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Techno-Economic Study of SS Marginal Gas Field Development Using Integrated Production Simulation

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Abstract.
There are many marginal fields in Indonesia that have not been developed and have the potential to be profitable if a proper techno-economic study is carried out. The SS field is a marginal offshore gas field with small reserves. The challenge is how to economically develop the SS field, which is 30km from the nearest island. The research method is to conduct technical studies using integrated production simulations as inputs to economic calculations, then apply drilling and pipeline technology to optimize production and reduce costs. At beginning NPV of this field was USD -2.5 Million, but after a techno-economic study using integrated production modelling NPV of this field became USD 35.6 Million.

Keywords: marginal field, small reserves, integrated production simulation, drilling & pipeline technology, techno-economic study.

Introduction

Natural gas is the cleanest burning fossil fuel and plays a vital role in meeting global energy demand, accounting for 24%, and is expected to grow by about 2% a year until 2040[1].

However, the war that occurred between Russia and Ukraine greatly affected the supply and demand for energy globally. The oil and gas industry are getting excited again, as seen by the increase in exploration and exploitation activities lately.

On the other hand, the decline in the discovery of natural gas resources has occurred in the past few years [2] while the demand for natural gas continues to increase both locally and internationally. This condition has spurred the government and the production sharing contract (PSC) contractors to be active and innovate so that they are able to produce gas reserves even though the reserves are not too large (marginal).

A marginal field is an oil or gas field that has not been exploited for a long time because in terms of the relatively small size of oil and gas reserves making it less attractive to develop economically, the availability of the surrounding infrastructure and limited potential consumers, as well as the problems of CO2, H2S, Wax, Asphaltene etc. Integrated production modelling is essential for well performance evaluation and enhancement of the production system. It is a process of predicting the effects of changes through a systematic analysis of individual components and the impact of their interaction on field performance [3]. Good knowledge of the production sharing contract (PSC) model opens the opportunity to get incentives (variable split, gas price) that may be able to help the economics of the project that has been technically evaluated.

Field Location

The research field is located off the coast of East Kalimantan which is close to the border with Malaysia (see Figure 1). Many challenges come with small field reserve and far from existing field. Development of this field is not only economically excited, but also geopolitically interesting due to located near to border with others country.

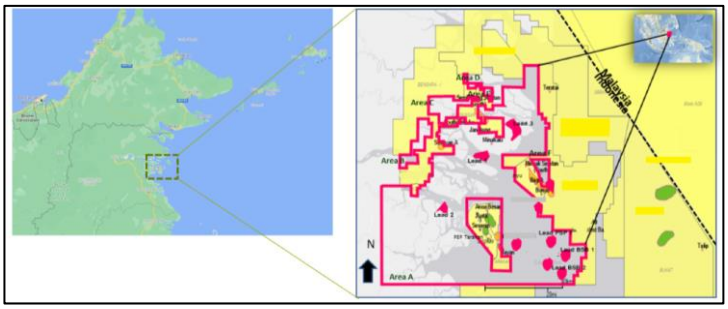


Figure 1: Location Field SS

Marginal Field Potential

Marginal gas fields can be caused by technical factors and technical economic factors. Technical factors include the amount of hydrocarbon content, impurities, environment, access, and available infrastructure, while economic factors include gas price stability, fiscal terms, market conditions and government policies. However, if technology and economic conditions change, marginal fields can be developed at any time.

According to the Society of Petroleum Engineers (SPE) organization, marginal fields are oil or gas fields that have not been exploited for a long time because:

1. In terms of the size of oil and gas reserves, which are relatively small, they are less attractive to develop economically.
2. In terms of the availability of the surrounding infrastructure and potential consumers
3. Available technological constraints (impurities: CO_2, H_2S, Wax, Asphaltene etc.).

Meanwhile, based on the regulation of the Minister of Energy and Mineral Resources (ESDM) number 0008 of 2005, a marginal field is a field which, based on the applicable PSC terms and conditions, is not yet economical to be developed in a work area with a production status. So, it can be considered for incentives by the government.

The difference between the two definitions above is that in their approach, SPE categorizes the criteria for a marginal gas field in terms of field characteristics, while the government sees that it only focuses on the economic side. If you look at the average economic period of oil and gas fields in Indonesia, which are in the range of above 10 years, it also refers to PSC contracts which are in the 30-year period for the first period and 20 years for the extension period. Furthermore, the authors will use the parameters of the SPE, especially in terms of the size of reserves, infrastructure and development costs required.

Horizontal Well Technology

Horizontal wells have been used to produce thin zones, fractured reservoirs, formations with water and gas coning problems, waterflooding, heavy oil reservoirs, gas reservoirs, and in EOR methods such as thermal and CO_2 flooding. The paper includes field examples with cost benefit analysis for various applications.

Cost/Benefits of Horizontal Wells

Disadvantages of horizontal wells as discussed by Bossio [4] are:

1. High cost as compared to a vertical well. Statistically a new horizontal well drilled from the surface, costs 1.5 to 2.5 times more than a vertical well
2. Generally, it is not easy to drain multiple layers using a single horizontal well.
3. The overall current commercial success rate of horizontal wells in the U.S. appears to be 65%.

Benefits of horizontal wells are:

1. Higher rates and reserves as compared to vertical wells.
2. For many horizontal well projects, the finding (developing) cost, defined as well cost divided by well reserves, is about $3 to $4/bbl.
3. To produce the same amount of oil, one needs fewer horizontal wells as compared to vertical wells. This results in reduced need for surface pipelines, locations, etc.

The drilling technique used by Elf Aquitaine was involved drilling long radius (1000 ft. turn radius, see Fig. 2) and long length (a few thousand ft.) [5] wells. They were also using down-hole motors to turn the bit and drill wells.

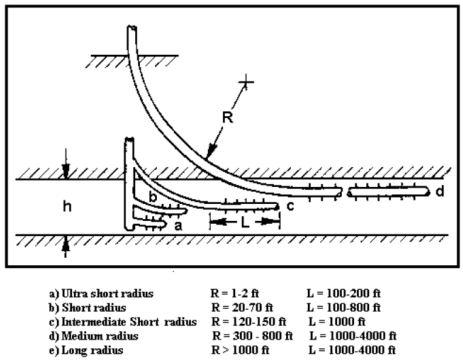
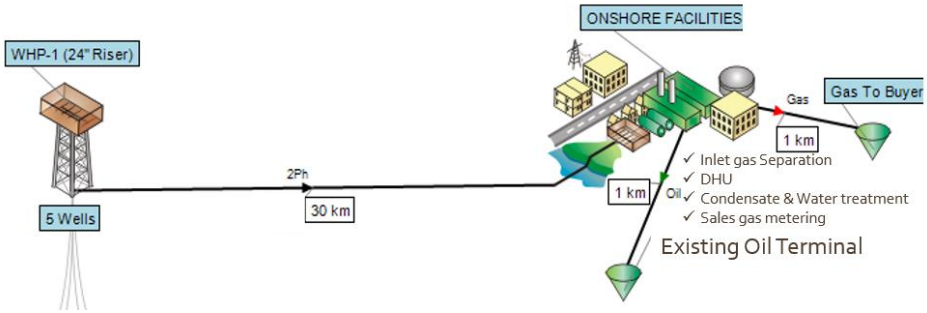


Figure 2: A Schematic of Different Drilling Techniques

Development Plan



The development of the SS field begins with designing the surface facility using the results from the integrated production simulation. Some of the parameters that must be designed are type of platform, size and length of the production pipeline, and gas processing facilities.

PSC Model

Economic calculations are carried out by following the provisions of the North Kalimantan PSC. The following is a brief explanation of the PSC scheme in Indonesia. In the Cost Recovery mechanism (Fig 3), government revenue is only obtained if the recovery from costs does not exceed the revenue (income) each calculation year. Recovery is calculated based on the smallest amount of revenue and cost recovery. Cost Recovery is what is billed, while recovery is what is paid.

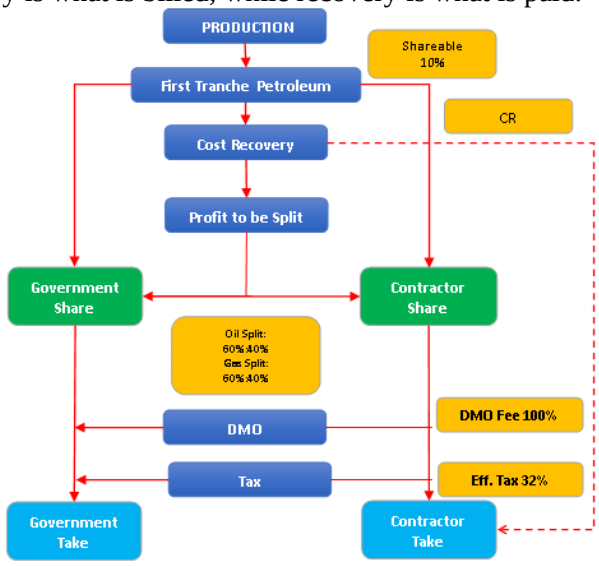


Figure 3: A Schematic of Different Drilling Techniques

Methods

The methodology of the research is selecting the field to be developed, creating, and aligning an integrated production simulation model, optimizing the production rate, calculating the economics of field development. After getting the results from these economic calculations, the next step is to apply horizontal drilling technology and production pipes to get the most optimal production rate and low cost (Fig 4).

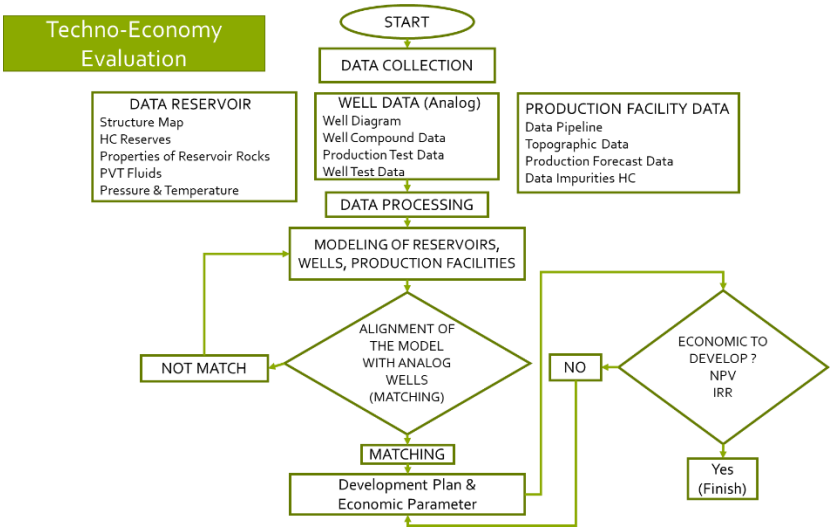


Figure 4: Techno-Economic Methodology

The limitations or scope of the research in this study are as follows:

1. Data used is data from analogy field
2. Field development studies are carried out on Lead SS or structures that do not have drilled wells, so the data used is using analogy data from wells around the SS Field which have similar reservoir properties and almost the same rock quality.
3. The simulation used as one of the inputs for economic calculations is using Integrated Production Modelling (IPM) software from Petroleum Expert (PETEX) Edinburg, UK.
4. Assuming the distance from the field to the production facility based on the map
5. Fiscal terms & conditions used are PSC cost recovery
6. Calculation of the value of Capex and Opex will use the software cost estimate Aspen Questor referring to projects that are already running in the Asian region
7. The economic calculation uses the cash flow method assuming the applicable fiscal terms and which are usually given by the government to operators

Results and Discussion

The result of this research is an integrated simulation model which will give the output of gas production rate and SS field development design as shown below (Fig 4).

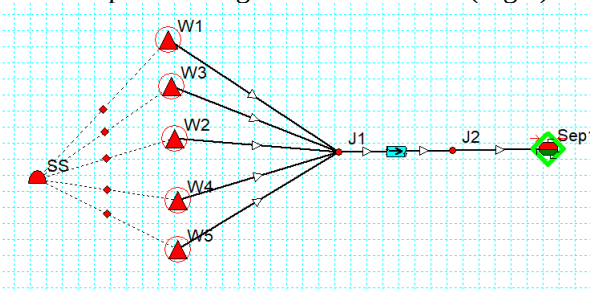


Figure 5: Integretd Production Simulation SS Field

The results of the economic calculations before and after the Techno-Economy study in marginal fields (Table 1). Net cash flow graphic shows how the economic parameter change yearly since the beginning until the end of life (Fig 6) and analysis of the tornado chart obtained as follows (Fig 7). To find out the economic parameters that have the most influence on the development of the SS field is shown in table 2 and figure 8

Table 1: Economic Parameter Comparison. (a) Original economic valuation (b) Optimalization economic valuation

CR ECONOMIC INDICATO	A	1/Jan/22	
NPV Project		-2.5	Mn USD
Profitability Index		1.0	
Cost/boe (Real Term)		13.5	USD/boe
Capex/boe (Real Term)		4.5	USD/boe
Opex/boe (Real Term)		10.1	USD/boe
NPV/boe		(0.0)	USD/boe
IRR		10.97%	

CR ECONOMIC INDICATORS	B	/Jan/22	
NPV Project		35.6	Mn USD
Profitability Index		1.2	
Cost/boe (Real Term)		12.5	USD/boe
Capex/boe (Real Term)		3.5	USD/boe
Opex/boe (Real Term)		10.1	USD/boe
NPV/boe		0.4	USD/boe
IRR		13.35%	

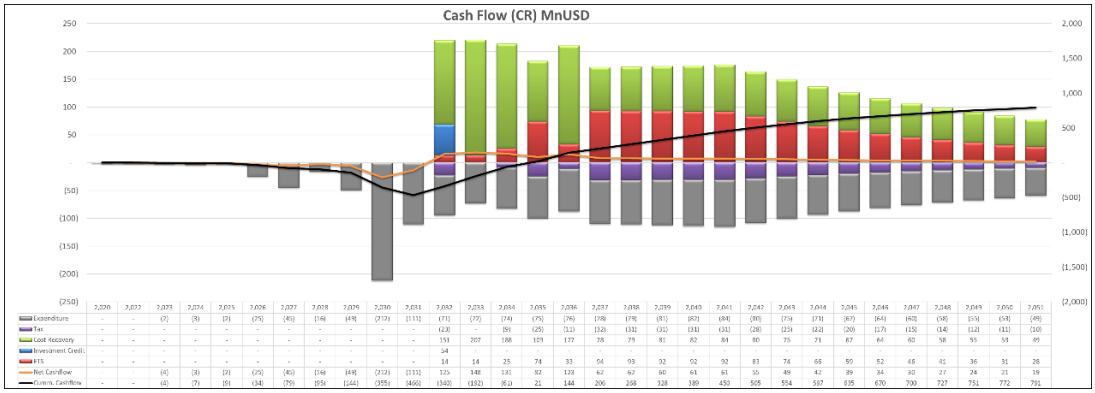


Figure 6: Cash Flow Profile SS Gas Field

Table 2: Sensitivity Analysis of Economic Parameter

COST RECOVERY SENSITIVITY ANALYSIS

in Mn US$	-20%	-15%	-10%	-5%	0%	5%	10%	15%	20%
Gas Production	*(24.7)*	*(8.1)*	*5.9*	*20.9*	*35.6*	*50.0*	*62.7*	*77.0*	*91.1*
Gas Price	*(11.3)*	*(0.1)*	*12.0*	*24.0*	*35.6*	*47.0*	*56.8*	*68.3*	*79.7*
Capex	*62.7*	*55.5*	*48.3*	*42.7*	*35.6*	*28.4*	*20.9*	*13.3*	*5.8*
Opex	*54.8*	*51.1*	*45.9*	*40.8*	*35.6*	*30.4*	*25.1*	*19.7*	*14.3*

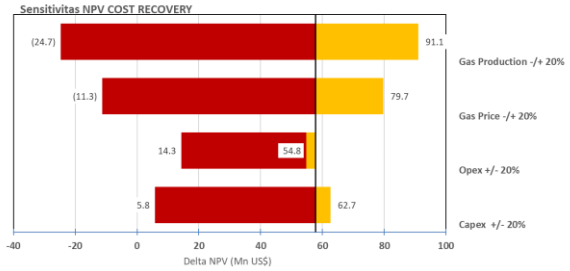


Figure 7: Tornado Chart of Economic Parameter

Conclusions

1. Integrated production simulation is very helpful in field development as an input and optimization tool in economic calculations
2. The economy of marginal fields can be improved with the application of drilling technology and production pipelines
3. The most influencing parameters in the development of marginal gas fields are the rate of gas production, gas prices and capital expenditures
4. NPV of SS field development increase from USD -2.5 Million to USD 35.6 Million

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