1.0 THE ECONOMICS OF EXPLORATION AND PRODUCTION PROJECT

Projects in the upstream petroleum industry are characterized by *large capital investment*; in addition to that, there are some other factors that make this sector different from other investment opportunities, such as:

- ✓ Time lag between expenditures and revenues,
- ✓ High levels of uncertainty& risk.
- ✓ Most of the projects involve high technology.
- ✓ High level of regulation
- ✓ Complex tax rules
- ✓ Specialised financial accounting rules.

The capital intensive nature of the oil and gas industry pervades all phases of the petroleum industry to marketing. This requires that any study of the basic economics of this important industry must direct great deal of attention to the massive monetary outlays of investment, and how those investments are recovered through the cash flows from the operation. The three key elements in any economic evaluation are:

- ✓ Income
- ✓ Expenditure
- ✓ Time.

These three elements are brought together in the forecast of future cash flow which will result from making an investment. Cash flow, which is the periodic recording of income and expenditures, is the most important tool for evaluating investments and choosing alternatives. For a company to remain in business, it must generate positive net cash flow if it is to remain solvent, pay its debts, and provide a return to its investors, and to have money for new investments. Cash flow is the basis of most management decisions. It must embrace all cost which will be incurred as a result of the operation, including both a portion of the company's overhead as well as an operation's impact on the total income tax paid by the company.

The most important reason for doing economic evaluation is to make investment decisions. This process involves answering three critical questions:

- ✓ What will it cost?
- ✓ What is it worth?
- ✓ Will it earn enough profit?

These questions cannot be answered easily or simply, but require sophisticated forecasting and calculation techniques.

After an oil company has identified an area with potential, the company will seek to acquire the right to explore, develop and produce any minerals that might exist beneath the property,

unless it already holds those rights. The right, along with the right to simply share in the proceeds from the sale of any mineral produced is called **mineral interest** or an **economic interest.** The U. S. and, to a limited extent, Canada are the only two countries in the world where individual ownership of mineral rights is allowed. In countries outside the U.S. (Ghana, Nigeria etc) ownership of mineral rights resides solely with the government. Therefore, oil and gas companies wishing to obtain a mineral interest in Ghana must do so by executing lease agreement with the Government of Ghana.

1.1 THE LIFE CYCLE OF PETROLEUM PROJECTS

The phases of typical oil and gas project can be described as follows:

- ✓ Pre License /Prospecting
- ✓ Mineral Acquisition/Contracting.
- ✓ Exploration.
- ✓ Appraisal.
- ✓ Development.
- ✓ Production.
- ✓ Closure.

1.1.1 PRE LICENSE PROSPECTING

Pre-license /prospecting typically involves the geological evaluation of relatively large areas before acquisition of any petroleum rights. This also involves broad reconnaissance work to identify an area of interest. Aerial photographs and aerial gravity and magnetic surveys are made followed with seismic survey.

1.1.2 MINERAL ACCQUISITION/CONTRACTING

Mineral interest acquisition involves the activities related to obtaining the mineral rights to explore for, develop and produce oil or gas in a particular area. Typically the oil and gas company receives a mineral interest if the negotiation is successful. A mineral interest is an interest in a property that gives the owner the right to share in the proceeds from oil or gas produced.

1.1.3 EXPLORATION

Exploration is detailed examination of an area for which a mineral interest has been acquired. Generally, the geographical area has demonstrated sufficient potential to justify further exploration to determine whether oil and gas are present in commercial quantities.

1.1.4 APPRAISAL

Appraisal phase involves confirming and evaluating the presence and extent of reserves that have been indicated by previous Geological and Geophysical testing and exploratory drilling. Exploratory wells may have found reserves; however, appraisal is necessary in order to justify the capital expenditure related to the development and production of the reserves – in other words confirming that the reserves are commercial.

1.1.5 DEVELOPMENT

This phase involves undertaking the steps necessary to actually achieve commercial production. Typically this involves:

of services related to the exploitation of petroleum resources. The *risk service contract* appears similar to the *production sharing contract* but differs in certain important matters. Its basic distinctive feature is that it reimburses the contractor *in cash, not in crude oil*, although it may have provisions permitting the contractor to buy back an amount of crude oil at an international selling price equivalent to the amount to be paid to the contractor.

1.5.3 PURE SERVICE CONTRACT

A *pure-service contract* is an agreement between a contractor and a host country that typically covers a defined technical service to be provided or completed during a specific period of time. The service company investment is typically limited to the value of equipment, tools, and personnel used to perform the service. In most cases, the service *contractor's reimbursement is fixed by the terms of the contract* with little exposure to either project performance or market factors. *Payment for services is normally based on daily or hourly rates, a fixed rate, or some other specified amount*. Payments may be made at specified intervals or at the completion of the service. Payments, in some cases, may be tied to the field performance, operating cost reductions, or other important metrics.

1.5.4 RISK SERVICE CONTRACT

These agreements are very similar to the production-sharing agreements with *the exception of contractor payment.* With a risk service contract, the contractor usually receives a defined share of production (in cash). As in the production-sharing contract, the contractor provides the capital and technical expertise required for exploration and development. If exploration efforts are successful, the contractor can recover those costs from the sale revenues and receive a share of profits through a contract-defined mechanism.

1.6 PROJECT BASED SYSTEM

Before project cash flow analysis, one has to understand the relation among the reservoir, property (contract terms) and the project itself. Figure 5 help to clarify the concept.

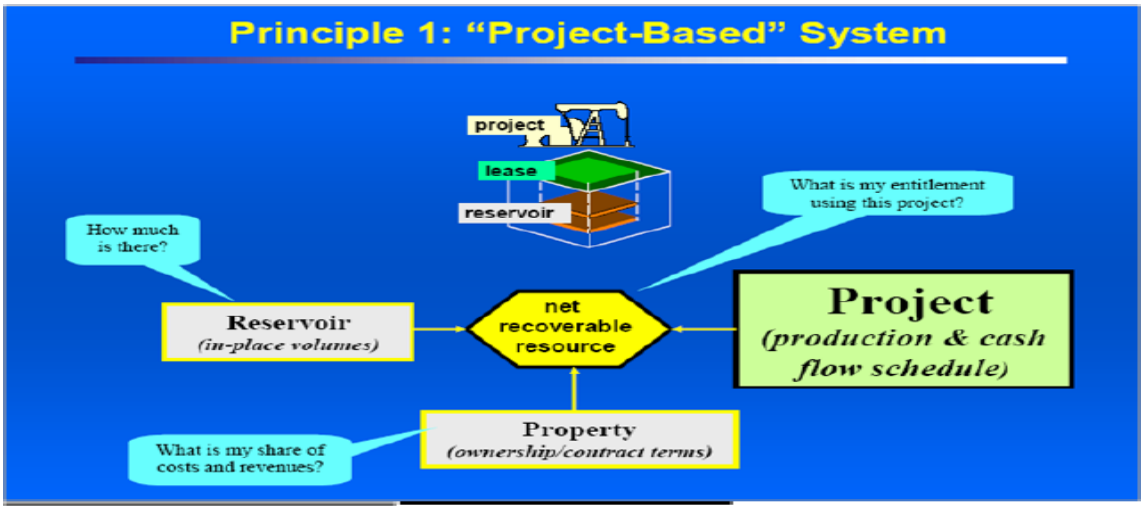

Figure 5. The Project Based System

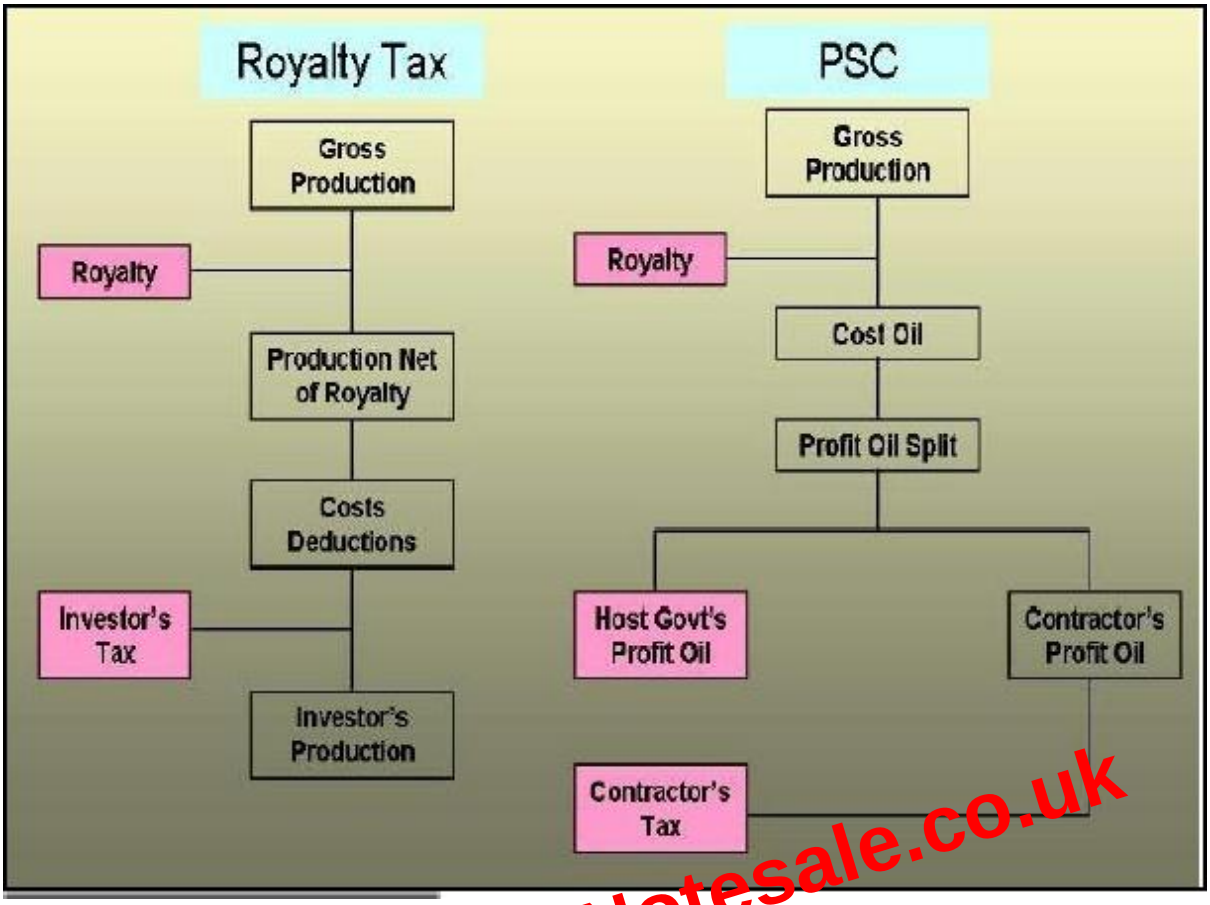

Figure 7. Cash flow model for both Concessional and Production Sharing Contract Agreement.

PSC system tends to be slightly more complicated in many contracts; the royalty is applied in the PSC system. It is common in PSC terms that the cost recovery allowed to be recovered each year is limited to a certain percentage of Gross Revenue (so-called "cost recovery limit"). If the actual cost is more than the limit, the unrecovered cost is carried forward to the following year. If the actual cost is less than the cost recovery limit, then there is "excess cost oil". The treatment for excess cost oil can be divided into three categories:

- ✓ The excess costs are divided between government and IOC similar to the profit oil split.
- ✓ The excess cost oil is divided between government and IOC with a certain split (difference with the profit oil split).
- ✓ The excess cost oil is not divided between government and IOC, all excess costs oil goes directly to the government.

1.8 SENSITIVITY ANALYSIS

In order to investigate the economic performance in the base case input data, sensitivity analysis is performed. This indicates how robust the model is to variations in one or more parameters, and also highlights which of inputs in the model is the most sensitive. These inputs can then be addressed more specifically.

1.9 PRODUCTION AND SALES

2.6.2 SPOT CASH AND FUTURE MARKETS

There are two basic types of markets in crude oil: The "wet" barrel or cash market where oil is bought and sold in individual deals between buyer and seller, and the future market where trades are made through a formal commodities exchange for some specified future delivery date. The term "spot market" is generally understood to denote a onetime short-term transaction. Dealing is done by telephone or telex. The history of most commodities in international trade has been to start from individual or spot market, sales and then to evolve gradually to longer term contracts as the markets become established. However, the world market in crude oil has had just the opposite history with long term purchase contracts giving way to spot sales. The industry trend now undertaken by most companies is to use a combination of contact and spot trading.

2.6.3 HEDGING

Hedging is a future market technique by which investors insure against risk of market changes in price. The two main prime reasons for hedging are to protect the value of inventory and to fix ahead of time the cost of purchases. A crude oil trader, who may wish to avoid the risk of significant decline in price of crude oil say the next 90 days, can contract to deliver a specified number of future barrels at a fixed agreed price. If the price does drop, he is protected because he will receive the previously determined price. If the price goes up during the period he has lost the opportunity to take advantage of the change since he will receive only the previously agreed price. Hedging is the simultaneous initiation of equal and opposite positions in cash and futures market. It is a technique or strategy employed as a protection against adverse price movements in the cash, or spot market.

2.6.4 MARKET PARTICIPANTS

The players in the spot marketing of crude oil include:

- ✓ The major international oil companies
- ✓ Traders
- ✓ Brokers
- ✓ Independent oil companies.

Brokers: Brokerage firms differ from traders in the fundamental distinction that brokers do not take title to crude oil, but rather bring buyers and sellers together for which they receive a commission. All trading requires current and future price information. Otherwise striking a bargain with any confidence is hardly possible. Brokers are generally good sources of current crude oil prices in contrast to the traders. Trader is understandably somewhat reluctant to disclose his purchase price to a prospective purchaser. The broker functions more or less from position of neutrality and doesn't have the same problem. However, neither the trader nor the broker has any responsility of publicising his/her dealings. Such price information as they do release is voluntary on their part.

- ✓ Geosciences-hydrocarbons in place estimates.
- ✓ Reservoir Engineers- Reserve estimates and production profiles.
- ✓ Facilities and cost engineers- Development plan and cost profiles.
- ✓ General Economist- Micro and Macro economic data.
- ✓ Taxation- Tax and fiscal advice.

3.5 ECONOMIC ANALYSIS

The economic analysis of a project should provide the decision makers with the following information:

- ✓ A view of the future cash flows of the project, both positive in the form of revenue and negative in the form of expenditure and taxes.
- ✓ Estimates of the profit (loss) and return on investment of the project.
- ✓ The relative ranking of the project in comparison with alternative investment options.
- ✓ Estimates of the risk, both financial and technical, in undertaking the project.
- ✓ Forecasts of the effect of the project on the overall company position.

3.6 MEASURE OF PROFITABILITY

Management needs an objective means of measuring the economic worth of individual investment proposals in order to have a realistic basis for choosing among them and selecting those which will mean the most to the company's long-run prosperity. *Investment means committing funds in order to maintain or increase a company's overall value*. Typical investment requires an up-front cash payment to acquire **asset –** ownership of something of value to the business. Every business hope to earn net benefit- the **returns-** that is worth more than the initial investment cost. People invest in corporations in anticipation that their investment will provide returns worth more than their investment. These returns are usually in the form of **stock dividends** and proceeds from selling shares in the future. The growth in shareholder equity is a principal sign of performance. This growth is obtained by continuous reinvestments of the funds. The rate at which the composite grows might be called the *appreciation rate/ average opportunity rate.* Consequently, the value of money received from any special project being considered is determined by the rate at which the money (revenues) can be reinvested to provide appreciation of the firm's total assets. *It should be noted that the motive for being in oil and gas business is to make financial profit- not just to find, produce and transport petroleum!*

3.7 DISCOUNTED CASH FLOW ANALYSIS

The economic evaluation methodology is the discounted cash flow:

- ✓ Determine the estimate of the future net cash flow of the oil and gas project for each accounting period over its full life.

The above shows a general cash flow diagram involving a series of uniform receipt, each of amount A, occurring at the end of each period for N periods with interest at *i* % per period. Such a uniform series is often called an *annuity*. P (present worth) occurs one interest before the first A (uniform payment). F (future worth) occurs at the same time as the last A, and N periods after P.

4.8 INTEREST FORMULAR FOR CONTINUOUS COMPOUNDING AND CONTINUOUS CASH FLOWS

Continue flow of cash means a series of cash flows occurring at infinitely short intervals of time; this corresponds to an annual annuity having an infinite number of short periods.

To Find	Given	Factor by which to be given	Factor Name	Factor, Function, Symbol
For single cash flows: F	P	e^{rN}	Continuous compounding compound amount (single cash flow)	(F/P, _r%, N)
P	F	e^{-rN}	Continuous compounding present worth (single cash flow)	(P/F, _r%, N)
For uniform series (annuities): F	A	$\frac{e^{rN}-1}{e^{r}-1}$	Continuous compounding compounding amount (uniform series)	(F/A, r_%, N)
P	A	$\frac{e^{rN}-1}{e^{rN}(e^{N}-1)}$	Continuous compounding present worth (uniform series)	(P/A, r_%, N)
A	F	$\frac{e^{r}-1}{e^{rN}-1}$	Continuous compounding sinking fund	(A/F, r_%, N)
A	P	$\frac{e^{rN}(e^{r}-1)}{e^{rN}-1}$	Continuous compounding Capital Recovery	(A/P, r_%, N)