Deepwater Developments

Critical Aspects and Key Considerations for Technology Selection

This article provides an overview of deepwater activity and trends around the world, and discusses some of the most critical aspects of deepwater developments, including some key considerations for the selection of production platform technologies.

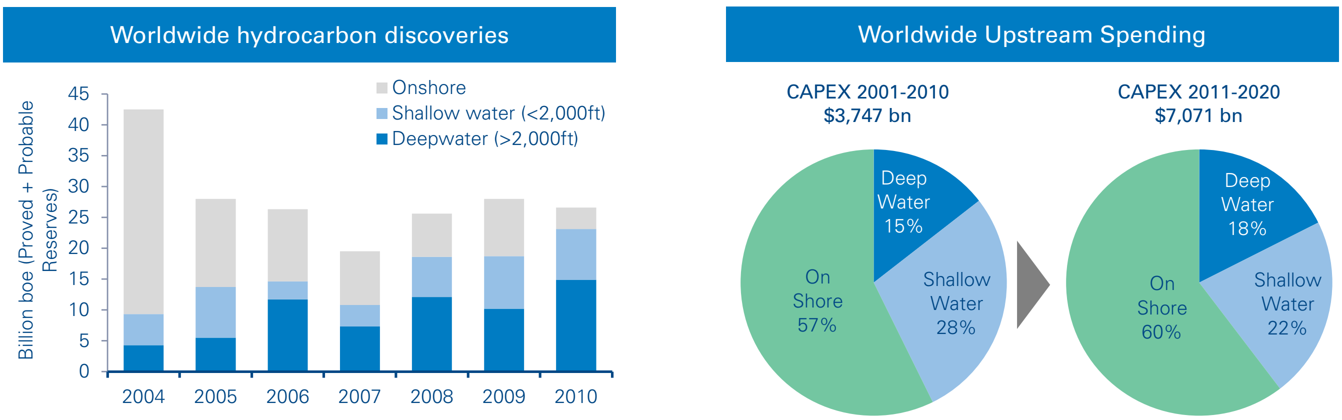
With fewer remaining easy-to-access oil fields, the oil industry has moved into new growth avenues such as onshore unconventional hydrocarbons and operations in more remote and deeper offshore water areas. Investors are now venturing into the exploration and development of opportunities at record water depth levels (now 12,000 feet) and distances from the coast (up to 400 miles). The on-going development of new hydrocarbon discoveries in different deepwater regions creates significant opportunities for a variety of industry players. Arthur D. Little has helped a number of companies understand the emerging opportunities associated with deepwater developments by applying some of our proven methodologies in technology development and selection, as well as project execution strategy design.

In 2010, deepwater discoveries amounted to approximately 50% of the proved and probable hydrocarbon reserves; whereas in 2005 these discoveries represented less than 10% of worldwide reserves. This has necessitated an increase in capital investments for deepwater growing from US$ 40 billion in 2005 up to US$ 70 billion in 2010. Furthermore, over the current decade Capex investments are expected to double (from US$ 541 billion in the 2000s to US$ 1,245 billion in the 2010s). This will represent around 50% of the overall offshore E&P capital spending (see figure 1).

Deepwater developments present an array of challenges, even for the most experienced players

Technology has been a key enabler of deepwater developments, and will continue to be so as new wells are now being drilled at water depth of over 3,000 meters. While the oil industry has gone through a long learning curve, and technology advancements have helped drive down the costs of deepwater

Figure 1: Global Deepwater Activity



Source: IHS CERA, PFC Energy; Analysis Arthur D. Little production, players still face a myriad of challenges resulting in long development times of up to twelve years for deepwater projects .

The most critical challenges and decisions that deepwater project developers face are:

- **Resource potential uncertainty:** A successful exploratory well can generate a lot of excitement. However, the magnitude of the required investment for the next stage, and the need to maximize synergies for the deployment of infrastructure requires an accurate view of field potential to avoid suboptimal decisions regarding the dimensions of the required infrastructure.
- **Drilling rigs availability:** Drilling costs can account for over 60% of the total capital expenditures in a typical deepwater development. Many development wells are required over the life of a project to help maintain production plateaus. The market for deepwater drilling rigs has been very tight, and there are usually long lead times for ordering new equipment.
- **Technology concepts:** The selection and adoption of a technology concept for a deepwater platform (e.g. FPSO, semi-sub or Spar) is one of the most critical decisions during the planning stages of a new development – this is discussed in more detail below.
- **Logistics and infrastructure:** Understanding the future production profiles and adequately sizing the infrastructure to transport the hydrocarbons is a challenge. Crude oil and natural gas transportation costs can be significant, particularly when the offshore production platforms are far from the coast with no pipeline infrastructure. FPSOs, shuttle tankers and FNLG are alternatives but require complex logistics.
- **Project Management:** Deepwater developments are especially susceptible to project delays and cost overruns. These delays and cost escalations during development can quickly erode the economic returns of investments in deepwater opportunities.
- **National content:** Host governments and national oil companies need to carefully weigh the potential benefits and risks of national content requirements particularly where the use of a local contractor for drilling or other key activities could slow down developments.
- **Fiscal terms:** The economic attractiveness of investment in deepwater is dictated by the tax and royalty scheme of the host country. In many countries the authorities recognize the complexities of these activities and have implemented special fiscal incentives for deepwater developments.
- **Regulatory aspects:** Delays with permits and regulatory approvals are often blamed for oil and gas project delays and cost over-runs. These issues are even more critical in emerging deepwater regions where regulators are still trying to catch up with industry players.
- **Environmental risks:** The environmental risks can be devastating for a deepwater operator. As a consequence the relative costs of deepwater production have been increasing. Another complication is the environmental restrictions to flare natural gas, requiring costly reinjection solutions when the volumes of gas cannot be commercialized.
- **Weather hazards:** In some regions such as the GOM, the exposure to hurricanes affects design considerations for deepwater developments. Since 2005, five major hurricanes have caused significant damages to the offshore oil industry in the GOM and explains why FPSOs have been largely absent from this region.

The choice of a technological concept is one of the key decisions during the planning stages of a new deepwater development

While a number of key activities need to be carried out early on, our work on field exploration and development strategies, as well as evolution of technology, suggests that there will be significant value in introducing some flexibility into the project concept to allow adoption of future technologies.

Project owners and operators have a menu of production platform options which can largely be grouped into three main types: FPSOs, Spars and Semi-submergible platforms. Each

Figure 2: Development challenges and technology considerations

	Deepwater Capability	Large Field Capability	Stability in waves and weather	Mobility	Commercial Storage Capability	Drilling/ Workover Capability	Dry tree/DVA capability	Quayside topside integration
FPSO	●	●	◑	◕	●	*No*	*No*	*Yes*
Spar	●	●	●	●	○	*Yes*	*Yes*	*No*
Semi-Sub	●	●	◕	◑	○	*Yes*	*No*	*Yes*

Source: PFC Offshore Concepts

● Strong ○ Weak/none

Figure 3: Deepwater options and capabilities

	Description	Advantages	Disadvantages
Floating Production, Storage and Unloading units (140 units operating)	FPSOs are a vessel based floating platform option that allows for production, storage and offloading of crude oil. FPSOs can operate in water depths that range from shallow to over 8,000 feet	■ Can substitute for expensive transportation pipelines ■ Provides independent mobility ■ Oil storage built into the hull ■ Can employ steel catenary risers	■ It is not possible to drill from the platform, and a separate Mobile Drilling Unit is required for drilling and workovers ■ A disconnectable turret may be required in hurricane territory, which limits the number of risers
Spars (20 spars currently operating)	Spars are ultra-stable floater platforms that have become very popular in US GOM deepwater developments. Spars can operate in water depths ranging from 1,000 feet to over 8,000 feet	■ Provides inherent stability and low motions ■ Can use steel catenary risers (SCR) at different depths ■ Dry tree option for drilling ■ Adjustable mooring system allows for drilling of DVA wells	■ Lack of mobility ■ Installation requires offshore lift and integration ■ Limited storage capabilities ■ Limited flexibility for incremental facilities due to weight restrictions
Semi-submersibles: (40 semi-sub platforms currently operating)	Semi-submersible platforms are floating production system platforms that are generally less costly and without any storage capabilities. Semi-subs can operate in water depths from 600 to over 8,000 feet	■ Installation is wet-towable with simplified quayside integration and lower installation costs ■ Typically have a large deck space ■ Semi-subs allows for steel catenary risers (SCR) in water depths over 3,500 feet	■ Motion at sea requires wet tree subsea completions ■ They are dependent on support ships for long distance mobility ■ Limited storage capabilities ■ In shallower waters may require alternate riser technology

Source: Analysis Arthur D. Little

of these options provides different features and capabilities as illustrated in figures 2 and 3.

While project economics will be a key factor in the selection of the platform technology, there are many other technical and operational considerations that should be taken into account (see figure 3).

Insights for deepwater project developers

The complexities of deepwater developments requires close attention to a series of factors during the visualization, conceptualization and execution stages. The industry has proceeded along a steep learning curve and experienced operators continue to venture into deeper waters. However, the number of experienced players in deepwater is still relatively small, and the global activity is largely dominated by the major oil companies and some specialized national oil companies like Petrobras.

For less experienced players, moving into deepwaters can be daunting. The best way to develop the required knowledge and experience is by starting small and partnering with more experienced operators and service companies. However, some NOCs will not have the luxury of time to learn since their countries are hungry for the wealth that can be generated through the development of massive resources. Valuable lessons can be derived from the mistakes and successes of others in this arena. Key success factors include:

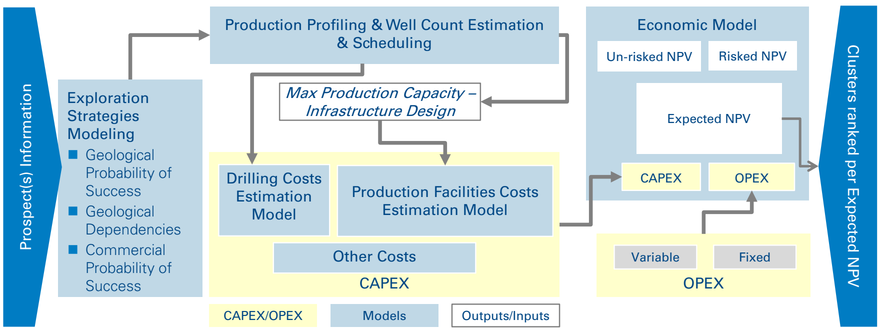
- **Strategic approach:** Offshore development demands executive commitment, long-term vision and sound decision making based on comprehensive data analysis and economic evaluations. Technology is not necessarily a limitation when the appropriate resources (human and financial) and executive vision can meet.
- **Resource Evaluation:** It is important to take the time to do the science upfront to access as accurately as possible. Significant geological evaluation must be completed before committing to drilling in a full scale offshore development. Successful players explore multiple opportunities with the possibility of consolidated development to minimize risks.
- **Infrastructure planning:** A clustering approach for geological opportunities helps reduce risks, captures development synergies and minimizes capital expenditures. Development flexibility can also help offset field risks. Less permanent solutions like FPSOs and tankers can be redeployed if fields fail. Many deepwater platforms around the world have been overbuilt due to over-estimation of production so it is usually better to start with an infrastructure that can be expanded as new reserves are incorporated.
- **Project management:** Project schedules need to consider the company's processes, value assurance procedures, market conditions, equipment availability and other technical and economic variables. It is also critical to start verification and approvals processes as early as possible to minimize cost and time delays.
- **Multi-disciplinary approach:** Large scale projects in deepwaters call for the integration of many disciplines. Integrated project management, systems engineering and supply management are key for the success of these developments.
- **Contracting:** Demand for deepwater and ultra-deepwater high specification drilling rigs is outpacing supply. Contract daily rates are volatile, so it is important to lock in contracts

for existing rigs or new builds early (many years in advance) to avoid high contract rates or potential delays

- **Drilling:** Large time investment in drilling wells can affect production schedule significantly. It is advisable to pre-drill production wells and development wells concurrently with facilities construction to avoid delays. Complex and fractured reservoirs require many wells to maximize recovery. Rigs must be available to perform maintenance.
- **Production facilities:** Strategic and technical factors should be considered in the selection of the optimum platform. FPSOs certainly provide more flexibility and mobility (and can reduce capex for transportation pipelines), but the ability to drill wells from the platform can provide an important drilling cost advantage for Spars.

Arthur D. Little has developed a number of methodologies to support the analysis of multiple offshore exploration and development strategies, however, as noted above, there

Figure 4: Arthur D. Little Approach Overview



remains a number of real challenges when making these decisions for deepwater developments.

Our approach to offshore E&P strategy and technology selection is grounded in aligning geological and technical information with the operating and corporate strategy, optimizing the choice of platform and technology for the expected future life of the asset. This means modeling the exploration strategies based on available geological information, developing drilling forecast and production profiles, designing operation infrastructure and estimating the value creation from developing different field clusters. This whole process should be assessed understanding likely technology evolution over the life of the asset to ensure that future improvement options are not excluded (see figure 4).

Based on our experience, a comprehensive assessment of the development strategy at an early stage of the exploration campaign generates high value because it helps focus resources and efforts on high value targets and identify the critical variables for the success of the offshore projects.

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Arthur D. Little

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