Subsea Production Systems
An Enabling Component of Offshore Production

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Photo: Oceaneering
1. Deepwater drilling began long before we had production capability
2. Time and depth gap between drilling and production is closing
3. 10,000’ has been the water depth threshold for almost 10 years
Maximum Water Depth Progression of Subsea Projects 1961-2015e Startup Year

Based on actual subsea tree awards through Q1 2010

Courtesy of Quest Offshore Resources, Inc.
Subsea Tree Configurations

Horizontal Tree

- Tree Cap
- Crown Plugs
- Tubing Hanger
- Treehead
- Tree Connector
- Wellhead

Vertical Tree

- Tree Cap
- Master Valve Block
- Tree Connector
- Tubing Hanger
- Wellhead or Tubing Head Spool

Courtesy of GE Oil and Gas
Two Types of Trees

Horizontal

Vertical

Courtesy of GE Oil and Gas
Set Surface Casing

Land BOP on Guidebase and Wellhead

Courtesy of Schlumberger
Drilling Through BOP

Courtesy of Schlumberger
Run Subsea Tree

Courtesy of Schlumberger
Horizontal Tree on Wellhead
Land BOP on Subsea Tree
Land Tubing Hanger in Subsea Tree

Courtesy of Schlumberger
Perforate Well

Courtesy of Schlumberger
Flow Well
Run Internal Tree Cap

Courtesy of Schlumberger
Retrieve BOP

Courtesy of Schlumberger
Install Debris Cap

Courtesy of Schlumberger
Early Trees

Shell Dry Chamber Tree

Texaco Tartan Stacked Valve Tree

Courtesy of FMC Technologies
Initial Subsea Tree Systems

Fire Safe “USV’s” under a Platform 1968

Diver Intensive Mudline Tree 1970’s

Diver Assist Tree early 1980’s

Courtesy of FMC Technologies
Tree Technology Evolution

1992

1994

1996-1998

2000

Courtesy of FMC Technologies
Vertical Subsea Tree at Installation and 20 Years Later

circa 1964

Caliente State #2

20 years later

Courtesy of FMC Technologies
Example of a Small Subsea Project

- Petrobras Cottonwood (2200 ft water depth)
Example of a Large Subsea Project

- Petrobras Roncador (6600 ft water depth)

Courtesy of FMC Technologies
SUBSEA IS A GROWTH INDUSTRY

• Over the long term, growing hydrocarbon demand coupled with the depletion of existing onshore and shallow offshore fields will require further drilling in deeper water and more remote regions
  – While discoveries have increased over the past decade, they continue to fall well short of production by a considerable degree.
  • According to IEA, 12 billion barrels were discovered in 2011 equating to only 40% of the oil produced during 2011
  – Oil companies are looking for the most impactful projects to add reserves which are largely located offshore in deeper waters
  • Deepwater is the primary value creator for the oil & gas industry
• The number of floating production systems is increasing and most require subsea trees
Leading Indicators for Deepwater Business

• Floating Rig Construction
  – Record floater orders in 2011/2012 support strong growth through 2015
  – Even with recent reduced rig rates, backlog is still high

• Subsea Equipment Projections
  – Subsea Tree Awards – strong growth projected through 2016
  – SURF activity – strong projected growth to mirror tree awards
  – Subsea processing is becoming an accepted technology

• Projected Capex
  – Quest projects double digit annual increases in Subsea Capex spending during 2013 through 2017

• Emerging Subsea Technology is Supportive to Deepwater Business

• For aging fields, moving activities to the seafloor can lead to substantial cost savings, while many marginal greenfield projects can become economic with the aid of subsea processing
Continued Growth in Deepwater Oil Supply

Due to the value creation opportunities in the deepwater, expect an increasing share of global production to come from the deepwater, from roughly 7% currently to around 12% by 2030.

Courtesy of Wood Mackenzie
Deepwater Drilling Expanding Rapidly

- New deepwater basins are being identified at a rapid pace
  - Expansion is enabled by the significant additions to the floating rig fleet over the next several years

Source: Wood Mackenzie
Global Subsea Capex
Forecast spending 2014-2019e $75.2bn

94% Increase
Growth in future driven by North Sea, Africa and Asia.

US$38.8bn
US$75.2bn

Courtesy of Quest Offshore Resources, Inc.
Quest Global Subsea Tree Forecast Awards
Mean Case 2000A to 2018e

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Courtesy of Quest Offshore Resources, Inc.
New Subsea Wells On Line

- Overall subsea spending to double during the 10-year period ending 2021
- Deepwater (>5000') growth is projected to be even more dramatic
- Significant number of new subsea wells projected to come on line through 2017
Global Subsea Trees on Stream by Decade With Average Water Depth

Courtesy of Quest Offshore Resources, Inc.
Significant Increase in Umbilical Activity

- Umbilical activity is projected to trend higher over the next 4 years, consistent with the upward trend predicted in subsea trees.

Courtesy of Quest Offshore Resources, Inc.
Worldwide Pipeline Demand 2007 – 2019

World pipeline demand will continue its growth trend into the foreseeable future buoyed by the development of large projects such as those in the Brazilian Pre-Salt and investments in export infrastructure in select regions such as Australia, Norway and the Gulf of Mexico. 2014 installations see a significant increase in the 25+ category with the planned installation of large exports for projects such as Wheatstone, Ichthy’s and the South Stream Pipeline.
SURF CAPEX – Installation  2008 - 2015

$Billions

Year


Africa, Mediterranean  Asia Pacific  North Sea  North America  South America

Courtesy of Quest Offshore Resources, Inc.
Market Summary: Subsea Spending is Growing

• Oil and gas recovery has over the last century gradually spread from land via coastal areas to deep sea.
• The continuous technology development has made it cost efficient to recover oil and gas from deeper reserves, in deeper waters and further from shore.
• Investment in subsea installations is in many cases lower than a platform solution, and this is the reason why subsea solutions are expected to see a rapid growth in the coming years.
• There is extensive offshore activity on all continents.
  – Main established geo markets are the North Sea, the Gulf of Mexico, Brazil, West Africa and South East Asia.
  – Other markets include Eastern Mediterranean, Canada, Sakhalin area, Indian subcontinent and the Arabian Gulf.
Other Subsea Activities

Courtesy of FMC Technologies
Subsea Well Intervention

- The number of subsea wells continue to grow and the age of all wells becomes greater each day
- The high costs of drilling rigs and related services are encouraging Operators to look for lower cost options in well intervention
- Larger intervention vessels with more robust capabilities can provide services not available in the past
- Teaming of key players in the industry are offering new capabilities
  - FTO (FMC and Chouest)
  - OneSubsea with Helix
  - Aker Solutions with Baker Hughes
Subsea Well Intervention Issues

• Some subsea wells are over 40 years old and still on the seafloor
  – Intervention tooling and running tools can be difficult to obtain
  – Information on older subsea wells can be difficult to obtain
• Operators often sell off older assets late in field life to smaller companies
  – Smaller Operators focus on costs and will use the most cost effective vessels they can find
• Intervention in existing wells can improve recovery but the cost of intervention reduces increased well revenue
Types of Subsea Processing

- Subsea Boosting (including pumping)
- Subsea Raw Water Injection
- Subsea Separation and Processing
- Subsea Gas Compression
Benefits of Subsea Processing

- Increase a well’s recovery rate to enhance project economics (greenfield and brownfield)
- Moves “boosting and processing” to the seafloor from the surface (platform or floating production system topside)
- Reduce topside weight
- Can allow production from subsea to shore
Slow Acceptance of Subsea Processing

- Oil and gas industry typically requires 30 years for new concept to reach 50% market penetration
- Much of the world’s offshore production is still produced to fixed platforms in less than 1,000 ft of water
- Oil company and service company R&D programs have been reduced over the years (mergers as well as market downturns)
Most Likely Subsea Processing Opportunities

- Deepwater - Generally in excess of 2000 ft
- Large Subsea Developments - Usually producing to a floating production system
- Major Oil Companies who have already tried subsea processing
- Geographic areas having the above criteria
  - Expected to be Brazil, GoM, W. Africa and North Sea
Subsea Processing Market Has Been Largely Dominated by Brazil, West Africa, and Norway

![Pie chart showing subsea processing awards]

- **Brazil**: 31%
- **GoM**: 13%
- **Norway**: 18%
- **W. Africa**: 18%
- **UK**: 10%
- **Other**: 10%

*Courtesy of INTECSEA, Morgan Stanley Research*
Subsea Boosting Projects To Date

Boosting systems by award date

Packager: BHI GE OneSubsea FMC Aker

Courtesy of INTECSEA, Morgan Stanley Research: note, some projects shared by two manufacturers, in which case each was attributed half a project
Subsea Separation Projects Have Been Awarded at a Pace of About 1 Per Year

Courtesy of INTECSEA, Morgan Stanley Research: note, some projects shared by two manufacturers, in which case each was attributed half a project
Subsea Separation Systems Market Share of Eight Installed/Qualified Systems

- FMC: 62%
- TWISTER (qualified): 13%
- GE: 12%
- CAMERON: 13%

Courtesy of Quest Offshore Resources, Inc.

Subsea Separation System photo courtesy of FMC Technologies.
Market Potential for Subsea Processing (Based on award dates)

• Current estimates of $400 million in 2012
  ($200 million hardware and $200 million installation)

• Estimates of $2.6 billion in 2015
  ($1.3 billion each)

• Estimates of $8.1 billion in 2020
  ($4.1 billion each)

Courtesy of Morgan Stanley Research
Subsea Processing Conclusions

- Subsea processing has been very slow to be accepted by industry, but is now a huge growth market
- While there are a few key suppliers, these are supported by a number of other high tech companies
- A few key Customers will lead, but others will follow as the industry accepts the technology
Subsea Decommissioning Is a Growing Market

• Subsea decommissioning is a major area of concern for the industry in the future.

• Rules and regulations in the GoM and North Sea are well defined but this is not so in most other geographic areas.

• Costs for subsea decom are difficult to estimate and have a negative impact on Operator economics.

• P & A costs are a significant portion of overall subsea decom costs but this is sometimes mitigated by leaving trees and tubing in place.
Summary

- Subsea is a growing subset of the offshore oil and gas industry.
- Subsea is still a relatively young industry and will be a significant industry segment for the future, especially for deepwater.
- Subsea installation requires purpose built vessels and engineered solutions.
- Subsea processing has become a proven technology.
- Subsea intervention and decommissioning are growing markets.
Bruce Crager
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Bruce Crager is Executive Vice President for the Expert Advisory Group at Endeavor Management in Houston, TX. This group focuses on Offshore, Subsea and Marine activities. He has 40 years’ experience in offshore drilling and production, including senior management positions at McDermott, INTEC Engineering, ABB Offshore and Oceaneering. This includes evaluating and providing field development solutions, particularly those based on floating production systems and subsea production equipment. Since joining Endeavor in 2010, Bruce has consulted with many clients; a few include Addax, Cameron, GE Oil and Gas, Pemex, Petrobras, Ridgewood Energy and Shell.

Bruce holds a BS in Ocean Engineering from Texas A&M University and a MBA from the University of Houston. He has co-authored 4 patents, and has written numerous technical and management articles. Bruce's message, delivered to audiences worldwide, provides an overview of deepwater development, future trends, and solutions for complex offshore development.

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