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RCP GAS FIELD DEVELOPMENT PLAN TO FULLFILL GAS SALES AGREEMENT PLAN

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ABSTRACT

The RCP field is an exploration field which is currently in the early development stage. From the drilling of exploration wells, a gas reservoir has been found in the Basal Sand formation. The Basal Sand Formation itself is a fairly deep formation and includes a large reservoirhigh pressure high temperature(HPHT). This RCP field hasInitial Gas Inplace IGIP) of 1202 Bcf. Currently there is a demand for gas supply of 50 MMSCFD for 10 years, so it is necessary to evaluate as a supporter of the Gas Sale and Purchase Agreement (PJBG). This research is expected to find out that the RCP field is able to fulfill the PJBG according to the plan.

The development of the RCP Gas Field starts from the IGIP calculation, then calculations are carried outrecovery factorto getestimate ultimate recovery(EUR), which will then be corrected for reserves of impurities. The next stage is the field development scheme. For field development during the PJBG contract period, it is planned to use 3 development wells with optimization of the production rate using chokes. Gross rate field of 67 MMSCFD (22.3 MMSCFD per well) to getgas salesof 50 MMSCFD. After planning the development of the field, the next step is to calculate the economy. The economic calculation is calculated using the PSC scheme based on Fiscal Termapplicable in the RCP field.

The results of the analysis of the development scheme show that the RCP field is able to produce according to the PJBG plan with gas sales daily amount of 50 MMSCFD for 10 years. Economic calculations show positive results so that it is concluded that the RCP Field has economic value and is feasible to be developed. From the economic calculation, we get NPV@10 % = 96.2 MM US$; IRR = 27.1%; POTS = 2.5 years.

Keywords: *gas field development, Gas Sale and Purchase Agreement, Fiscal Term, economic analysis*

I. PRELIMINARY

The RCP gas field is currently in the initial development stage. From the drilling of exploration wells, a gas reservoir has been discovered in the Basal Sand formation. The Basal Sand Formation is a fairly deep and high pressure high temperature (HPHT) reservoir, there for it is challenges to be developed

PT. Pupuk Iskandar Muda (PT. PIM 1) is a subsidiary of PT. Pupuk Indonesia and is located in North Sumatra. Currently PT. PIM 1 has stopped production due to

gas supply constraints. PT. PIM 1 currently needs 50 MMSCFDgas supply and expects to be allocated from the RCP field considering the distance is not too far. Therefore, this research was conducted as an assessment and the basis for preparing the PJBG.

According to Ikoku, Chi. U. in his book entitled "Natural Gas Production Engineering" explains that the development of a gas field that can be considered good is one that has economical but still optimal results. It is strengthened by the results of this study which have economic results so as to strengthen the words of Ikoku, Chi. U.

In general, in the development of oil and gas fields, compressors are needed to increase gas pressure along with decreasing pressure during the production process. In the case in the RCP field, the initial pressure is very high at 7300 psi, while the pressure required to enter the gas plant is 1000 psi for the selling point pressure of 600 psi. So that additional treatment is needed in the form of a Pressure Reduction Valve (PRV) to reduce pressure from 7300 psi to 1000 psi.

II. METHODOLOGY

The methodology used in this research are collecting all the required field data, then analyzing the Initial Reserve Calculation (IGIP), Determination of Recovery Factor, then correcting the impurities to get net gas, then planning PJBG (Gas Sale and Purchase Agreement), this plan is based on requests from potential gas buyers, the last, field development planning and economic calculations.

GAS RESERVE CALCULATION

In estimating the amount of gas reserves in a reservoir, several methods have been used, there are: Volumetric Method, Material Balance Method and Decline Curve Method.

Volumetric Method

The volumetric method is usually used in the early stages of an oil or gas field. Calculating Original Gas In Place from a initial reservoir, it can be calculated volumetrically with the following equation:

$$GIIP = \frac{43560 \times V_b \times \phi \times (1 - S_{wi})}{B_{gi}}$$

Ultimate Recovery Determination (EUR)

Ultimate Recovery is the amount of reserves that can be taken commercially in a reservoir. The relationship between Estimated Ultimate Recovery (EUR), Original Gas in Place, and Recovery Factor (RF) is as follows:

UR = OGIP x RF

Determination of Well Deliverability

The deliverability test is a well test that is commonly used to determine the productivity of gas wells. The productivity indicator obtained from this test is the Absolute Open Flow Potential (AOFP). Absolute Open Flow Potential (AOFP) is the ability of a gas well to produce gas to the surface with a maximum flow rate at the bottom of the well at atmospheric pressure (± 14.7 psia).

$$q_{sc} = C(P_r^2 - P_{wf}^2)^n$$

Determination of Well Production Potential

The potential for well production can be found by the equation:

Well Production Potential = 30% x AOFP

Determination of Field Production Potential

Determination of field production potential is determined to determine whether the field can meet the requirements for the production rate of the PJBG contract. Field production potential can be determined by the equation:

$$\text{Field Production Potential} = \frac{IGIP}{365\ hari\ X\ Waktu\ Kontrak\ PJBG}$$

NET CASH FLOW CALCULATION

*cash flow*is a picture of the final flow of funds that can be obtained by contractors and the government.

Gross Revenue

*Gross revenue*is the result of multiplying the rate of production of oil/gas with the price of oil/ gas. To determine the amount*gross revenue* using the equation:

$$GR = (q_g\ x\ a)\ x\ (n\ x\ b\ x\ \$)$$

Investation

Investment is the amount of cost or the amount of capital invested in a project. Investment is divided into two, namely:*capital (tangible) cost*and*non-capital (intangible) cost*. SS

Capital Cost

Capital cost (*capital cost / tangible cost*) namely expenditures related to physical objects, such as machinery, drilling equipment, construction equipment, oil storage facilities (tanks), construction and transportation equipment which depreciated in value due to time of use. Examples of capital costs in the petroleum industry are wellheads, tubing, packers, flowlines, manifolds, headers, storage tanks, pumps, and so on.

Non-Capital Cost

Non-capital costs (*non-capital costs / intangible costs*) are costs associated with procurement or use goods which not depreciate, for example drilling mud in drilling operations. As for the non-capital costs are Exploration and Development which include *Geologic And Geophysics (G&G) Work*, *Intangible Drilling Exploration And Development Cost*, *Workovers, Plug-Backs, Deepening*and production costs are*Non-Capital Production Costs.*

Operating Cost*(OPEX)*

Operating Cost (*Operating Cost*) are costs incurred both in connection with the existence of production operations (*variable cost*) as well as costs that must be incurred by the company in the form of general administration which does not affect the size of production (*fixed cost*).

Escalation Rate

In doing calculations*net cash flow* should also be taken into account the possibility of inflation in the future. The existence of inflation will affect the increase in investment in the form of capital and operating costs. The amount of inflation is expressed in*escalation rate*. As for the formula *escalation factor*what will be done in the calculation*net cash flow*are as follows:

Escalation Factor= (1+*Escalation Rate*)(n-1)

Revenue Sharing (Share)

Based on the production sharing contract, the equity share between the contractor and the state (before tax) in the RCP field case is 53% : 47%, previously deducted by FTP and Cost Recovery.

Recoverable Cost

*Cost recovery*is the return of costs used for field development to contractors through certain mechanisms.*Cost recovery*taken from*gross revenue*before the remainder is divided between the contractor and the government.

Taxable Income

*Taxable income*is the total taxable income of the contractor. the size *taxable income*is *contractor share*which has been reduced by DMO then added with *investment credit*.

Tax (Tax)

Taxes are one of the sources of government revenue. The government takes its share of the production of oil and gas through a tax levied on all contractor income earned from these businesses. The tax system created by the government is intended to

maximize government revenue. The current tax rate is 40%.

Net Contactor Take*(NCT)*

*Net Contractor Take*is the contractor's net income or the amount of contractor's income that has been taxed or*taxable income* reduced *tax*.

Net Government Take*(NGT)*

*Government Take*or Indonesia Take is the total revenue received by the government. This income is the result of the government's calculation, which is gas sales (gross revenue) minus the total revenue from contractors.

DETERMINATION OF ECONOMIC INDICATORS

The Economic Indicators to be determined are as follows:

***Rate of Return*(ROR)**

Internal Rate of Return(IRR) or*Rate of Return* (ROR) indicates the relative value*earning power* of the capital invested in the project i.e *discount rate*which causes the NPV to be zero. The ROR price must satisfy the following equation:

$$0 = \sum_{i=1}^{n} CF_o + \frac{CF_n}{(1+ROR)^n}$$

Usually every company has a minimum value limit of the desired ROR which is expressed in MARR (*Minimum Attractive Rate of Return*). A project is considered feasible if the IRR is greater than the bank interest or greater than the MARR. An example of an ROR or IRR interpolation curve is presented in **Figure 1.**

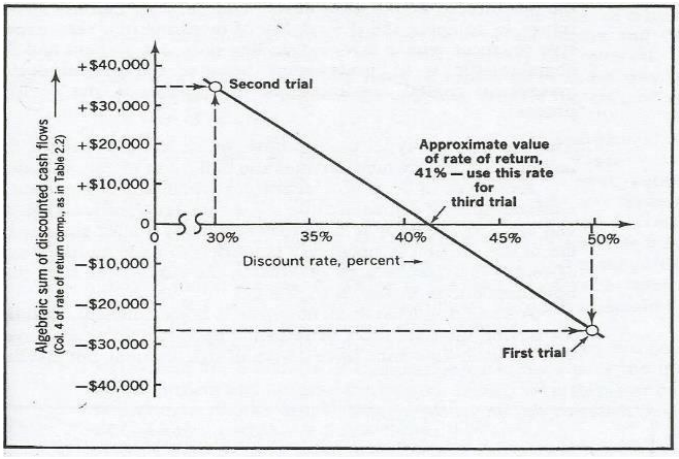

Figure 1. ROR . Interpolation

***Net Present Value*(NPV)**

Net Present Value(NPV) is the net profit value of a project measured at the present time. A project is said to be feasible if the NPV is positive or greater than the minimum target NPV that can be obtained by the company, if the NPV value of a

project is negative, it can be said that the project has suffered a loss. The NPV value of a project is zero, so the amount of expenditure to carry out the project is equal to the amount of revenue. The general form of the NPV equation is:

Profit to Investment Ratio (PEAR)

Profit to Investment Ratio(PIR) is also called *Return on Investment*(ROI) is the ratio of the net profit that is not deducted (*undiscounted net cash*flow) to the amount of investment invested. *Profit to Investment Ratio* formulated as follows:

$$NPV = \sum_{t=1}^{n} CF_o + \frac{CF_n}{(1+r)^n}$$

Discounted Profit to Investment Ratio (*DPR)*

Discounted Profit to Investment Ratio (DPIR) is a measure that reflects the ability to provide total benefits. DPIR is defined as the ratio between NPV to investment.

$$PIR = \frac{\text{Total Undiscounted Net Cashflow}}{\text{Investasi}}$$

A project is said to be feasible if the DPIR is positive or greater than the minimum DPIR target that can be obtained by the company.

Payout Time(POT)

Payout Time(POTS) or*Payback Period*(PBP) is a period required to be able to recoup investment spending by using*net cash flows.*The POT of an investment describes the length of time it takes for the funds invested in an investment to be fully recovered. A project is said to be feasible if the POT is small compared to the life of the project or smaller than the minimum target time for the company to return its capital or investment.

III. RESULTS AND DISCUSSION

Calculation Reserve at first (IGIP)

Calculation backup at first obtained from reservoir static modeling. The reservoir static modeling was then calculated using the volumetric method, so that the initial gas volume in place (IGIP 2P) was 1202 BCF.

RECOVERY FACTOR (RF) DETERMINATION

*Recovery Factor*obtained from the analysis *material balance*. The analysis was carried out by plotting P/Z against Gp (total gas production). The first plot point P/Z is 6097, which is obtained from the initial reservoir pressure (7300 psi) divided by the Z factor (1,197), with Gp 0. The second plot point is at P/Z 0 with Gp 1202. From these two points a line is then drawn connect the two, so that a certain equation will be obtained from the trend curve. Below is a graph plot between P / Z to Gp.

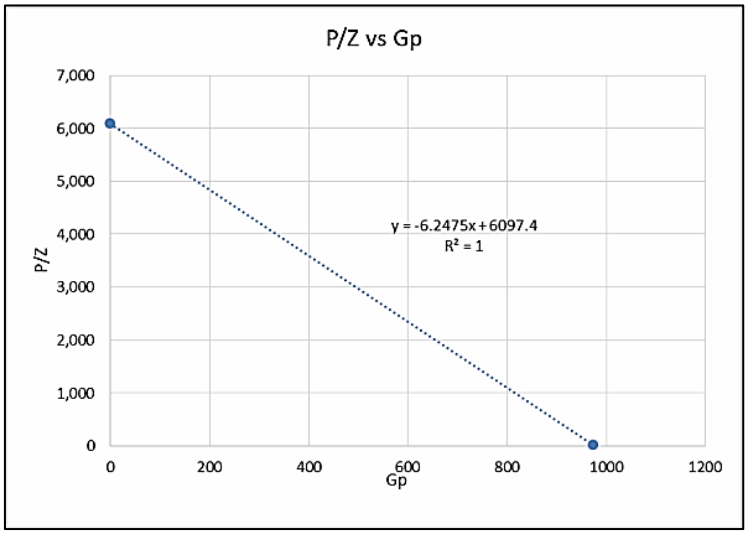

Figure 2. P/Z vs Gp . plots

Next, an abandonment pressure plot is carried out (minimum gas pressure will be produced) based on this curve, so that EUR or field reserves of 974 BCF will be obtained with a recovery factor of 81%.

IMPURITIES CORRECTION

Reservoir fluid samples for the Basalt Sandstone formation in the RCP Field were obtained from well RCP-01. Samples were taken during the DST-1, DST-2, and DST-3 well testing operations. The initial reservoir conditions obtained in this study were determined based on composition data, which refers to data from the DST-1 data of the RCP-01 well, which has a dry gas reservoir fluid type. Data from DST-1 well RCP-01 showed no condensate formed at the surface. The following is the average reservoir fluid composition data obtained from DST-1 well RCP-01 (Table 1).

Table 1. Average fluid composition data from DST-1 . operation well RCP-01

Composition	Mol (%)	Mol (frac)	Note
C_1	80.721	0.8072	Based on DST-1 (Average Fluid Compositions)
C_2	0.806	0.00806	
C_3	0.256	0.00256	
iC_4	0	0	
nC_4	0	0	
CO_2	18.214	0.18214	
H_2S	0.002	0.00002	

Based on the composition above, this will then be used as a correction to the existing gas reserves. This is done to get the value of gas reserves that can be produced for sale. The amount of impurities is 18.216% then multiplied by EUR or reserves of 974 BCF so that the gas reserves that can be sold are 974 BCF - (974 BCF x 18.216%) = 797 BCF.

PLANNING OF GAS PURCHASE AGREEMENT (PJBG)

The planned sale of gas from this field is 50 MMSCFD for a period of 10 years. The sale is planned to start on January 1, 2024 until December 31, 2033. The RCP field itself manages the block under a PSC scheme until November 2035. Therefore, the completion of the Gas Sales Purchase Agreement (PJBG) is expected before the completion of the PSC period.*contracts.*

DEVELOPMENT SCENARIO

The development of the "RCP" gas field is carried out using 3 production wells, namely the RCP-D1 well, the RCP-D2 well, and the RCP-D3 well with a gas rate per well of 21.7 MMSCFD. PJBG (Gas Sale and Purchase Agreement) with a total gas rate of 50 MMSCFD for 10 years starting from January 1, 2024 – December 31, 2033. So that the total production for this field is added with 18% impurities and a safety factor of 7% of the total PJBG contracts, namely of 67 MMSCFD.

The first step is to calculate the potential for well production by following the rule of thumb 30% of the AOFP for a gas well capable of reaching a longer plateau rate.

- Calculation of potential well production : 30% x AOFP
  Calculation of potential well production : 30% x 90 MMSCFD
  Calculation of potential well production : 30 MMSCFD
- Calculation of field production potential : EUR : (365 days x PJBG Contract Time)
  Calculation of Field production potential : (974 x1000) : (365 x 10)
  = 266.85 MMSCFD Field production potential
- calculation (net gas) : EUR : (365 days x PJBG Contract Time)
  Calculation of field production potential (net gas) : (797 x1000) : (365 x 10)
  = 218.36 MMSCFD
- Field gas rate calculation : PJBG Contract Rate + (PJBG Contract Rate x 7%) + Impurities
  Field gas rate calculation : 50 + (50 X 7%) + (50 X 18%)
  = 67 MMSCFD

For produce gas as big as 67 MMSCFD, then this field will use 3 production wells. So that every 1 well produces a gas rate of 22.3 MMSCFD, with*net gas*each well is 16.7 MMSCFD.

The next plan is to find out the amount of gas rate decline every year with the assumption that there is a decrease from*initial rate*by 3%. So that it is known when is the right time for optimization*choke*and additional production wells.

Development planning begins with drilling 1 development well in 2022 and 2 wells in 2023. Initial production starts on January 1, 2024 using 3 production wells.*gas rate*each well is 22.3 MMSCFD. Wellhead pressure (Pwh) is 6750 psia. With a total rate of 67 MMSCFD and taking into account the decline rate of 3%, the

production rate will decrease in the 2nd year by 65 MMSCFD, in the 3rd year by 63 MMSCFD, and in the 4th year by 61.1 MMSCFD. In the next 5 years the production rate will decrease to 59.3 MMSCFD. A rate of 59.3 MMSCFD will get net gas of only 48.6 MMSCFD. Therefore, the next opening will be*choke*by lowering *Tubing Head Pressure*from 5800 psi to 5700 psi to get a return production rate of 67 MMSCFD (based on IPR data plot). Furthermore, for the 6th year, you will get a rate of 65 MMSCFD, the 7th year of 63 MMSCFD, and the 8th year of 61.1 MMSCFD. For the next 9th year will do the opening*choke*back by lowering *Tubing Head Pressure*from 5150 psi to 4975 psi to get a return production rate of 67 MMSCFD. For the 10th year, the rate will return to 65 MMSCFD. So that the total production wells until the end of the PJBG contract is 3 wells with an optimization scheme*choke*. The tabulation for production planning for the RCP gas field is shown in Table 2 with the production planning drawing in Figure 11.

Table 2. RCP gas field production planning tabulation

Waktu PJBG	Jumlah Sumur	Gas Rate Tiap Sumur (MMSCFD)	Gas Rate Lapangan (MMSCFD)	Net gas (MMSCFD)	Gas Sales (MMSCFD)	Keterangan
01 Januari 2024	3	22.3	67	54.9	50	
01 Januari 2025	3	21.6	64.8	53.1	50	
01 Januari 2026	3	21	63	51.7	50	
01 Januari 2027	3	20.4	61.2	50.2	50	
01 Januari 2028	3	22.3	67	54.9	50	Melakukan choke up untuk menurunkan THP 5800 psi ke 5700 psi
01 Januari 2029	3	21.6	64.8	53.1	50	
01 Januari 2030	3	21	63	51.7	50	
01 Januari 2031	3	20.4	61.2	50.2	50	
01 Januari 2032	3	22.3	67	54.9	50	Melakukan choke up untuk menurunkan THP 5150 psi ke 4975 psi
01 Januari 2033	3	21.6	64.8	53.1	50	

*gas rate*produced will be directly sent to the sales point / consumer. The sales point specifications are as follows:

- Sales point pressure : 600 psia
- Gas rate : 50 MMSCFD

The pressure reduction from 6750 psi to 1000 psi is to install a choke valve and then the Pressure Reduction Valve (PRV) is 2x until it gets a pressure of 1000 psi to enter the gas plant.

From the gas plant to the next delivery station, the pressure will decrease from 1000 psi to 600 psi.

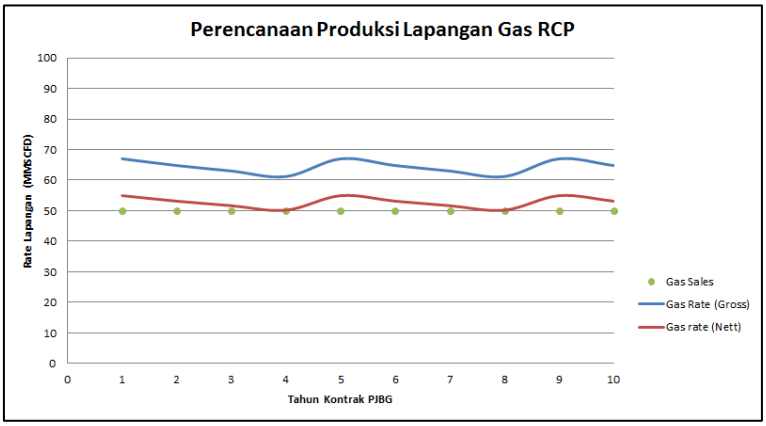

Figure 11. RCP Gas Field Production Planning

ECONOMIC CALCULATIONS

Capex . Calculations

The Capex calculation includes the cost of drilling wells and surface facilities.

Well Cost

The development of this RCP field uses the scenario of adding 3 development wells at a cost of one well of 25 million dollars. The drilling of 1 well will be carried out in 2022 and 2 wells in 2023. The total investment cost for the development well is 75 million dollars.

Cost*Surface Facility*

Surface facility fees include costs of*Gas Plant, Pipeline*(*flowline*and*trunkline*), and*Delivery Station*.

- *Gas Plant*including*CO2 and Acid Removal*requires an investment cost of 49.2 million dollars for a production capacity of 70 MMSCFD.
- *Pipeline*covers*flowline*2000 m long 8 inch pipe and*trunkline* 35000 m long 10 inc pipe with an investment cost of 12.8 million dollars.
- Delivery Station (metering) requires an investment of 6.5 million dollars.

Opex calculation

Opex calculations include operational costs during field development, such as employee salaries, etc. The estimated amount of opex costs in developing the RCP field is 105 million dollars over the period of the PJBG contract.

ECONOMIC ANALYSIS

In the economic analysis, it is necessary to know beforehand about the Block contract scheme as well as *Fiscal Term*applicable to the block. The RCP field is part of the CP Block and has a PSC contract with the state with a system *Cost Recovery*.

Table 3. *Fiscal Term*and*Cash Flow*RCP Lapangan field

RCP Field	
First Tranche Petroleum	20% Shared
Incentives	
Oil Investment Credit	0%
Gas Investment Credit	0.00%
Oil Interest Cost Recovery	0%
Gas Interest Cost Recovery	LIBOR+1.5%
Taxation	
Corporation Tax Rate	25%
Branch Profit Tax Rate Effective	20%
Profit Tax Rate Interest	40%
Withholdings Tax Rate	15%
Profit Split	
Gas Split Pre Tax	53.3%
Gas Split Post Tax	32.0%
Oil Split Pre Tax	29.2%
Oil Split Post Tax	17.5%
DMO	
DMO Obligation (%of production)	25%
DMO Compensation (%of ICP)	25%
Production Bonus	
Initial Payment, $MM	0
Cumulative I, MMBOE	25
Bonus payments, $MM	0.5
Cumulative II, MMBOE	50
Bonus payments, $MM	1
Cumulative III, MMBOE	75
Bonus payments, $MM	2
Signature Bonus	
Sign agreement, $MM	0
Depreciation	
Oil Depreciation, Years	5
Oil Depreciation, %	25%
Gas Depreciation, Years	5
Gas Depreciation, %	25%

By calculation, Gross revenue will be obtained from the PJBG contract for 10 years. Furthermore, the revenue will be deducted by FTP (First Tranch Petroleum) by 20% and the recovery factor will be equity to be split, which will then be divided by 53% for contractors and 47% for the government. Furthermore, the contractor share will still be subject to a 40% tax. FTP itself is shareable, where 53% of FTP is

for contractors and 47% of FTP is for government.

From the economic calculations that have been carried out, we get*economic valuation* as table 4. below.

Table 4. *Summary*RCP Field Economic Calculations

Parameter	Nilai
Gas Production	183 BCF
Daily Gas Prod	50 MMSCFD
Gas Price	6 US$/MMBTU
Gross Revenue	1095.9 MMUSD
CAPEX	144 MMUSD
OPEX	105 MMUSD
Cost Recovery	249 MMUSD
Tax	180,6 MMUSD
Government Share	576.1 MMUSD
Net Contractor Equity (after Tax)	270,8 MMUSD
Total Contractor Share	519.8 MMUSD
Contractor Cashflow	271 MMUSD
Cum Contractor Cashflow	271 MMUSD
NPV10	96,2 MMUSD
IRR	27,10%
POT	2.5 tahun

IV. CONCLUSION

Based on research result about in the development of the RCP gas field, the following conclusions can be drawn:

1. From the research conducted, the results of the initial gas reserve calculation (IGIP) are 1202 BCF (2P),*Recovery factor*81%, EUR 974 BCF, and net gas reserves that can be produced are 797 BCF.
2. From this study it was found that the daily production potential of each well is 30 MMSCFD and the daily production potential from the field is 266.85 MMSCFD.
3. The RCP field will plan a Gas Sale and Purchase Agreement (PJBG) of 50 MMSCFD for 10 years.
4. The best development for the RCP field to fulfill the PJBG plan is to add 3 development wells with *rate*initial production of 67 MMSCFD with optimization*choke*to get a net gas of 50 MMSCFD.
5. The total investment cost required to develop the RCP Field is $249 million.
6. The economic calculation of the RCP field is considered economical, with economic indicators using the method*Production Sharing Contract*(PSC) With calculation results*Gross*

Revenue: US$ 1,095.9 Million,*Cost Recovery*: US$ 249 Million (22% of*Gross Revenue), Net Government take*: US$ 576.1 Million (53% of *Gross Revenue*),*Net Contractor Share*: US$ 271 Million (25% of*Gross Revenue*) with IRR *contractor*27.1% and POT 2.5 years.

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