

# Management And Financial Accounting In Oil and Gas Upstream Industry.

## Investment and Decision Analysis for Petroleum Exploration & Production

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### Abstract

Investment and decision analysis for petroleum exploration is a topic that many explorationists, geologists, management accountants and finance managers like to know about. This paper shows the major concepts of how investment, decision or project analysis is made for petroleum exploration in financial view. Such analysis depends on cash-flow models and applying capital budgeting techniques per International Oil and Gas business practices that consider accounting concepts, taxation, and contractual arrangement that impact on such analysis. This paper does not cover such analysis in technical view because it is out of specialization, but this financial analysis shall be made in conjunction with technical experienced staff to obtain some technical information of estimated reserves, estimated initial production, chance of success and others to enable Company to prepare investment and decision analysis.

*Keywords: Investment and decision analysis for petroleum exploration; Project Analysis for Petroleum Exploratio;, Present value of net cash flow in future for reserves, fair value of exploration license.*

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For Petroleum investment, decision or project analysis, we need to consider the home country taxation, production sharing and joint interest arrangements, and environmental legislations. It is preferred to divide this paper into some sections; the first two sections that brief the major aspects of Production Sharing Agreement (PSA) and Joint Operating Agreement (JOA), the major aspects of taxation, and accounting

practices, the major risks that can be faced by Oil Companies, the input and output of the investment and decision analysis.

### Major aspects of Production-Sharing System

Presenting the major aspects of production sharing contracts enable management accountant to know how the cash flow analysis should be processed.

### **Exploration and Development**

Many fiscal regime in Middle East and Africa divided the periods of the Production Sharing Agreement's (PSA's) into a) Exploration phase that is most likely divided by two periods; first exploration period; second exploration period, each having specified minimum exploration obligation and expenditures that must be conducted within specified time limit. Each exploration period takes about between 2 and 3 years that can be extended from 6 months to 2 years. b) Development phase is commencing of the first Commercial Discovery of Oil/Gas and continue for a period of 20 years and can be extended by up to 5 Years more.

### **Work Commitment**

Work commitment is always indicated in PSAs that covers the minimum work obligation and minimum expenditure/financial obligation during the exploration period. The Multi-company is obligated to conduct the following Exploration work during the Exploration Period:

- a) Seismic Data that are generally measured in kilometers of 2D or 3D seismic lines to be acquired, processed and interpreted or reprocessed the available data.
- b) G&G studies
- c) Drill and evaluate number of exploratory and appraisal wells.

Production Sharing Agreement determines how many dollars are spent during each

exploration period as minimum expenditure obligation.

For each exploration period, Contractor shall deliver irrevocable letter of credit that covers the minimum expenditures obligation, that is reduced when the Contractor meet the minimum expenditure obligation. Most of oil companies spend exploration cost that exceeds the value of minimum work commitment.

### **Annual Work Program**

Subject to the provisions of PSAs, the multi-company shall conduct the required exploration activities during the Exploration period of Exploration work program cannot be changed or amended without the approval of host government. The Exploration work should be fulfilled even if it exceeds the Minimum Expenditure Obligation.

### **Financing & Technology**

The Contractor provides all the required financing and technology in according to the minimum work obligation in the PSA, and multi-company bears all the risks solely.

### **Relinquishment and Assignment**

There is requirement to relinquish certain portion of the exploration area at the end of the first exploration period and totally relinquish at the end of the second exploration period. The area to be relinquished at the end of the first exploration is about 25% of many of PSAs. The multi-company has the right to withdraw before end of the first exploration period but has to fulfill the minimum work obligation.

Any assignment by any partner license of all or part of its interests shall be subject to specific rate of the Net Sales Proceeds that shall be paid to host government in some PSAs.

### **Bonuses Payment**

Bonuses are paid upon signing the Production Sharing Agreement that is called Signature bonus which is varied in dollars depend on the prospectively of the contract area, competition and negotiation. Also, Contactor shall pay annual bonuses to the host government. Kurdistan PSAs consider the annual bonus as recoverable costs but Yemen PSA does not. Also, first production bonus is paid after the first tanker lifting of multi-company's share, , and pays another amount of production bonus that is based on the daily production scales or cumulative productions depends on PSAs, this bonus in non-recoverable in most PSAs.

### **Production Sharing Oil**

The remaining of crude oil or natural gas after deducting royalty and cost oil from the gross average daily crude oil produced and not used in petroleum operations, is calculated based on scales that the government portion is increased if the average daily production is increased such as Yemen and Tanzania PSAs or based on R-Factor that government portion is increased if R-factor increased by increasing the cumulative net revenue obtained by subcontractors to the cumulative cost spent, R-factor is applied per Tunisian PSA, Kurdistan PSA. As per Libyan PSA, multi-company is entitled to crude oil in percentage determined for cost recovery until cumulative value equals cumulative

expenditures that is computed based by multiply Base factor (that is determined at indicated levels of average total daily production) by A factor (that is determined by indicated ratios of cumulative value of production received by contactor)

### **Non-Recoverable Cost**

In the fiscal system, there are some expenditures is non-recoverable from oil production such as signature bonus, fixed tax and costs and expenses not related directly or indirectly to Petroleum Operations such as

- 1) Losses which are recovered through insurance, any contract of indemnity
- 2) Specific bonuses paid to host government
- 3) Interest, fees and commissions on loans and guarantees.
- 4) Exploration and production rentals.
- 5) Expenses incurred and paid for the marketing of Crude Oil from the Agreement

### **Cost Recovery**

All the following costs and expenses will be recovered to the multi-company by Oil Cost:

- a) Operating expenses
- b) Exploration expenses that include but not limited to, those accumulated prior to commencement of initial commercial production that should be recoverable at specific rate.
- c) Development expenses that include but not limited to, those accumulated prior to commencement of initial commercial production that should be recoverable at specific rate.

If all costs, expenses and expenditures that are recoverable in any Quarter, exceed the “Cost Recoverable Ceiling”, it shall be carried forward for recovery in the next succeeding Quarter or Quarters until fully recovered, but in no case shall be recovered after the termination of an Agreement

#### **Administrative Overhead**

Multi-Company is compensated its administrative overhead for tasks performed outside host government, that is applicable to Petroleum operations under the PSA. Such overhead can be recovered but within specific limits which shall be calculated by multiplying the applicable sliding scale percentage stated times the total year-to-date exploration recoverable costs and/or specific agreed rate times the development, production and decommissioning costs in most PSAs. The Multi-company is not allowed to recover more than the limited amounts stated in PSAs.

#### **Corporation Share**

Many PSAs in Middle East require the Multi-company to carry The Public Corporation of a host government that shall not receive any cost oil, but acquires specific rate of the profit oil.

#### **Host government Taxes**

PSAs exempt multi-companies from any taxes and levies except for some specific taxes such as fixed tax on exploration expenditures in some country such as Yemen, withholding income taxes on local staff salary, some PSA exempt the expatriate’s salaries from taxes but other PSAs impose taxes on expatriate’s salaries during development phase based on host government taxation.

For the income tax on Multi-company’s income, the income taxes will be paid by host government on behalf of the Contractor and not be charged against the company.

#### **Major aspects of Interest and Operation Arrangements**

##### **Joint Operation Agreement**

The type of interests between partners rather than government that is Working Interest or (Joint Operating Interest) which is the interest in the oil and gas in place that bears most or all of the cost of exploration, development and operation of the property. The Contractor partners will bear the cost and the partners share the profit oil except for public corporation of host government that does not bear the cost.

##### **Direct Charges**

Operator will charge or credit Joint Venture accounts for all expenditures or credits incurred or received in conducting Joint Operations.

##### **Indirect Charges**

An indirect charge is to compensate Operator’s parent affiliate in Home Office and its affiliates, for its administrative contributions of performing services not chargeable under direct charges for the benefit of Joint Operations. The Indirect charge is calculated by multiplying the applicable sliding scale percentage stated in Joint Operation Agreement times the total Joint Account costs excluding some specific expenses. The operator cannot be compensated more than the limited amount of overhead that is allowed by JOA.

### **Farm-out/Farm-in/Carrying Interest Agreement**

The Farm-out obligation is either overriding royalty, retained interest, carved-out interest, net profit interest or neither. The most farm-out agreement in some Middle East is to transfer the rights and obligations from transferor to transferee and the transferee will become working interest partner for specific interest rate, and in condition to pay Farmor specific amounts to transfer part of the its working interest to Farmee. The Amounts that Farmee should pay them either is related to planned well or all previous costs were previously paid by Farmor based on the assigned working interest, or/and specific amount when producing the first discovery.

Carrying Interest is used specially between Agent or Sponsor of Contractor/multi-company to transfer part of working interest from assigner to assignee in condition that carried party (assignee) either pay specific amounts presently or not pay any amount until license become productive then working interests will revert back to the carried party when carrying party (assignor) reaches payout.

### **Major aspects of Investor's Country Prevailing Laws:**

Double taxation occurs when countries have different definitions of taxable income and tax rate, it rises when taxpayer is resident in foreign country and generates income in another country such as host country. Relief from double taxes comes in three basic forms; exemption; tax credits; and deduction. In some countries income tax,

allow taxpayers to deduct the foreign tax payments, but not exceeding the tax limits, other countries have no limits.

Calculating the preliminary taxes that shall be paid is important for investment analysis. Management Accountant needs to have the key concepts of taxation of the resident country. In our paper we will display the key concepts of most international taxation. The income tax that is paid by host government on behalf of Multi-company is not considered tax credit, exemption or deductions because multi-company does not pay such taxes in most international PSAs.

### **Taxation**

Most of multi-companies' net income are subject to between 30-40% corporate tax rate.

In most international taxation, Corporate should reach to taxable income, it should immediate deduct, and not immediate deduct;

Corporate should not immediate deduct the following:

- 1) Some expenditure, such as the cost of acquiring capital assets, is generally not deductible that is depreciated over the economical life of reserves.
- 2) development drilling for petroleum and facility costs which is depreciated over the economical life of reserves;
- 3) Cost of a depreciating asset. Depreciating assets are assets with a limited effective life that are

reasonably expected to decline in value.

Some states have cost threshold for assets that are to be considered as depreciating assets.

- 4) Also, some countries, e.g. U.S and Canada divided development costs into Tangible Drilling Cost (TDC) that are depleted over the economical life of reserves and Intangible Drilling Cost (ITD) that may part of it is amortized over period of time.

Depreciating assets include such items as computers, electric tools, furniture and motor vehicles. Depreciating assets excluded from the UCA; depreciating assets that are capital works – for example, buildings and structural improvements for which deductions are available under the separate provisions for capital works or would have been available if the assets had met certain conditions for the deductions.

Corporate can immediate deduct the following:

- 1) exploration or prospecting G&G costs except for acquiring acreage that includes:
  - a. geological, geophysical and geochemical surveys; And any G&G study costs except for acquiring license.
  - b. Exploration well costs that found no commercial oil
  - c. feasibility studies to evaluate the economic feasibility of mining minerals or quarry materials once they have been discovered;
- 2) Workover and Operating costs
- 3) rehabilitation of mine and quarry sites; and;

- 4) Environmental protection activities.

Also, the Corporate that produce and sale crude oil, may be subject to Crude Oil Excise Rates, ad-voluerum, production or sale tax rates.

## **Financial and Management Accounting Practices**

### **Depletion, Depreciation & Amortization (DD&A)**

Both reserves and production/sale data are used for calculating Depletion. Depletion calculation include only the portion of total proved or proved developed reserves and production that the working interest owner is entitled to.

$$\frac{\text{Book Value end of period}}{\text{Estimated Reserves at beginning of period}} \times \text{Production for period}$$

The following Capital Expenditures are allocated over years by computing Depletion.

- a) Development Cost
- b) Facility Cost
- c) Acquiring Cost

Depreciation is calculated for depreciating assets. Amortization is calculated for part of intangible drilling cost that should be amortized not more than 5 years for domestic integrated producer and no more than 10 years for foreign intangible costs per U.S tax, and part of it is immediate expensed. However, GAAP require the company that follows successful effort method to expense any costs that are not determination of proved reserves and capitalize otherwise.

### **Asset Retirement Obligation**

Asset Retirement Obligation is future decommissioning costs were estimated and it is treated as reduction of future net cash flows. Some PSCs such as Kurdistan require Contractor to start depositing a funds and making provision for decommissioning costs before the end of productive contract by 10 years.

### **Operating Expenditures**

This cost is called OPEX that is referred to Lease Operating Expenditures which are occurred periodically and are necessary for the day-to-day operations of the field. In the feasibility study and cash-flow model, such costs are usually expressed per year per barrel. It consists of two elements 1) indirect cost; 2) direct cost per production level.

Opex include cost of manpower; utilities and materials that are consumed for operation activities; credits of co-products; administrative and general expenses spent for operations activities; maintenance of facility equipment; lifting cost; treatment cost and insurance cost.

### **Capital Expenditures**

The main characteristic of CAPEX is usually incurred at the beginning of a project, may be several years before any revenue is obtained. The below costs are considered in the CAPEX budget.

#### **a) Acquiring Cost**

Acquiring cost paid by Multi-companies to obtain a license that includes lease bonus; data purchased; G&G cost spent for acquiring acreage, legal fees and management or manpower spent for obtaining

such lease before signing the Production-sharing contract with government. Acquisition costs is capitalized, but not recovered from oil cost as per some PSAs. This cost is depleted over the life of net Contractor's share of oil reserves. This cost is considered as initial investment if new acreage will be acquired, but shall be considered as sunk costs if the acreage is already acquired and Company needs to make project analysis for other activities.

#### **b) Geological & Geophysical Studies**

G&G cost are pre-drilling exploratory well; this cost includes topographical, geological, geophysical, geochemical costs. In accounting standards, the Company which use successful efforts method, expense such cost except the G&G that is related to acquiring acreage is capitalized as acquisition cost, and the Company which uses the full cost method, capitalize such cost. For feasibility study of investment or project evaluation analysis, G&G is consider as relevant cost if Company needs to decide to have G&G to drill a well.

This cost is considered as part of initial investment if the acreage not acquired or seismic is not run yet, but the historical costs of such activities shall be considered as sunk costs and excluded in project analysis of drilling well.

**c) Exploratory Well**

Exploratory well is a well drilled to find and produce oil or gas in an unproved area. In view of accounting standards and under successful method, exploratory well that does not find commercial oil or gas, the cost of this well is expenses, but if commercial oil or gas is found, the cost of this well is capitalized however, under full cost method, the cost of this well is capitalized, whether oil/gas is found or not. For feasibility study of investment or project evaluation analysis, exploration cost is considered as relevant cost.

Any costs that were incurred before making a decisions of drilling exploratory well shall be considered as sunk cost, and only the estimated costs of drilling exploratory well shall be considered as relevant costs.

**d) Development & Appraisal Well**

Development well is well drilled within the proved area of an oil or gas reservoir. Appraisal well is a well drilled to evaluate the reservoir. The cost of such well is CAPEX.

Any costs that were incurred before making a decision of drilling development well shall be considered as sunk cost, and only the estimated costs of drilling development well, facility costs shall be considered as relevant cost.

**e) Facility Cost**

The cost of Facility equipments are required to produce oil/gas. Some of those equipment are required at earlier before production and some later during economic life of well. Facility cost includes tanks, storage, treaters, heater, meter run, separators, flow-line pipes, Vapor recovery, circulating pump, Injection pump. Those costs are CAPEX.

Any costs that were incurred before making a decision of drilling development well shall be considered as sunk cost, and only the estimated costs of drilling development well, facility costs shall be considered in the cash-flow model

**Gross Revenue and Net Cash Flow**

In accounting view; Contractor's gross revenue is the Contractor's portion of oil produced includes the oil cost deducting the expenses The net income of Contractor calculated as follow:

Net Income = Total Sales – Expenses

Where: Total Sales = Total Production – Royalty – Government's share – Agent Fees  
Expenses = Operating Expenses – DD&A – Non-Recoverable Cost

In Cash flow Analysis view; Contractor's calculate the net cash-flow as follow:

Net cash-flow = Cash Flow-in – Cash flow-out

Where: Cash Flow-in = Total Cash Sales  
Cash Flow-out = Operating Expenses – Non-recoverable cost

## **Risk and Risk Management for Foreign Investment**

### **Stock price risk:**

The market value of stock are effected by various factors that will be headlines below, there are factors that directly impact the market valuation of stock and some factors have indirect impact on stock price.

Below are some factors that can impact on short-term and long-term investors' decisions.

- 1) Long-run and volatility of ESP growth rate
- 2) Duration of business cycle
- 3) Beta risk of the firm
- 4) Correlation between the firm's EPS and interest rate.
- 5) Dividend payout ratio
- 6) Liquidity ratio
- 7) Profitability ratio
- 8) Finding cost ratio
- 9) Reserve replacement ratio
- 10) Reserve life ratio
- 11) Net wells to gross wells ratio
- 12) Operating cost per well
- 13) Present value of cash flow in future for reserves

There is indirect factor that can impact on the ethical investors' or long-term investors' decisions which is the Corporate Social Responsibilities (CSR) or Social Disclosure Index (SDI) such as community involvement, environment, Human resources, rights and workplace. However, some researchers find there is ambiguity of links between Corporate Social Responsibilities or Social Responsibilities Index disclosed in the financial statements and financial performance or capital market performance, but we can summarize the major correlation between CSR/SDI and

stock price, it was found that the Companies that pay more attention to Corporate social responsibilities have lower medium-term return than those Companies that pay less attention to such responsibilities. Means, the ethical Companies have more financial sacrifice which is accepted by the ethical investors who pay for CSR, there are many studies enhance the positive correlation between CSR ratings/SDI and stock price such as study that made by Alexis Cellier, Pierre Chollet from University Paris for knowing the impact of CSR on Stock Prices based on Vigeo Rating Announcement.

Also, there is study made by Haslinda Yusoff and Glen Lehman from University of South Australia for international differences on corporate environmental disclosure practices: a comparison between Malaysia and Australia, this study enhanced positive correlation between ISO 14001 requirements and EPS and ROE.

Therefore, we can confirm there is very little or no relationship between SDI/CSR and stock price in short-term, weak relationship between them in medium-term, good relationship in long term.

Also, the press release that is announced by Company or any of kind of media and related to results of drilling results, potential oil, financial performance, management performance for managing investors' money can directly impact the short-term of the stock price.

### **Uncertain Oil price risk:**

Oil and gas prices are subject to high levels of volatility in price and demand. While oil prices rapidly increased and decreased over the past years. Decrease oil prices may lead to close some wells or license that can be non-profitable project. There are many factors that can effect oil price that we can list part of them as follow

- 1- Scarcity of natural resources (oil)
- 2- Strategic Oil stock

- 3- Increasing the demand of power
- 4- Substitutive commodity
- 5- No. of wells determined proved reserves.

**Insufficiency of funding risk:**

The Company may be unable to get sufficient funds for additional capital to implement and complete its business plans on the lease it has interests in which make Company has no oil production interests. Therefore, there can be absolute assurance given that the Company will achieve production from the lease.

**Political and Security risk:**

These include the consequences of terrorist, political unsettlement and other activities, which themselves impact adversely on the economics of project or investment. Expropriation of assets and terrorism are greatest risks that Oil Industry may face.

Expropriation is not easy decision taken by government because it can lead International business community to impose penalties on a government that take such decisions especially if it is illegal expropriation even if the government compensates foreign Company.

Expropriation and exercising authority over foreign companies is not illegal in the view of international law such as article 1110 of NAFTA and UN Resolution 1803, as long as it is done in the best interests of the country, for public purpose, non discriminatory basis, foreign company has been compensated at market fair value immediately before expropriation took place. Therefore, if it is proved that the Company acts illegally that lead to significantly harm the Country's

interests or harm the national economy by reducing prospective leased acreage, Company may face more realistic indirect expropriation risks that include increasing taxes, compulsory sale produced natural resources via government's control, progressive labor legislation, or other activities controls that can be initially imposed when Contracts signed with government or imposed later when Companies start violating contracts or working in contrast of Society's health, environmental or welfare interests.

The best way to evaluate the political and security risks can be quantified with expected range. Each political and security risk scenario has different degrees of uncertainty. Therefore, Company may quantify such risk by estimating the probability of the each scenario that may happened and the estimated present value of net cash flows to get the Expected Monetary Value. [Daniel Johnston. 1994. *International Petroleum Fiscal Systems and Production Sharing Contracts*. PennWell Publishing Company. Tulsa. Oklahoma.U.S. Page 136-138 & 145-148]

**Litigation risk:**

The Contractor/Operator partner will operate through a series of contractual relationships with subcontractors and non-operators. All contracts carry risks associated with the performance made by the parties within a time and quality of work performed.

The Contractor/Operator partner is not aware of any basis on which any litigation against the Company may arise. However, there is always the risk that litigation may occur as a result of illegal acts;

unprofessional manner; management overriding controls; differing interpretations of obligations.

**Exploration and drilling and environment risk:**

Oil and gas exploration involves significant inherent risks in predicting the location and nature of potential oil accumulations in the subsurface. No Company can give absolute assurance that its exploration investment will result in the discovery of oil or gas, nor commercially recoverable. Risks in relation to drilling operations or drilling work structural breakdown may delay for some months or few years due to weather or offshore conditions and shortages of critical equipment or materials.

Financial and environmental risks: such risks include drilling incidents like blow-outs, fires and oil spills. Those risks can be mitigated by safety and environmental policies, plans and procedures and will arrange appropriate insurances for particular risks. No Company can give absolute assurance against the occurrence of any of these or other adverse events.

In the event that exploration activities prove to be unsuccessful, this will likely lead to:

- 1) Diminishing the value of any of the Company's license subject to such unsuccessful exploration activities; that may lead to Asset Impairment; and
- 2) Reduction in the cash reserves of the Company by paying the costs of such unsuccessful activities, reducing cash flow-in that is resulted from sales proceeds of the asset; and, increased difficulty in obtaining additional funds

following any such unsuccessful activity; and

- 3) Increase the probability of relinquishing the lease without recovering the capital investment.
- 4) Decrease the probability of obtaining new leases in the same Country. If the government of host country promoted and marketed for the already obtained lease that is the one of the best leases in the country, and the Company has not had any professional drilling and explorative care for this lease, host government will consider the long term economy benefits more than short-term and refuse to provide any new license or extend period of current license.

**Discovery risk:**

Any discovery may not be commercially producible. Most of explorationists use different approach for judging discovery probabilities and chance of success. The successful discovery requires the trap to be presented in position indicated by geologists, the target formation must have sufficient thickness, porosity and permeability characteristics must be sufficient. The initial/original risk assessment or discovery uncertainty is revised based on little information available, therefore, if prospect was drilled and well was dry it increases the probability of failure and reducing the probability of success because drilling wells in the same basin is dependent events. To mitigate such risk; Oil Companies should hire high skilled geologists, and not using very optimistic factors which increase the discovery probability and facing dry well after drilling.

**Risk Management:**

Risk Management include risk avoidance, risk mitigation, risk retention, and risk transfer, each risk scenario can be managed by one or more of the risk management method depend on the nature, significance, and ability of Company to face the risk.

**Risk Avoidance:**

Risk avoidance is going without an opportunity because risk of loss is too high. If the expected loss is too high that Company cannot take it. The Company either relinquishes to government or assigns all its working interests to other companies or refuse to invest in specific acreage.

**Risk Mitigation:**

Risk can be mitigated by reducing loss frequency or loss probability. Such as environment risks which include well blowout, harming staff during working period, fires or oil spills, all such risks can be mitigated by effective Health, Safety, Environment, and Security policies and procedures that can reduce the probability of occurring such risks. Also, Political unrest risks can be mitigated by the actions against loss of expropriation and political unrest risks:

Reducing expropriation risks and losses by:

- 1) Keep low profile investment
- 2) Keep very good relationships with the government and host country community.
- 3) Avoid layoffs and any abusive treatments particularly with nationals.
- 4) Dealing with local suppliers and national personnel more than

international suppliers and foreign employees.

- 5) Stop new investment and purchases
- 6) Reduce any susceptible assets to expropriation or theft risks like inventories and cash
- 7) Pay down liabilities to home country suppliers
- 8) Borrow heavily from local sources.

[Daniel Johnston. 1994. *International Petroleum Fiscal Systems and Production Sharing Contracts*. PennWell Publishing Company. Tulsa. Oklahoma.U.S. Page 147-148]

**Risk Retention:**

As it is known that not all risks are avoidable or 100% eliminated, Company may establish fund reserves to offset losses. Therefore, Some Companies start establishing provision for meeting any probable commitment.

**Risk Transfer:**

All the risks that can be mitigated, cannot be 100% eliminated as we mentioned above, but the remaining exposure that cannot be mitigated to the minimum acceptable level can be mitigated by spreading risk through farm-out, carrying interests, joint ventures and/or insurance, which allow other parties to share the results of the risks instead of take it solely. Therefore, discovery risk, sufficiency of funding risks can be spread risk through farm-out, carrying interests and political risk, environment and safety risks can be spread through insurance policy.

## **Investment Analysis and Cash-flow Models**

Most of Projects of petroleum explorations are long-term capital investments that goes through capital budgeting process for making long-term investment decision for Petroleum Exploration often grouped in one of the following:

- Drilling Development wells in productive area for expanding its business
- Running seismic activities and drilling exploratory wells for new licenses.
- Acquiring new potential licenses
- Optimal production level of oil and gas and how to be produced.
- Enhancing Oil/gas recovery and remediating sites.
- Entering new joint venture arrangements or take solely risks.
- Optimal working interest in a license.

To take the above decisions, Company shall have input variable data for making cash-flow analysis for their long-term investment decision. The input variable data are explained as below.

### **Variables of Cash-flow Model**

For estimating expenditures and income to use it in the cash flow model, only the estimated relevant costs and revenue that will be incurred or avoided in the future based on the decision. In other word, the avoidable, incremental, or differential costs and revenue shall be considered in the cash flow analysis. Explorationists may consider unavoidable costs or non-incremental costs

in the feasibility study of petroleum projects. For example, the costs that are associated with already established activities of community affairs in the field that is incurred whatever the wells will be drilled or seismic acquisition will be run, shall not be accounted for such analysis except for the incremental costs that could be incurred if the well is drilled or seismic acquisition is run. Also, acquisition cost of license already acquired, and exploration cost of license that is already explored, are not relevant costs except if those costs will be incurred for exploring new prospects or license or acquire new license.

To know the variable inputs of cash flow analysis, the contents of the analysis should be identified first as follow:

- Total annual operating costs are daily estimated initial production multiplied by 365 days times estimated operating costs per unit and times inflation rate.
- For calculating taxes impact, DD&A should be calculated by dividing remaining estimated acquisition cost, tangible development costs by proved reserves times production and facility equipments are depreciated over their useful life. Intangible cost should be amortized based on the tax law.
- Total revenue is daily initial production or sales multiplied by 365 times oil price and times annual price increase per year.

After breaking down the contents of costs and revenue to cost and revenue drivers, the

variable input could be easily determined as follow:

### **Initial Production Forecast**

Various countries such as U.S issue regulations or have concession agreement indicating to well spacing limitations, utilization of reservoir, and allowable maximum production limits, all of those effect the estimated production. Also, some PSAs such as Kurdistan and Libyan require to produce rate not exceeding Maximum Efficient Rate (MER) which can effect reservoir pressure that lead to excessive decline of production.

The initial production per well can be estimated by the nearest productive well drilled that be expected to have the same wellbore pressure and target productive formation, or obtaining the average production of the nearest wells.

Discovery probability, Net present value of successful well, average cost of exploratory dry hole, Capital investment source available, and reasonable confident probability are factors that determine the number of well Company may need to drill.

Declined production can be considered in the analysis if the Company needs to drill in the same reservoir and cannot be considered in the analysis if Company drill the first well in new reservoir because to specify the decline rate, the quantity produced in t+1 or t time shall be known, and it cannot be known until the production run. Therefore, the estimated initial production for well or all wells is constant over the economic life of the prospect.

The estimated initial average daily production shall be estimated at bbls/day from number of well

### **Oil Price and price escalation**

Crude oil that is produced from different sources are categorized mainly according to its API gravity and sulfur content. The API gravity of light crude oils are over 40, heavy oils are below 25. The average crude oils have 25 to 40 range. The price of crude oil is dependent on API gravity and sulfur content, sweet crude oil contains less than 0.5% by weight and sour crude oil contains more than 1.5% by weight. The higher API gravity, the lighter oil is, the higher price receives and vice versa, and the lower sulfur contents in oil, the sweeter it is, the higher value of oil and vice versa.

Many PSAs recommend calculating the oil cost based on the international or world oil price market based on FOB. Even Contractor sells their portion of oil produced based on international market such as Brent that is traded in London and West Texas Intermediate (WTI) that is traded in New York Mercantile Exchange NYMEX or Dubai Market.

*[Morgan Downey. 2009. OIL 101. Wooden Table Press LLC. Page 34-36]*

The oil price shall be estimated at \$ per barrel Also, as we noticed recent years that oil price has been rapidly increased, therefore, price escalation should be considered and estimated by percentage per year.

### **Agent/Sponsor Fees**

Company intends to investment in oil & gas industry in Middle East, should have local sponsor, and have sponsor agreement which stated that Contractor's should pay percentage of contractor's profit oil to the sponsor

### **Reserves**

Reserves in barrels are disclosed in the financial statements, and it is a factor for calculating DD&A of CAPEX expenditure as it is mentioned in above.

Geologists calculate the expected recoverable reserves based on many factors water saturation, net pay thickness, porosity, and others.

The larger expected recoverable reserves in the field, the more field could be attractive and feasible, and the higher pressure in the reservoir the more recoverable reserves can be produced in short term. The expected recoverable reserves of any prospect shall be estimated by number of barrels that can be recovered and provided by technical staff.

### **Discovery probability (Chance of success)**

Calculation of discovery probability is made by Explorationists or Geologists that can be impacted on the following factors as examples:

- Probability of reserves trap
- Probability of source
- Probability of mitigation
- Probability of time
- Probability of net pay thickness
- Probability of reservoir porosity
- Probability of reservoir permeability

Drilling wells in the same basin is dependent events which need to revise or update the discovery probability that was previous calculated for the license or for the next drilling well, but it will be independent event if they are drilled in different basin.

[Daniel Johnston. 1994. International Petroleum Fiscal Systems and Production Sharing Contracts. PennWell Publishing Company. Tulsa. Oklahoma.U.S. Page 339-342 & 357]

The discovery probability shall be estimated by by explorationists in percentage.

### **Expenditure Forecast**

For estimating expenditures to use it in the cash flow model, only the estimated relevant costs that will be incurred or avoided in the future as we indicated above.

#### **a) Expected Drilling Well**

Preparation of drilling cost estimate is depend on type of wells, the drilling cost is high;

- 1) For exploration and appraisal wells generally cost more
- 2) If the well drilled horizontal or deviated.
- 3) If the well is drilled at offshore rig costs
- 4) If the well is more deep and formation is more complicated.
- 5) If well is drilled in high pressure, or through sloughing shale.

Estimating drilling a well will be one of the following method:

- 1) Obtain the average cost / meter depth for nearest well drilled, assuming the complexity and

pressure of drilled and undrilled reservoir are almost the same.

- 2) Obtain the average cost per meter depth for a well in anywhere in the basin with considering the pressure; and complexity of formation.
- 3) Making Work Structure Breakdown for drilling a well and estimate the cost for each activity. And this method is more accurate but consumed more time and cost to be prepared.

The average drilling cost can be estimated either by per well or per meter depth. Many Countries have statistics for well costs which show the costs per meter drilled and per well and by drilling service company, such statistics can provide us with estimated cost for well to be drilled in future but in consideration of inflation rate for the cost per year.

#### **b) Expected Lease Acquisition Cost**

As it was mentioned above that Lease acquisition cost paid by Contractors to obtain a license that includes lease bonus; data purchased; G&G cost spent for acquiring acreage, legal fees and management or manpower spent for obtaining such lease before signing the Production-sharing contract with government. Acquisition costs is considered as Initial Investment for feasibility studies of obtaining acreage, and it is considered as sunk

cost to project evaluation analysis for drilling a well, but we consider lease acquisition costs can be estimated by the actual costs paid by other Company investing in the same country or by providing the preliminary negotiated prices..

#### **c) Expected G&G Cost**

G&G cost includes; a) Seismic acquisition cost that is estimated based on the average cost of acquiring seismic survey per square kilometer if it is 2D or cubic kilometer if it is 3D, or per shots or lines, this cost is the highest cost in G&G which covers the costs of manpower and equipments such as vibrators, dynamites and others; b) Seismic Processing/Reprocessing and Interpreting; this costs may be done inside the company or outside the Company based on the experienced team and high technology is used; those costs are estimated based on average cost of processing/ reprocessing/ interpreting data per square or cubic kilometer or per hours spent by expatriates for such work; c) geological studies and geochemical studies this is estimated based on the cost of service is offered such as geological formation analysis. G&G costs before finding commercial oil or gas are considered cash flow-out.

In the whole world, the average cost of seismic acquisition is about \$ 2000-8000 per kilometer of 2D seismic data; and \$.15,000 - \$20,000.

Squ. kilometer of 3D seismic data with vibrator.

**d) Expected Facility Cost**

Facility cost shall be estimated based on the assets needs and activities performed. Facilities equipments cover various items such as tanks, pipelines, separator, heater, splitter.

**e) Operating Cost**

Expected operating cost is calculated by barrel. The operating cost per barrel can be obtained by

- a) taking the latest historical operating costs and production from the other Companies operated in the same country that is produced from the same target formation,
- b) statistics issued by official governmental of host country,
- c) from latest historical operating costs of consolidated financial information of a company divided by total equivalent production in BOE from home office financial statements or
- d) based on estimated cost of planned production activities which is more accurate but consumed more time and cost to be prepared.

**f) Non-Recoverable by government and partners**

Non-recoverable costs from oil costs and from non-operators are considered solely carried by operators which is offset with operator's overhead, and non-recoverable costs from only oil cost

are considered as billable costs which are carried by partners which is offset with PSA overhead. The annual estimated overhead can be computed based on provision of PSAs or JOAs

**g) Inflation Rate**

There is positive correlation between oil price and general inflation rate and operating cost escalation. Therefore, the higher oil price is, the higher inflation rate is and cost of oil equipment. In cash-flow analysis, it is assumed about general anticipated level of inflation rate and if this inflationary expectation is embedded in cash-flow analysis, the net cash flow will be called nominal net cash flow. The annual inflation rate is estimated in percentage and can be constant during the analysis period.

**Cost Recovery Ceiling**

Cost recovery ceiling is provided by PSA that make a limit for recovering costs and any cost recovery excess the limit should be forwarded to next period. The cost recovery ceiling is varied between PSAs.

**Contractor's working Interest**

Contractor's working interest is varied from from company to another.

Many PSAs indicates to Company's working interest of revenue that is different from paying interests. Paying Interests are higher than revenue interests due to foreign multi-companies carry the interests of public corporation of host government.

## **Taxation**

Income tax is accounted for DD&A which is considered as sunk cost, but taxes should be deducted from cash-flow.

### **a) Host Country Tax Rate**

PSAs in Middle East countries exempt International Oil Companies from taxes but PSA of Yemen require International Oil Companies to pay some taxes that are not recoverable such as fixed tax.

### **b) Corporate Tax Rate**

Corporate tax rate is varied from country to another. Corporate tax rate shall be determined in scale rate based on the law.

### **c) Production Tax Rate**

There is no production tax law is prevailed in some Middle East countries, but Volwore or exercise tax is imposed by some resident country of company. And foreign production may not imposed on such taxes

## **Bank charges on LOC**

Bank charges on Letter of Credit or Guarantee LOC/LG is non-recoverable cost as per some PSAs, but it is compensated by partners if it is accounted based on gross LOC not on partner's portion of LOC. Financing cost is deducted from cash flow. The amount of LOC should be the same value of the minimum work obligation. Bank charges rate shall be provided by finance team.

## **Cost of site remediation and abandonment**

Cost of abandonment should be anticipated to meet contractual obligations and usually before production began by performing Environmental Impact Analysis (EIA) based on either PSAs (e.g. PSC of Kurdistan) and local environmental regulations or constructive obligations based on Company's policy and practices.

Such cost could be recovered should be charge the Joint Venture and Petroleum accounts during the last period of productive license in some PSAs. This cost could be categorized under disposal cash flow but if it is 100% recovered when it is incurred, it will be nil and not be included in the cash flow model.

### **Proceeds of selling license.**

Company's may decided to sell its working interests to other Companies either license is productive, development or exploration license after period of time. The estimated proceeds of selling the license shall be considered in disposal cash flow.

For estimating the proceeds of sold licenses, we need to make cash flow analysis and estimate the present value of net cash flow for reserves after period of time for productive or development licenses only and it will be high roughly estimation. Cash-flow Model is useful for production and development licenses but for estimating the proceeds of exploration license the cash-flow model is not appropriate, the cost approach will be appropriate for estimating the value of exploration license in future. However, the proceeds will be high roughly estimated.

In summary, Cash-Flow Model contains three types of cash flow:

- a) Incremental Cash flow of initial investments
- b) Incremental Cash flow of operation
- c) Incremental cash flow of disposal

Those incremental cash flow have been summarized in the below figures. Figure 1 of initial cash flow which represents net

cash flow out and should not be discounted, figure 2 of operation cash flow which most likely represents net cash flow in that needs to be discounted over the period of cash flow in entity and figure 3 of disposal cash flow that represents either cash flow in or out and need to be discounted at the end of the period.

**Figure 1: Initial Cash Flow\***

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- Acquisition cost
- Exploration Cost (include G&G and exploratory drilling wells, regardless of recoverability concept)
- Development Cost (Include Development wells cost and facility cost)
- = Initial Cash Flow

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**Figure 2: Operation Cash flows\***

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- + Production Income [(Company's share of profit oil + Cost Oil) X Oil Price x Price Escalation %]
- + Credits against expense [ Overhead Compensated by other partners allowed by JOA]
- Royalties payments
- Ad volarem, production or sale Tax [Produced or sold quantities X tax scale rate]
- Operating Cost
- Corporate Overhead
- or + DD&A, Non Cash Outflows
- = Net Cash flow Before tax
- or + Tax effect (Taxes or savings)
- + or - DD&A, Non Cash Outflows
- = Net Operation Cash flows

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**Figure 3: Disposal Cash Flows\***

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- + Estimated proceeds of selling Company's working interests in a license.
- Cost of Disposed license [Remaining of non-depleted cost + non-recovered environmental Liability]
- = Net Cash flow Before tax
- or + Net Tax impact (taxes or savings)

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+ **Cost of Disposed license** [Remaining of non-depleted cost]  
= Cash flow at disposal

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\*The above figures have been excerpt from 2007 CMA Learning System: Strategic Management. Part 3. Version 2.0. IMA. Page 354-355

### **Discount rate and WACC**

The value of money is depreciated over time, therefore, for cash flow model and investment analysis, the present value shall be computed at required rate of return as discount rate, some companies preferred to use discount rates that equal to their weighted average cost of capital (WACC) or free-risk rate plus risk premium. Discount rate shall be provided by finance team.

### **Decision Analysis**

In decision analysis or project analysis, we need to use capital budget techniques and other techniques that apply the following.

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

Net present value is annual cash flow in times present value at discount rate deducting the initial investment amount. The positive and high NPV is, the more attractive investment or project is.

### **Expected Money Value (EMV)**

EMV is the NPV times the discovery probability or Chance of success in specific prospect. The higher EMV, the more attractive investment or project is. Company management select the project or license that have the greatest EMV if the risk is neutral between the alternatives. But if the decision maker is risk-seeker or averse, the risks should be considered in the preference model. Therefore, Utility function should be considered for evaluating among projects.

### **Expected Utility Value (EUV)**

EUV is the NPV which is converted into utility value using mathematical function which risk tolerance and net present value are the main variables in the function.

Risk tolerance is the risk valued in dollar which show how much the value of risk that Company can carry. The larger value of risk tolerance, the more indication of Company is risk-seeker and like to take more risks. Risk tolerance can be used for determining the joint venture working interests that optimizes its participation in Joint venture.

Company should select the project or license that maximizes the expected utility value. [Paul Newendorp, John Schuyler. 2000. 2<sup>nd</sup> edition. *Decision Analysis for Petroleum Exploration. Planning Press. Aurora. Colorado. USA. Page 159-219*]

### **Payback Period**

Payback period is the breakeven point or the period of time that a company will recover its initial investment cost. A corporate may has a policy that determine the accepted payback period of any new investment in years.

### **Internal Rate of Return (IRR)**

IRR is a measure of profitability that report the percentage of net cash flow to the initial investment. This ratio accounts for time value of money and cannot be useful if the all or cumulative cash flows are negative.

The investment or project that its IRR that is greater than return on alternative use of funds, required return or WACC, is acceptable investment, otherwise it is referred to be rejected. This technique shall be read with NPV and PI index.

#### **Accounting Rate of Return (ARR) or Average Return on Investment**

This technique calculates rate of the average annual income to initial investment that ignores the time value of money. This ratio may not be as useful as other techniques but some companies like to calculate this ration to know how much this investment or project will contribute in aggregate net income to assets.

#### **Profitability Index (PI)**

PI helps a company to know present value generated per dollar of investment, it is very useful because it considers the time value of money and size of the project. It is useful if Company needs to select several acreage or drilling well investment that have different NPV and initial investments. The higher PI is the more attractive the investment or project will be. And PI that is less than 1 will be rejected.

#### **Finding Cost.**

This ratio is used to evaluate the efficiency of a company in adding new reserves, it helps a company to know how much company carry dollars to find a barrel of proved reserves. This ratio can be revised to discounted costs, where, the finding costs is divided by discounted reserves that produced annually, if the discounted finding cost is greater than the estimated oil price, the project will not be attractive to enter to development or production phase.

#### **Capital Investment Fund Required**

Fund required for capital investment of reservoir is very important because the project might be very attractive but it will be beyond the ability of the company to operate and even to take the investment.

#### **Breakeven/ Cost-Volume-Profit Analysis**

Breakeven analysis could not be easy for management accountant because it depends on identifying the variable cost from fixed costs. However, operating costs area easily to be classified between direct and indirect costs, but discovery and production cost could be fallen into variable and fixed cost in somehow. Discovery and production fixed costs that are not changed in correspondence with changes in quantities of oil and gas produced. Therefore, fixed costs could be the DD&A of acquisition, development and facility cost or the full of such cost, cumulative exploration cost can be considered in addition to full cost of acquisition and development as fixed costs to determine the non-profit production that cover discovery and production cost and to determine the target profit from the production or development license. Variable cost is changed with quantities of oil/gas produced, variable costs are such ad volerum or severance taxes, royalties, cost of daily well operation activities.

## Comprehensive Example

The below data are variable input data that could be used in Cash-flow model. We will assumed that we have four licenses, one lincense is under exploration that a Company had three prospects to be drilled, two licenses are under study to acquire one of them or neither, one license is in development phase and another license is production license.

	Acquisition		Exploration			Development	Production
	License F	License E	Prospect A	Prospect B	Prospect C	License X	License Y
a) Estimated Reserves	950,000,000.00	200,000,000.00	135,000,000.00	25,000,000.00	8,000,000.00	65,000,000.00	25,000,000.00
b) Probability of discovery	50%	20%	7%	18%	27%	100%	100%
c) [Estimated] daily initial production per well	20,000.00	5000	7500	1200	350	3500	1500
d) Oil Price per bbl	110	110	100	100	100	110	110
f) [Estimated] Operating cost per bbl	19	9	15	20	26	12	10
h) No. of Exploratory wells (to be) drilled	1	1	1	1	1	2	2
i) No. of development wells (to be) drilled	4	5				5	6
j) [Estimated] Acquisition cost	10,000,000	800,000				3,000,000	2,000,000
k) [Estimated] Exploratory wells cost per well	36,000,000	15,000,000	27,000,000	21,000,000	25,000,000	18,000,000	20,000,000
L) [Estimated] Development wells cost per well	30,000,000	10,000,000				18,000,000	18,000,000
m) Estimated Facility cost per well	350,000,000	20,000,000	300,000	2,000,000	2,000,000	300,000	1,000,000
n) Non-recoverable costs (Annual Bonuses)	20,000,000.00	300,000.00	700,000	700,000	700,000	1,000,000	1,000,000
o) Non-recoverable costs (Other Initial payment)	100,000,000.00						
p) Non-recoverable costs (Community Develop)	0.30%	-					
r) Average Governmental Royalties	4%	3%	3%	3%	3%	3%	3%
s) Average Government's profit share	77%	60%	66%	66%	66%	66%	66%
t) Proceeds of selling working interests							
u) Severance Tax						15%	
v) Property profit Tax for selling interests		15%	15%	15%	15%	10%	
w) Legal Period	25	25	25	25	25	25	25
x) Average Compensated Overhead	100,000	3.00%				3.00%	3.00%
z) Income Tax	35%	35%	35%	35%	35%	35%	35%
aa) Required Rate of Return or WACC	10%	6%	10%	10%	10%	10%	10%

The below cash flow model is simply prepared to provide our readers an overall idea of how to make investment or decision analysis for petroleum exploration in brief:

- If we want to choose either to acquire license F or E, the below analysis can provide how much present value and expected monetary value are in both license, and IRR, payback, finding cost and breakeven point in daily produced bbl. Company may choose license E as long as it has not enough fund or its risk tolerance is small.
- Company has three prospects to be drilled in exploration license. Prospect C is not attractive because its net present value is negative, Prospect B is not attractive, however, its present value is in positive and it is about \$9mm but the expected monetary value of prospect B is negative and its expected profitability index is less than 1. It its feasible for the company to drill a well in Prospect A, however, its probability of discovery is 7%, but its net present value and monetary value is positive, and all

other indices such as IRR, PI, Finding cost, Breakeven points in daily bbl, and payback period encourage company to invest and drill a well in prospect A

Please see next page that show the table of investment and decision analysis that is simply prepared. Cash-flow and decision analysis could be prepared in more complicated form that show the annual cash flow in separate column and compute the net reserves, net production, escalated oil prices and increased operation costs and tax more accurately based on tax laws, PSAs, JOAs.

		Acquisition		Exploration			Development	Production
		License F	License E	Prospect A	Prospect B	Prospect C	License X	License Y
<b>Initial Investment Cash Outflows</b>	Acquisition cost	110,000,000	800,000				3,000,000	2,000,000
	Exploration Cost	36,000,000	15,000,000	27,000,000	21,000,000	25,000,000	36,000,000	40,000,000
	Development & Facility Cost	470,000,000	70,000,000	300,000	2,000,000	2,000,000	30,300,000	103,000,000
		(616,000,000)	(85,800,000)	(27,300,000)	(23,000,000)	(27,000,000)	(30,300,000)	(151,000,000)
Annual Income, Cash Inflows	Gross Production Income	3,212,000,000	1,023,825,000	273,225,000	44,676,000	13,030,500	716,677,500	368,577,000
	Net Production Income (1)	1,136,395,514	453,621,643	120,758,176	21,423,368	7,339,638	313,072,606	183,353,234
	Compensated overhead (2)	55,000.00	46,537.50				261,877.67	117,471.60
		1,196,450,514	453,668,180	120,758,176	21,423,368	7,339,638	313,334,484	183,476,706
Annual Expense, Cash Outflows	Ad valorem Tax (3)	-	-	-	-	-	107,501,625	-
	Operating Cost (4)	554,800,000	82,125,000	41,062,500	8,760,000	3,321,500	76,650,000	32,850,000
	Annual Non-Recoverable Cost (5)	21,713,471	300,000	700,000	700,000	700,000	1,000,000	1,000,000
	Overhead	55,000.00	46,537.50	-	-	-	261,877.67	117,471.60
		(576,568,471)	(83,071,538)	(41,762,500)	(9,460,000)	(4,021,500)	(185,413,503)	(33,967,472)
DD&A, Non Cash Outflows	DD&A (6)	(80,733,893)	(8,325,387)	(1,715,434)	(1,221,831)	(1,307,326)	(27,979,020)	(44,224,385)
Income Before Tax		539,142,150	362,271,256	77,280,243	10,742,137	2,070,872	99,941,362	105,284,249
Tax Expense, Cash Outflows	Income Tax	(188,639,753)	(126,794,340)	(27,048,085)	(3,759,748)	(724,805)	(34,979,687)	(36,843,487)
DD&A, Non Cash Outflows	DD&A (6)	80,733,893	8,325,387	1,715,434	1,221,831	1,307,326	27,979,020	44,224,385
<b>Net Operation Cash Flows</b>		431,182,291	243,801,703	51,947,591	8,204,220	2,653,393	32,341,295	112,653,747
<b>Discounted net operation cash flows</b>		\$3,313,858,310	\$2,930,344,829	\$471,530,364	\$74,470,036	\$24,084,356	\$577,048,317	\$581,146,213
<b>Net Present Value</b>		<b>3,297,858,310</b>	<b>2,844,544,829</b>	<b>443,630,364</b>	<b>51,470,036</b>	<b>(2,915,044)</b>	<b>486,148,317</b>	<b>430,146,213</b>
Expected NPV		1,648,323,455	568,308,366	31,054,126	3,264,607	(787,062)	486,148,317	430,146,213
Expected Loss		(55,000,000)	(640,000)	(25,110,000)	(17,220,000)	(18,250,000)	0	0
Expected PI		30	883	1.2	0.5	(0.0)		
IRR		70%	285%	185%	36%	3%		
Payback period		1.43	0.35	0.54	2.80	10.18	0.38	1.34
Finding Cost		2.34	1.11	0.63	2.73	10.23	4.24	18.31
Discounted finding cost		10.53	2.02	3.40	17.54	70.60	6.35	27.02
Breakeven in daily bbls		2,431	226	55	42	48	782	1,212
Expected Utility Value								

**Notes:**

- (1)  $c \cdot (1 - c)^{365 \cdot t} \cdot ((\text{Explor} \& \text{Dev cost}) / \text{net reserves}) \cdot c \cdot 365 \cdot t \cdot ((\text{Gross Prod Revenue} - ((c \cdot 365 \cdot t) \cdot (\text{Explor} \& \text{Dev cost}) / \text{net reserves}) \cdot c \cdot 365 \cdot t)) \cdot (1 - r)^{t-1} \cdot (1 - c)$
- (2)  $x \cdot (1 - y)$  or  $(\text{Explor and Dev Cost}) / \text{prod period} \cdot x \cdot (1 - y)$
- (3)  $\text{Gross Prod Revenue} \cdot u$
- (4)  $c \cdot (1 - c)^{365 \cdot t}$
- (5)  $n + ((\text{Gross Prod Revenue} - ((c \cdot 365 \cdot t) \cdot (\text{Explor} \& \text{Dev Cost}) / \text{net reserve}) \cdot c \cdot 365 \cdot t)) \cdot (1 - r) \cdot (1 - c)^{t-1} \cdot p$
- (6)  $(\text{SUM of Acqui, Dev and Facility Cost}) / \text{Net reserve} \cdot c \cdot 365 \cdot t$

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