Introduction to Petroleum Economics

An Online Continuing Education Course for Engineers

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Introduction to Petroleum Economics

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1. Introduction

Economics drives the entire oil/gas producing industry. Almost every decision is made on the basis of an economic evaluation. Economic evaluations are also performed to determine reserves and the "standardized measure of value" for reporting purposes for publicly held companies. In many cases, the goal of the company is to make decisions that have the best chance of maximizing the present day profit.

Petroleum Economics has a vital role to play in the oil and gas industry, and it lies at the heart of all decision making. Various techniques have evolved over time in determining and calculating economic inputs, evaluating investments, quantifying risk and generating feasible portfolios. Petroleum Economics brings together information and expertise across the Exploration & Production (E&P) spectrum, and a clear understanding of concepts such as cash flow analysis, organizational challenges, price forecasting, cost drivers and risk management is required. Investment opportunities are regularly proposed to E&P management. They may involve the development of a newly discovered oil or gas field, or exploration for hydrocarbons in a new area. There may also be the chance of a farm-in or farm-out deal or even the acquisition of an entire company.

It is the petroleum economist's job to advise on the economic attractiveness of these opportunities, taking into account the many uncertainties regarding reservoir behavior, development costs, future energy prices and relationships with governments. He / She will also be involved in some or all of the following activities:

- ✓ *Lease bidding*

  Often the company has to bid in order to acquire acreage. Petroleum licensing or exploration license is the act of giving licenses (geographical areas at land and/or sea) to a company or a joint venture allowing them to search for commercially feasible deposits for the extraction of petroleum.

  Each sovereign country distributes licenses in what is typically called a licensing round. The procedure for such can greatly vary from country to country. The largest change is usually if it is a bid system or a grant system. In the bid system, each company or joint venture will offer a bid to gain the rights for the petroleum exploration at the license for a limited period of time. The highest bid will obtain the rights. In the grant system, the license will be granted to the company or joint venture that shows the highest interest and ability for the exploration of the license. This can be shown by the company experience, projected plan for the exploration (by high investment) and or longest presence on the country as a petroleum exploration company. The bidding parameter may be the size of a signature bonus, the Group's share of production, a price discount for domestic supplies, etc. The economist will help establish the value of this parameter.

- ✓ *Choosing of best option*
  Usually a choice has to be made between development options. There may be more than one production method (water or gas injection, beam pumps, gas lift), development plan (underwater completion or deviated drilling from a platform) or evacuation method (truck, rail, pipeline, tanker), etc. Profitability plays an important part in such decisions.

- ✓ *Reporting*
  The project proposals of operating companies are formally presented to E&P management at the annual Programme Discussions. Prior to this, the Data Books are prepared, setting out the technical and economic merits of the proposals. In addition, where the proposed expenditure exceeds the chief executive's discretionary limit, a formal budget proposal will have to be submitted for approval.

- ✓ *Unitization discussions*
  If a field straddles the boundaries of several license blocks held by different licensees, the production of the field will be shared between the various parties. This sharing involves frequent unitization discussions, in which the economist normally takes part.

  In essence, unitization is the joint development of a hydrocarbon reservoir that extends across two or more license or contract areas (if the field is governed by a production sharing contract regime) in order to ensure the efficient production of the reservoir and to maximize the economic recovery of petroleum from such licenses of the contract areas. The net effect of this is that each license group agrees that the license or contract areas are aggregated as a "unit," with each owner receiving a percentage interest in the unit ("unit interest").

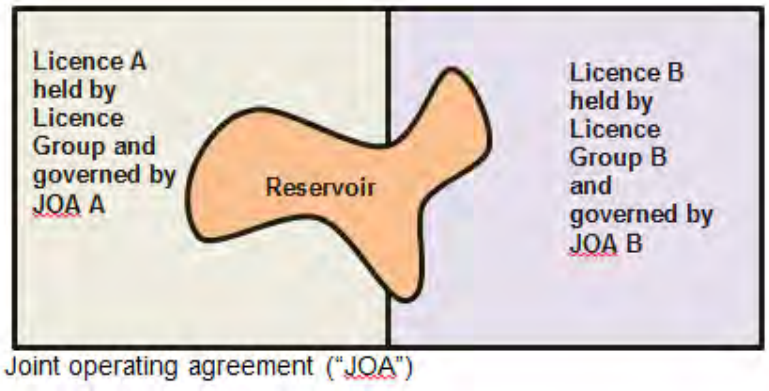

Figure 1 Illustration of unitization.

- ✓ *Fiscal changes*
  If fiscal changes are being discussed within or with the host government, the petroleum economist will inform his management of the economic consequences. Fiscal policy involves the decisions that a government makes regarding the collection of revenue, through taxation and about spending that revenue. It is often contrasted with monetary

policy, in which a central bank (like the Federal Reserve in the United States) sets interest rates and determines the level of money supply.

✓ *Contracts*
These may cover the sale of hydrocarbons, the sale or purchase of the right to use facilities such as pipelines, or the purchase of services or materials from third parties.

Figure 2 Licensing Block Map

Business decisions involving asset acquisitions, lease-buy assessments, exploration drilling options, oil and gas field development, equipment purchases, and fiscal negotiations all require detailed economic analysis. Basic petroleum economics facilitates good understanding of the process underlying optimal E&P investment decision, strategy, and profitability of E&P projects.

2. Licensing

The term "licensing" is used here to identify the process of granting permission to explore for and / or to produce petroleum. It is implied, that permission is granted by the owner of the resource, and that the license, therefore, has appropriate legal status. The owner of petroleum resources in the subsurface is normally the government but could be the landowner, or another company or individual. In the text, which follows, it is assumed that ownership is vested in the government. Frequently, the government is represented by a national oil company [NOC], which may or may not have the technical capability to operate independently.

The production of petroleum is a capital-intensive process, which may generate substantial revenues over a long period of time. Government and company have a common interest in this revenue potential. Government is entrusted with the husbandry of national resources and expected to maximize the economic benefit to its citizens. Benefit in this context may include taxation, industrial development, infrastructure, training, and employment, etc. The company, also, has responsibility for management of resources in the form of technology, skilled employees, and investment capital. Shareholders, who provide the risk capital, expect a reasonable return.

The government has power in the sense of having ownership of petroleum in the ground. In many cases, however, the government is dependent on the Industry for technology and capital to facilitate efficient production. Furthermore, there are competing claims for companies' exploration budgets. The government must, therefore, moderate expectation if they wish to attract attention.

Over the last hundred years, licensing procedures and formats have evolved, providing a formal basis for the relationship between company and government and a framework for technical responsibilities and the distribution of benefits. To some extent, these reflect changing views on oil price, local geology, economics and politics, and variation in the balance of influence between oil companies and government.

The following issues relate to most licensing systems:

- Definition of the license area
- Allocation procedure, to determine which companies are awarded licenses
- The mechanism for dividing financial benefits between government and company
- Technical and environmental requirements and constraints
- Ownership of produced oil and gas
- Investment risk
- Participation

Legally and logically, before drilling activity commences, a company should have a license to produce from that specific area. Furthermore, it is the responsibility of the prudent company to clarify international boundary issues, before committing such expenditure. A license normally relates to a specific geographical area, defined by coordinates, maps or physical markers. Extension of established land-based cartography to the offshore may lead to inaccuracy, which can be problematic, particularly in situations where subsurface resources approach or overlap license boundaries.

Licenses may be allocated by competitive, financial bidding [auction] or by some form of discretionary process, involving government selection. Auction is common in the US A and is a formal requirement for the allocation of offshore Federal areas. In an auction, the license is awarded to the highest bidder, which is normally for an up-front payment [bonus bid] but may be for a percentage of revenue [royalty bid], or of profits [net profit share]. Commonly, several blocks are offered to the Industry at the same time to create wider interest and to generate a competitive environment. The well-known semi-annual lease sales in Alaska have raised considerable income for the state. Proponents of the auction system argue that it is equitable and encourages efficiency. However, bonus payments up-front do add to exploration risk and favor larger companies.

Petroleum exploration is a high-risk business, with investment carrying a 75% probability of failure. Most licensing systems require the company to carry risk through to discovery. The standard concession or license then confers on the company the right to exploit any discovery for its own benefit [subject of course to any royalties and taxes].

Licensing Agreements
There are a number of styles of licensing agreement, which have been applied, within the petroleum industry. The most common are as follows:

a. *Old Style Concession*
A concession is an arrangement between a government and a company, whereby the produced oil and gas becomes the property of the company and the government receives various payments, in the form of royalties, taxes, etc.

The "old style" concessions, which predominated in the Middle East until the 1950's were characterized by large areas, long time periods, and managerial freedom. The original, 1901 Persian concession, was awarded to William Knox D 'Arcy [later Burmah, then Anglo Persian] for 60 years and covered around 75% of the country [some 1.2 million square kilometers]. There was no provision for relinquishment, and the company had considerable managerial freedom to explore and to exploit discoveries, with minimal interference from government.

This type of agreement was clearly inequitable and conceded excessive control to the company. After World War II, they were gradually replaced by production Licenses and by various forms of direct government involvement.

b. *Production License [New Concession]*
Modern production licenses [new concessions] offer much more control to government. Prospective areas are divided into many small blocks to increase competition and to reduce government dependence on any single company. Blocks are subject to relinquishment to encourage development. Licenses relate to shorter periods. Companies must compete for licenses on financial or technical basis. Development plans are subject to government approval. Revenues are subject to realistic levels of taxation.

c. *Production Sharing Agreement and Joint Venture*
A PSA is based on the principle that produced oil is shared or split between the company and government [or its NOC] in agreed proportions. Approved expenditure may be reclaimed from part of production, designated as "Cost Oil," the remaining part for sharing being called "Profit Oil." The company may also be liable for profit tax on its share of Profit Oil. In some cases, the company and the NOC form a separate company for the purpose of development. This arrangement is a form of Joint Venture.

Some of the earliest PSA's were contracted in Indonesia as exemplified by an agreement between Caltex and Pertamina in 1971. This was based on a production split of 85:15, Pertamina receiving the larger share. The agreement also included a signature bonus and relinquishment conditions. Caltex spent and reclaimed, and all data and facilities became the property of the NOC. Provision was also made for the use of Indonesian Nationals, goods and services.

d. Service Contract

In a service agreement, the company receives no equity in the project. All components, including produced oil and gas, belong to the state [through the NOC]. The company receives a fee for exploration and production services and may have an opportunity to purchase the production.

Latterly, Aramco [American joint venture company] provided exploration and production services for Petromin [the Saudi NOC at the time]. They received 6 cents for each new barrel discovered and 15 cents for each barrel produced. Most of this production was sold by Petromin to the Aramco partners for refining and distribution.

3. Production and Revenue

Petroleum fluids occur naturally as complex mixtures, which may form separate liquid and gaseous phases in the subsurface. Once produced, most petroleum forms liquid and gaseous phases at atmospheric conditions. Consequently, we can identify three important types of field:

a. Oil Field
An oil field is one in which the dominant, produced fluid is liquid. Many oilfields also produce associated gas. NGL may be recovered from the gas. If the quantity of associated gas is small, recovery and transportation may be uneconomic, resulting in re-injection or flaring. Larger quantities will justify recovery and sale,

b. Gas Field
A gas field is one in which the dominant produced fluid is gas. Many gas fields also produce some liquid [NGL].

c. Intermediate Field
An intermediate field i… …ificant quantities of both liquid and gas…

In business and econo… …uating success and progress is looking at t… …his important measure so that we can eventually…

Total revenue in petrole… …s of a given quantity of oil and gas. It is the t… …iplying the quantity of oil /gas sold by the price… …es 10,000 barrels of oil /day or bbls/d and the… …0,000bbls/d * $50/bbl = $500,000/day. Moreov… …s normally lumped together as Revenue or S…

Oil is usually priced in U… …ed by the tonne. Gas is priced either in $/millio… …meter. Be careful to use the same volume units… …rice of oil/gas varies dramatically with time and… …the oil or gas. There are several "benchmark" crudes in the… …price is reported on a daily basis. Benchmark