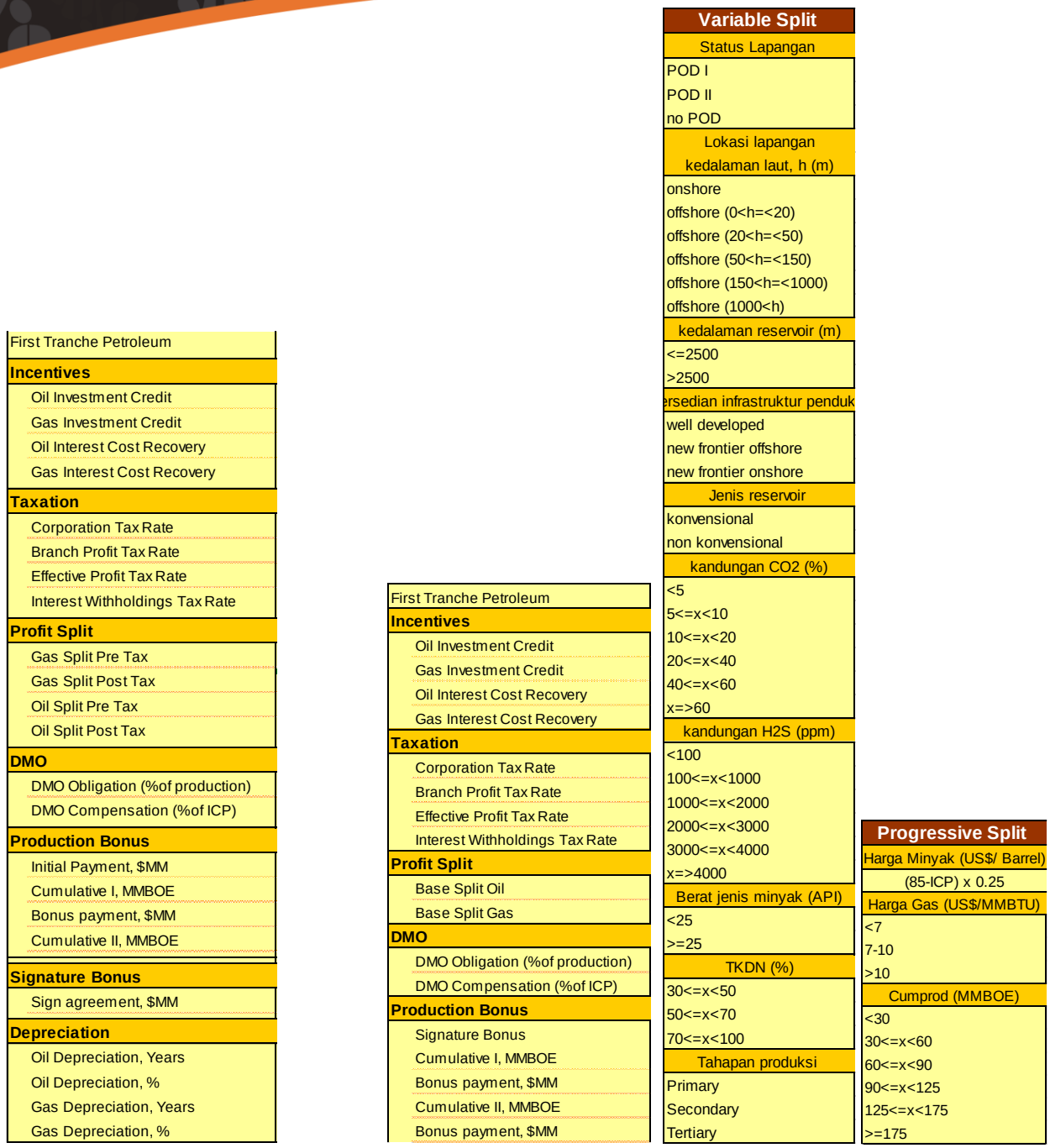


Figure-3 Fiscal Term from PSC Cost recovery B (Left) and Fiscal Term & additional Split (Variable, Progressive) from PSC Gross Split of M (right), for M the split component consists of base, variable and progressive split and split incentives in the form of discretion

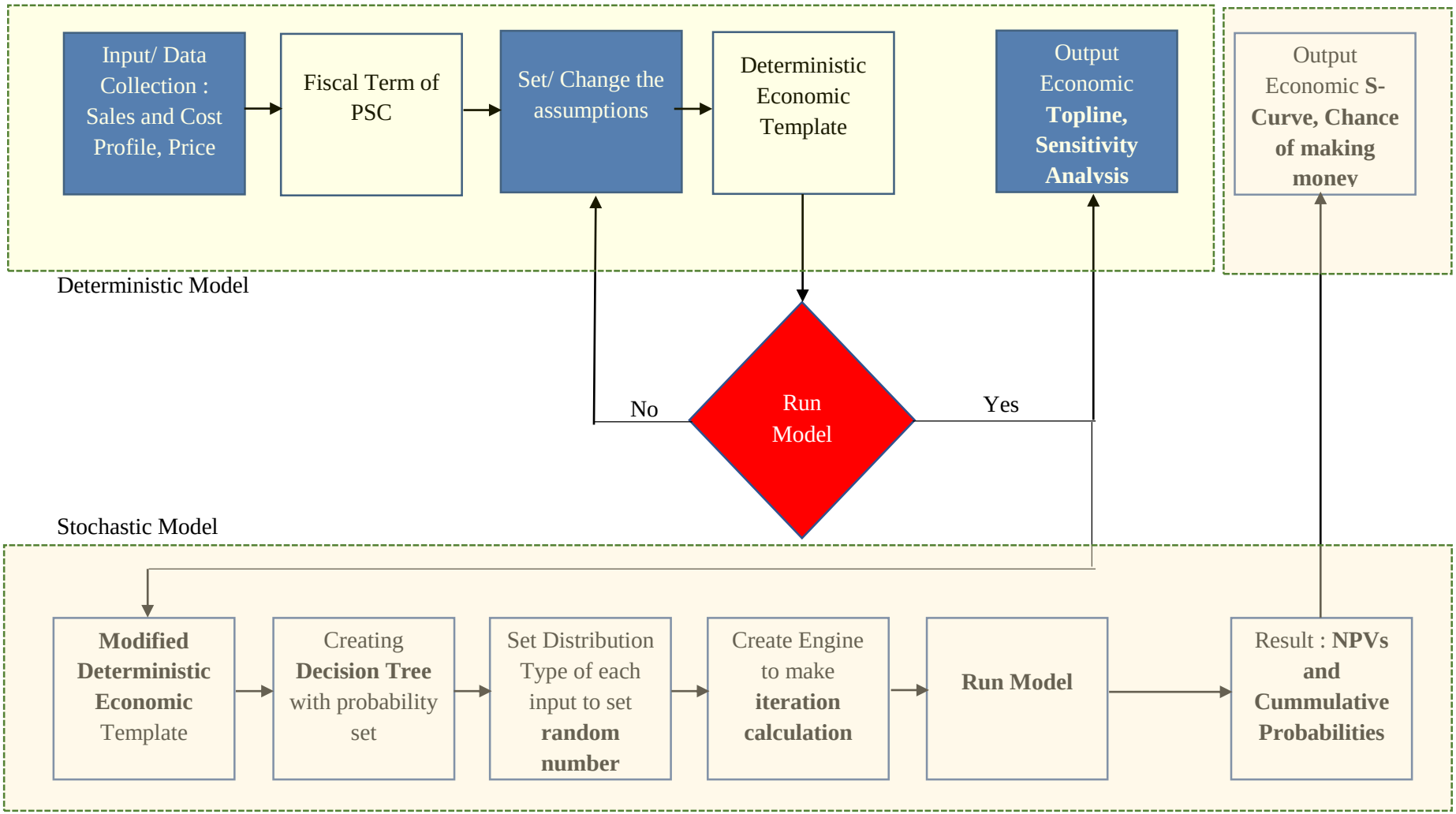


Figure-4 a simple flow in the creation of a deterministic economic model (top) and sthocastic economic model (bottom)

Figures in '000s unless otherwise stated			365 2022	365 2023	366 2024	365 2025	365 2026
DAILY PRODUCTION	**BOPD**						
OIL DAILY PRODUCTION	**BOPD**						
CONDENSATE DAILY PRODUCTION	**BOPD**						
ANNUAL LIFTING	**MMBO**						
PRICE (US$/Bbl)							
GROSS REVENUE							
FTP (First Tranche Petroleum)		20%					
Gross Revenue After FTP							
Investment Credit		0%					
Investment Credit Recovered							
Available for Cost Recovery							
COST RECOVERY							
Beginning Unrecovered Cost							
Add - current year cost :							
Operating Cost							
Non Capital Cost							
Depreciation							
TOTAL COST RECOVERY							
TOTAL RECOVERED							
Oil Revenue used as Gas Cost Recovery							
Cost Recovery from Gas Revenue							
EQUITY TO BE SPLIT							
Indonesia Share :							
FTP							
Equity Share							
Lifting price variance							
DMO							
Taxes							
TOTAL INDONESIA SHARE							
Contractor Shares :		31.7%					
FTP Share							
Investment Credit							
Equity Share		31.7%					
Lifting price variance							
less: DMO		25%					
add: DMO fee		25%					
Taxable Income							
Government Tax Entitlement		40%					
Net Contractor Share							
Total Cost Recovery							
TOTAL CONTRACTOR SHARE							
LESS - EXPENDITURES							
1. OPEX :							
- Routine Opex							
- ASR Opex							
Total Opex							
2. CAPEX :							
- Intangible							
- Tangible							
- Facilities							
- Others							
Total Capex							
TOTAL EXPENDITURES							
NET CONTRACTOR'S CASHFLOW							

	TOTAL	2022	2023	2024	2025
Average Lifting Prod. Mboed					
Oil, mbopd					
Gas, mmcfd					
Weighted Average Price					
Oil, US$/bbl					
Gas, US$/mmbtu					
Gross Revenue US$MM					
Oil					
Gas					
Opex, US$MM					
Oil					
Gas					
Capex, US$MM					
Oil					
Gas					
Taxes, US$MM					
Oil					
Gas					
Goverment Share, US$MM					
Oil					
Gas					
Contractor Share, US$MM					
Oil					
Gas					
Contractor CF, US$MM					
Oil					
Gas					
Production Bonus					
Cum. Cash Flow					
Opex/boe					

NPV10	
IRR	
GOI	
Opex/boe	
Capex/boe	

Figure - 5

Deterministic economic model spreadsheet, shown is a template for PSC cost recovery for oil in the red box is the fiscal term (Left) and a summary of the economy in the form of a topline from production or sales, up to cash flow, and the output NPV (Right)

Figure-6 an example of a decision tree in stochastic modeling, showing if the project is successful then there will be a profile (sales and costs), and the probability of success, if the project fails then the lost cost is only the first cost

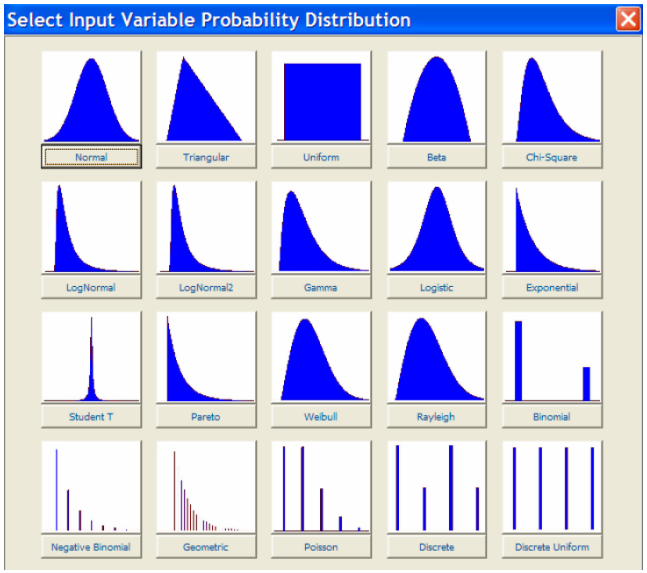


Figure -7 an example of a distribution diagram, the random input that appears will follow a distribution pattern adapted to its nature, which is used is discrete and triangular, using an equation or formula

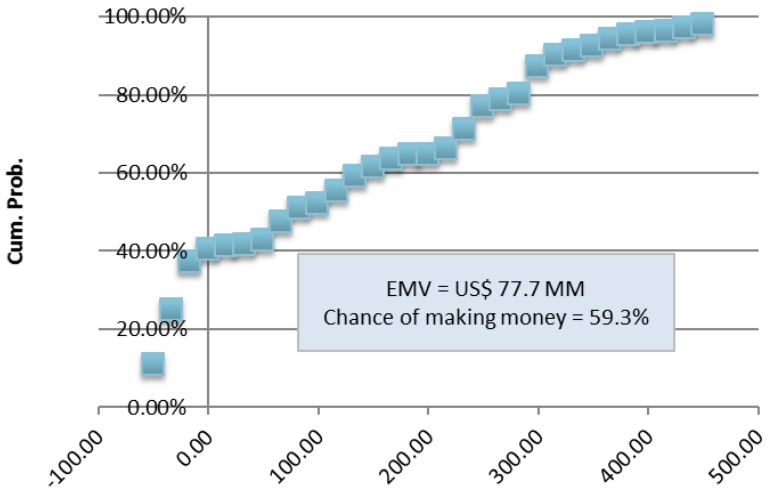
Run Montecarlo

Counter	1000	*allowable iteration set is only 1000*
Iterations	1000	
EMV (Mean)	**77.7**	
Chance of Making Money	**59.3%**	
Min	(14)	
Max	128	
Median	60	
Standar Deviation	41	

Iteration	NPV
1	48
2	74
3	53
4	52
5	37
6	39
7	(10)
8	42
9	107
10	(11)
11	(12)
12	(13)
13	38
14	100
15	116
16	40
17	(12)
18	105

No. of Iteration	Sorted Rank.	NPV	Act. Freq.
556	1	(14)	0.001
97	2	(14)	0.002
687	3	(14)	0.003
159	4	(14)	0.004
44	5	(14)	0.005
145	6	(14)	0.006
230	7	(14)	0.007
549	8	(14)	0.008
842	9	(14)	0.009
427	10	(14)	0.01
152	11	(14)	0.011
944	12	(13)	0.012
194	13	(13)	0.013
936	14	(13)	0.014
539	15	(13)	0.015
435	16	(13)	0.016
444	17	(13)	0.017
727	18	(13)	0.018

Set iteration for 1000 times



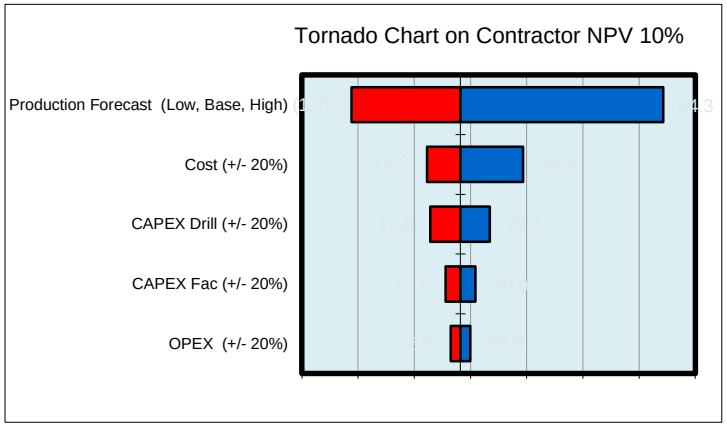


Figure -8 shows the input for calculation of iterations of stochastic models and summary of results (top left), the Curve of the exploration project (bottom left) where the EMV is positive so that the project is shortlisted, results of running NPV up to 1000 iterations (cut) and sorting data (top right) and the tornado chart for sensitivity analysis, the most sensitive is the one at the top (bottom right)