# Floating Production Systems

## *The Industry's Best Solution for the Future*

Presented by Bruce Crager

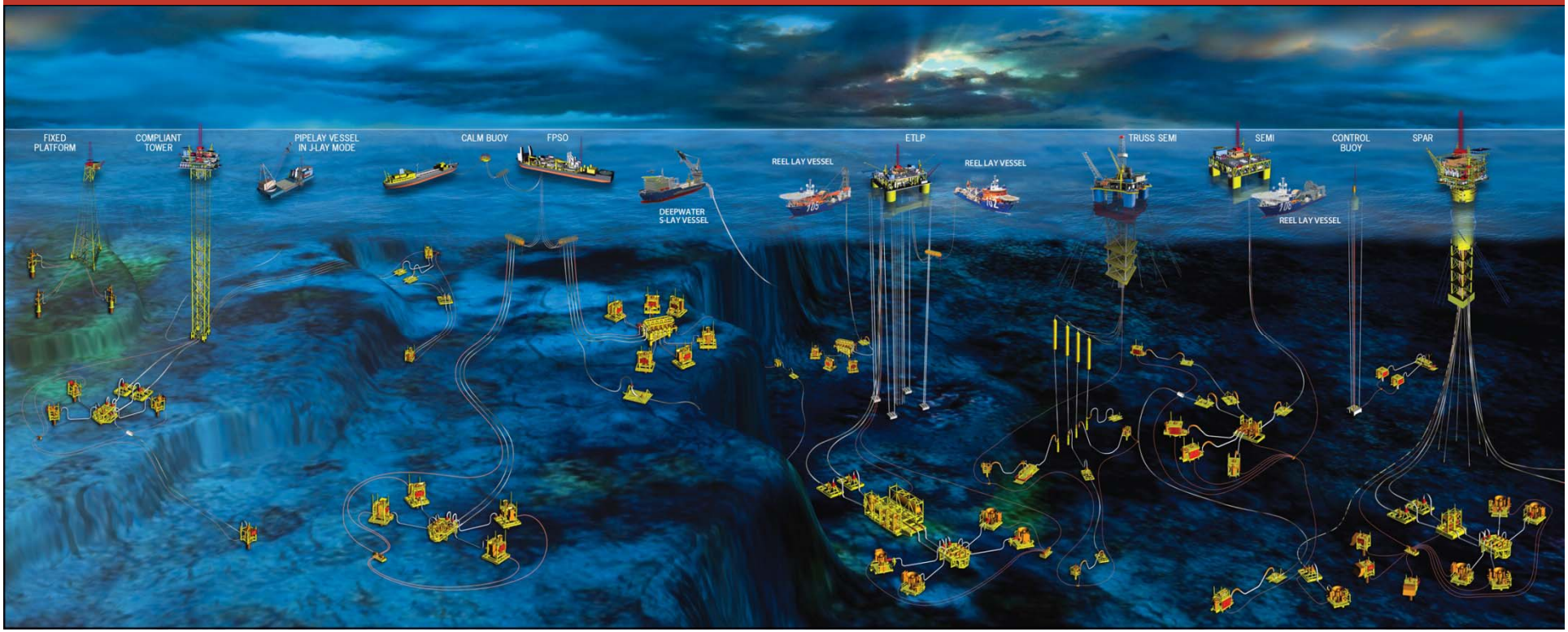
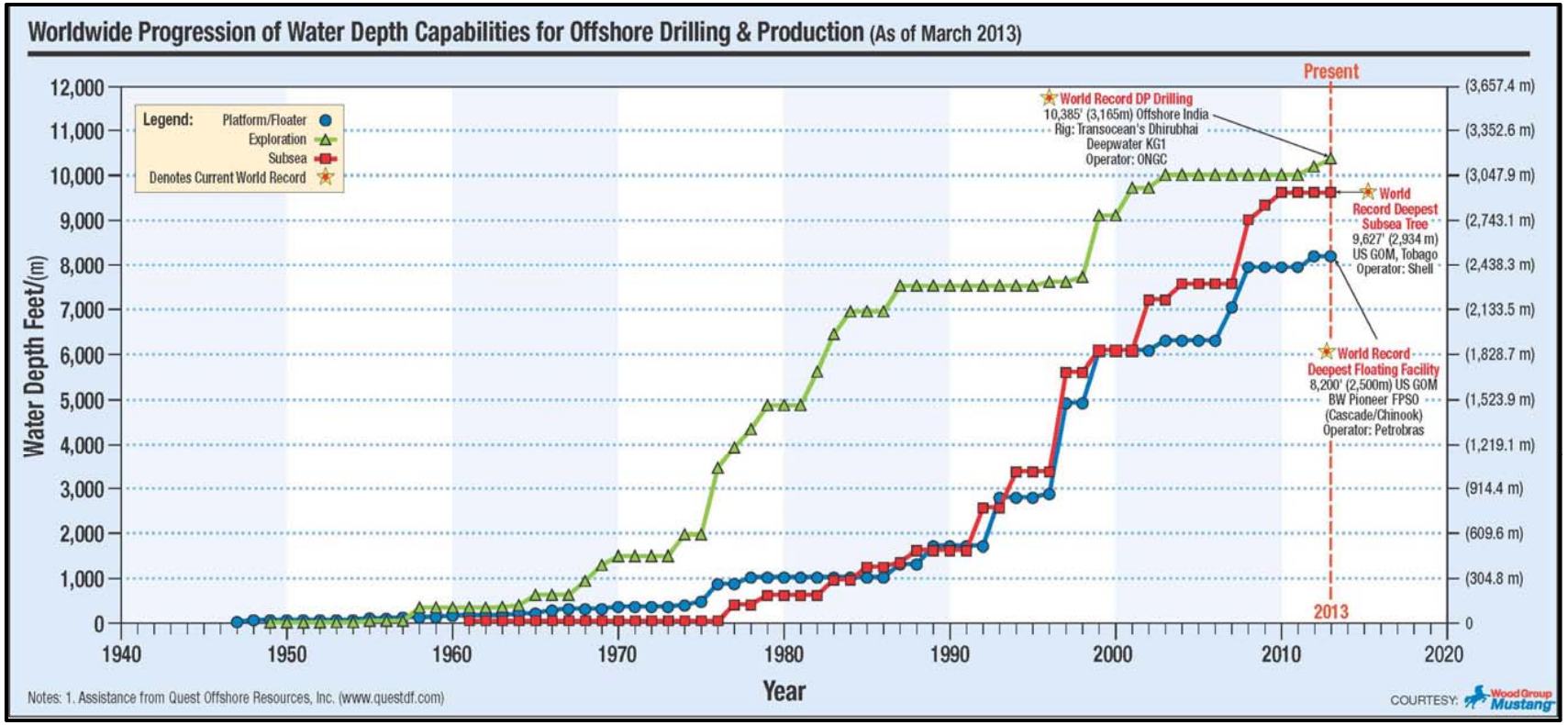



Image Source: McDermott Engineering

Rice Global Engineering & Construction Forum

November 8, 2013

Endeavor



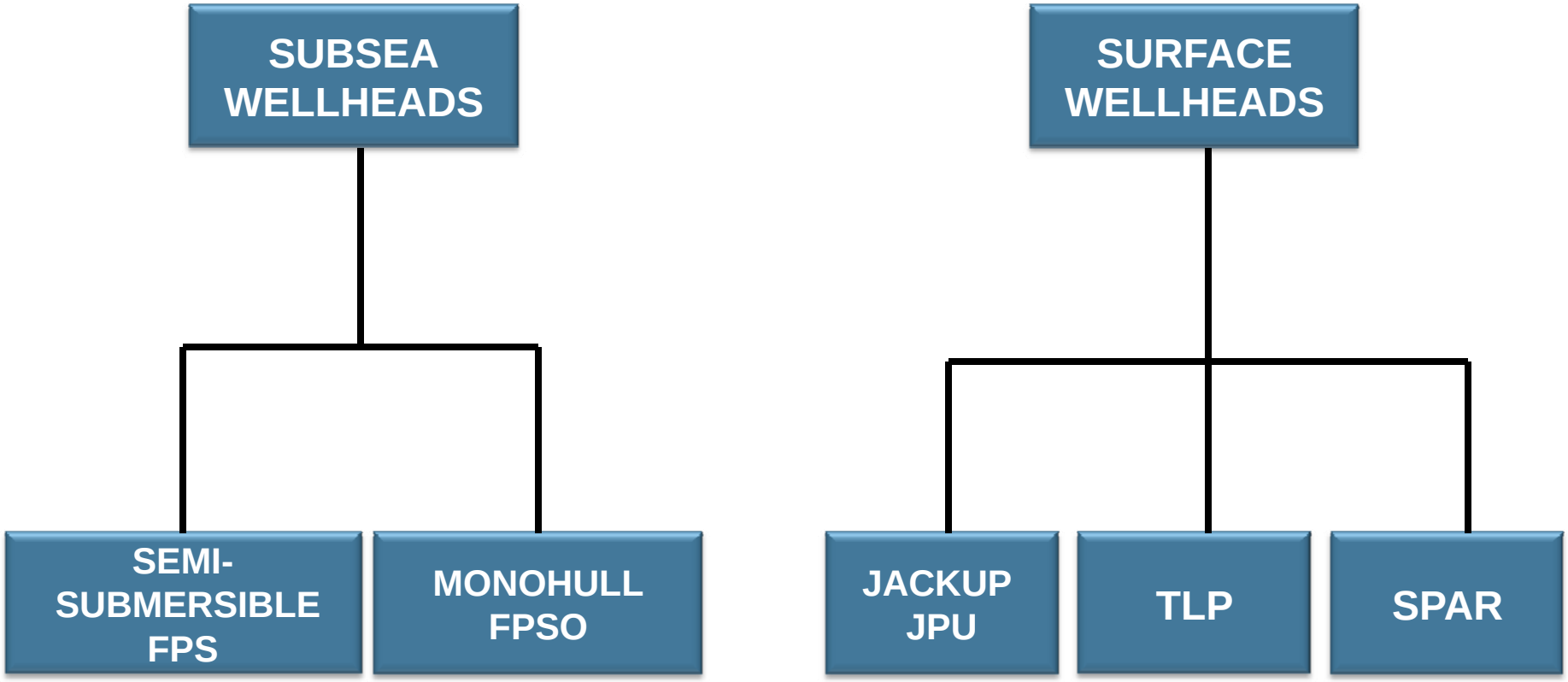

1. Deepwater drilling began long before we had production capability
2. Time and depth gap between drilling and production is closing
3. 10,000' has been the water depth threshold for almost 10 years

Source: Mustang Engineering

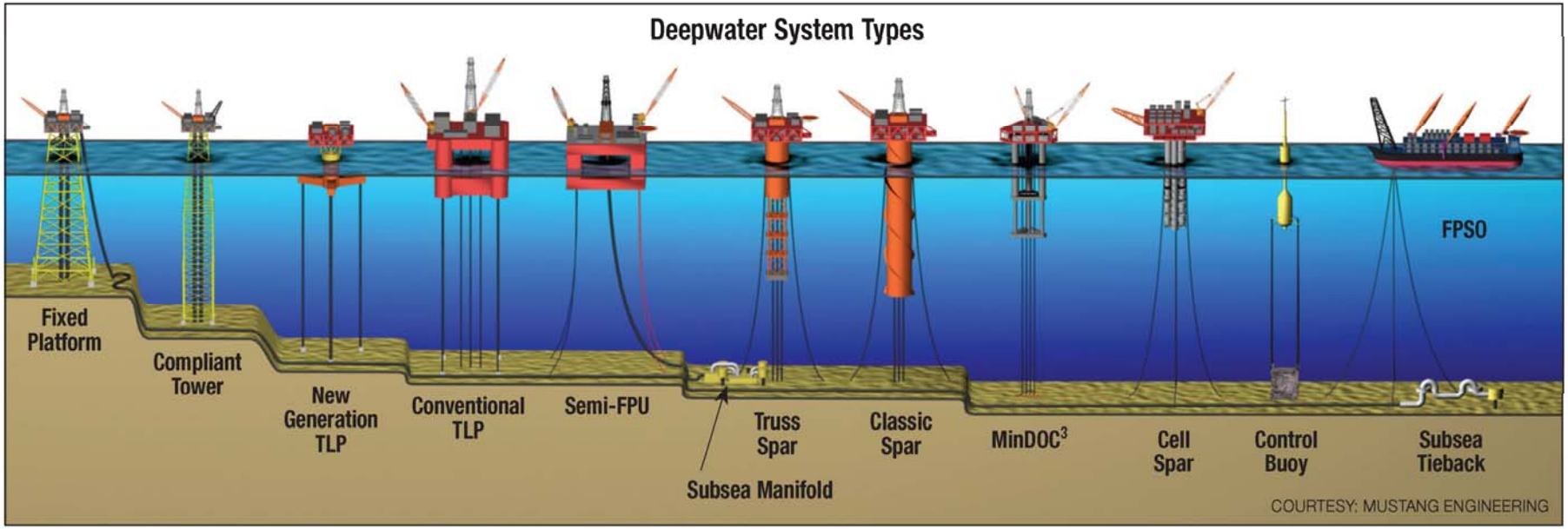
# Issues Driving Use of Mobile Offshore Production Systems (MOPS):

- Geographical Location
- Water Depth and Environmental Regime
- Wellhead Location (Surface, Subsea or both)
- Drilling/Workover Requirements
- Oil Export Options (Need Storage? )
- Gas Usage / Export Options
- Size and Weight of Process System (Primary Function)
- Fabrication (Local Content)

# Mobile Offshore Production Systems (MOPS): Principal Types



# PRODUCTION SYSTEM TYPES
## Solutions for Recovery of Offshore Oil & Gas




Source: Mustang Engineering

Three System Groups:

1. Dry Tree Systems – Fixed Platform, Production Jackup, Compliant Tower, TLP, Spar
2. Wet Tree Systems – New Gen. TLPs, Conventional TLPs, FPSOs, Cell Spar, Control Buoy, SS Tiebacks, Semi-FPS
3. Mixed Dry / Wet Tree Systems – Fixed Platforms, New Gen. TLP, Conventional TLP, Spar

# Jackup Production Unit (JPU) or MOPU

| | |
|---|---|
| Operating: | 40 |
| First: | 1971, Gulftide, Ekofisk |
| Deepest: | Harding, UK, 400 ft |
| Depth Range: | 43 ft – 400 ft |
| Construction: | 2 |
| Locations: | Worldwide |

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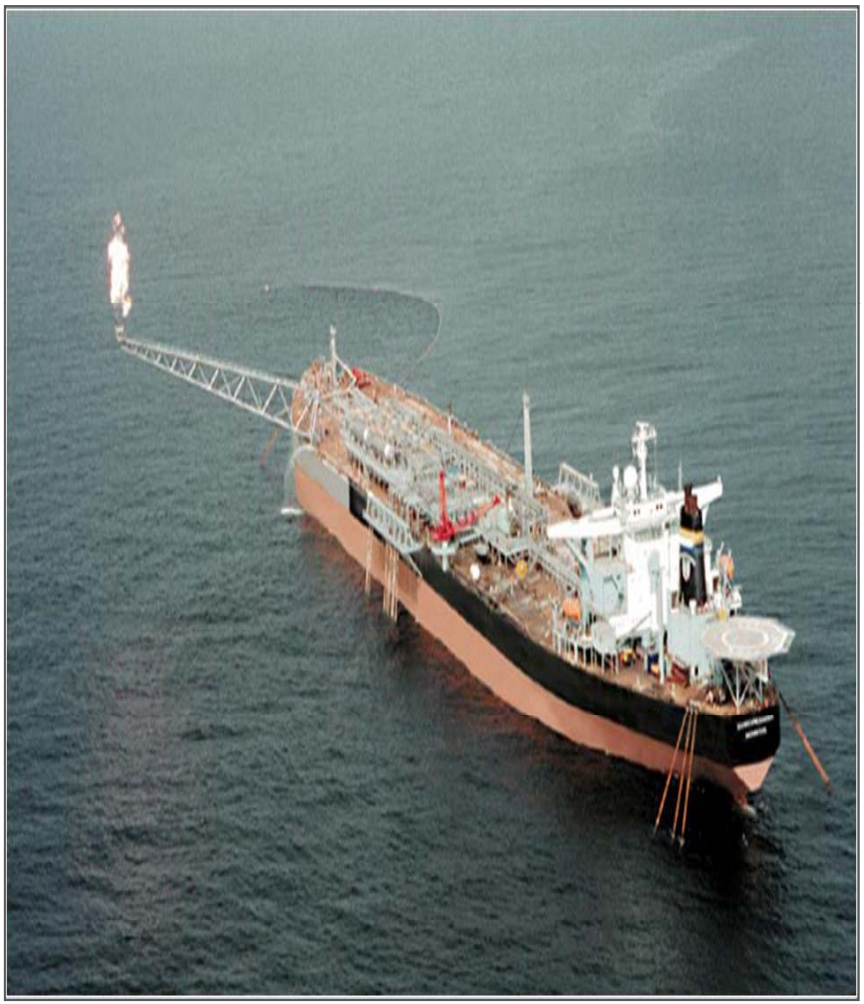
# FPS – Floating Production System (Semi)

| | |
|---|---|
| Operating : | 43 |
| First: | 1975, Argyll, Hamilton |
| Deepest: | 7,920 ft, MC920 Independence Hub |
| Construction: | 7 |
| Locations: | Worldwide |

# FPSO- Floating Production Storage & Offloading

| | |
|---|---|
| Operating : | 165 |
| First: | 1977, Castellon, Shell |
| Deepest: | 8,200 ft, Cascade Chinook |
| Construction: | 44 |
| Locations: | Worldwide |



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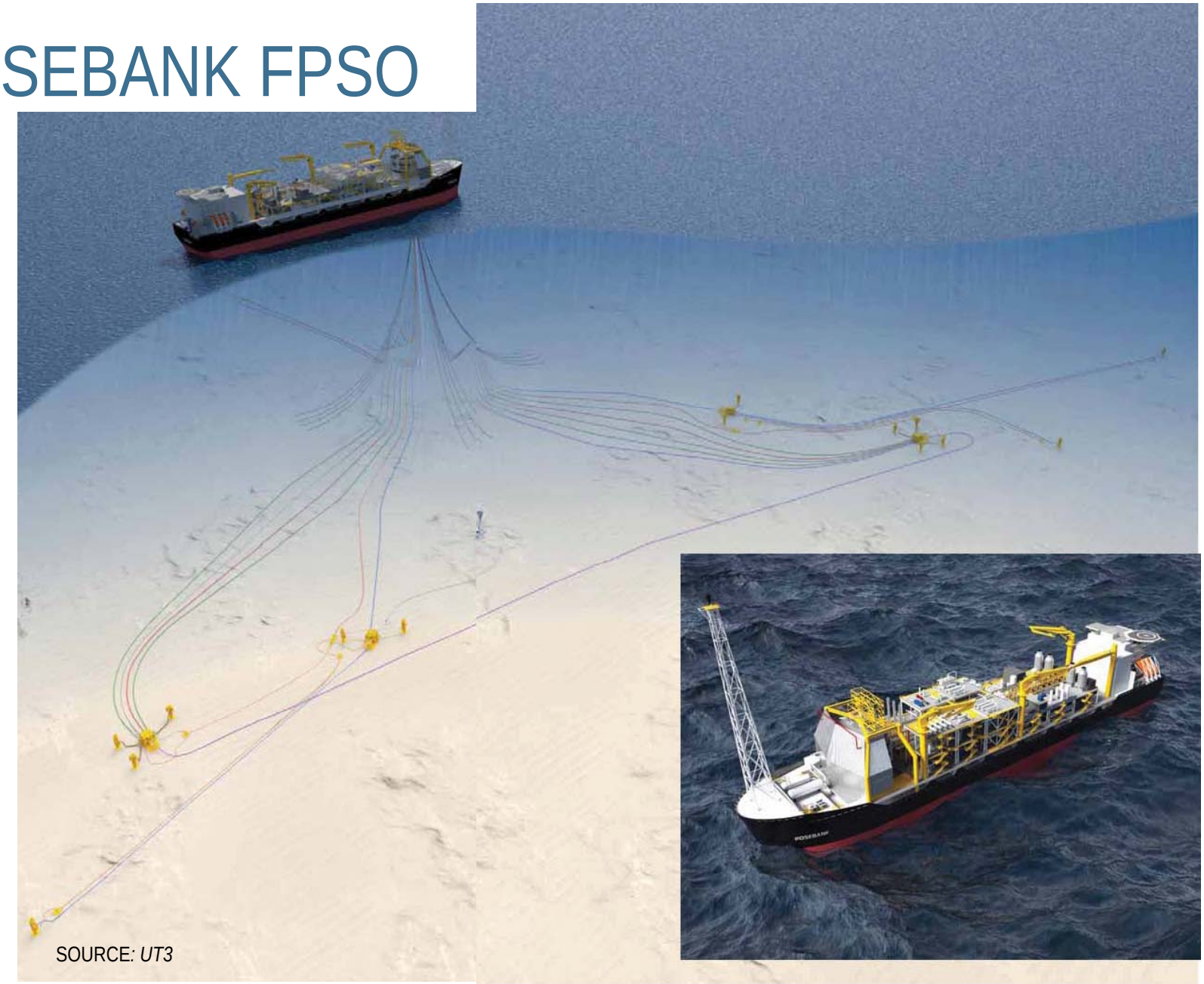
# ROSEBANK FPSO



SOURCE: *UT3*

# TLP- Tension Leg Platform

| | |
|---|---|
| Operating : | 22 |
| First: | 1984, Hutton, Conoco |
| Deepest: | 4,674 ft., Magnolia GB783/84 |
| Construction: | 5 |
| Locations: | North Sea, Angola, Brazil, Gulf of Mexico, Indonesia and Equatorial Guinea |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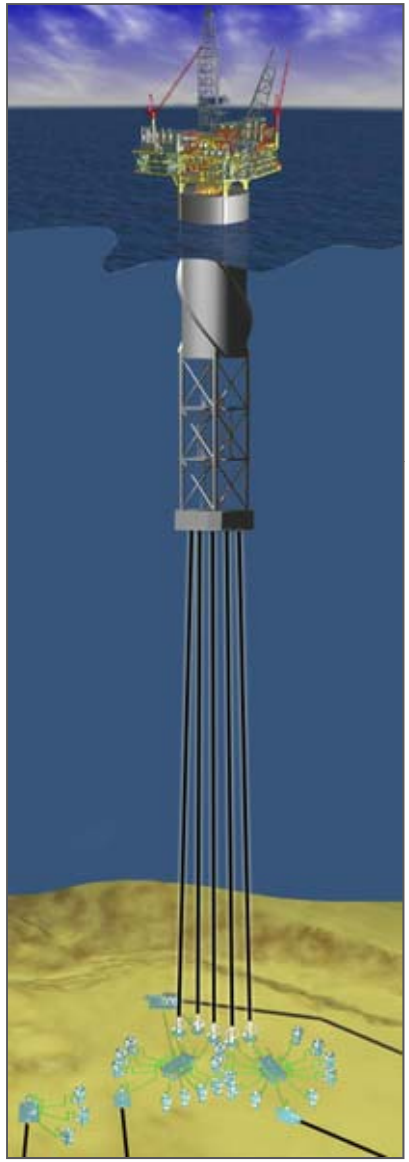
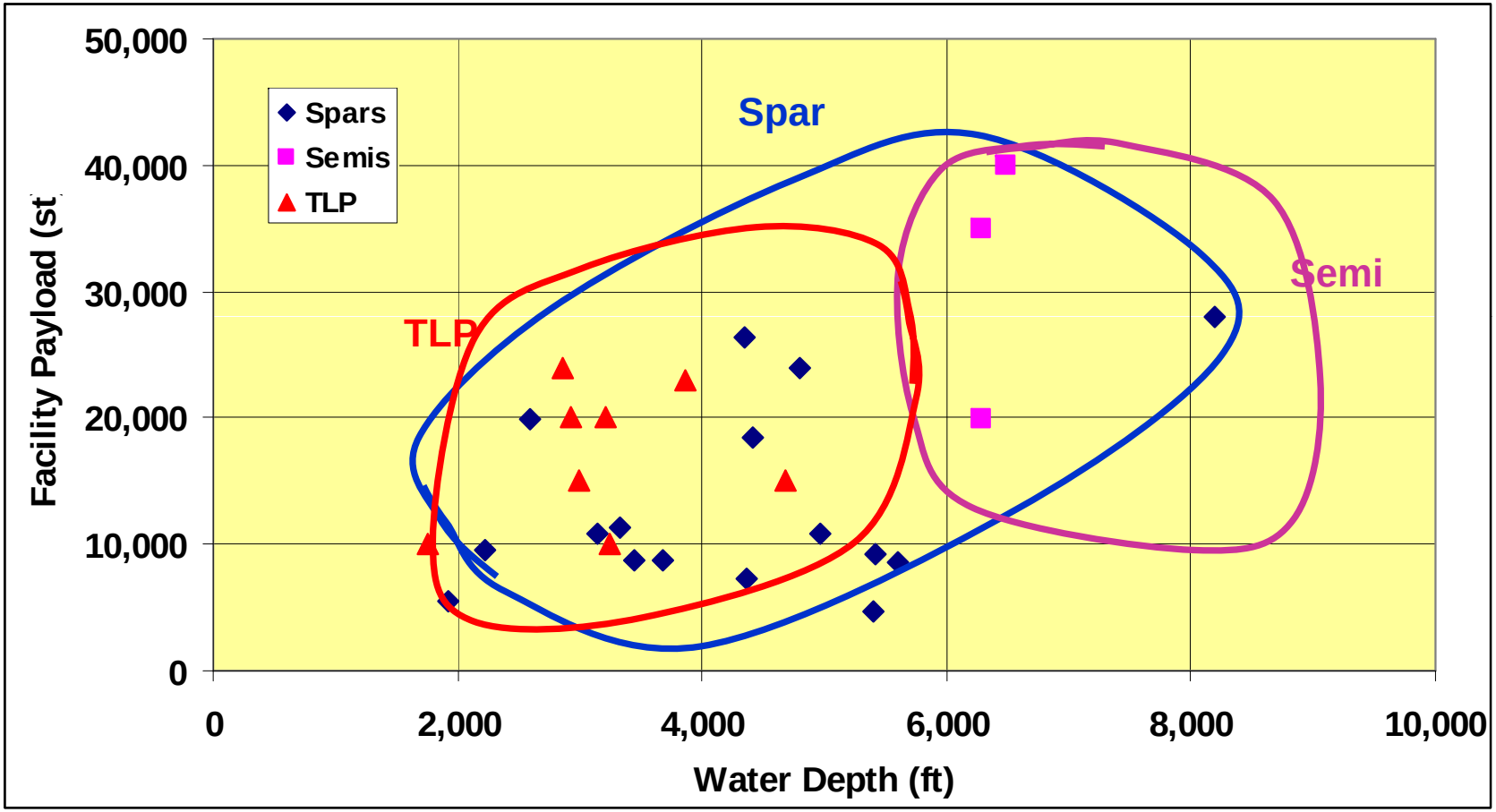
# SPAR

| | |
|---|---|
| Operating : | 19 |
| First: | 1996, Neptune, VK 826 |
| Deepest: | Perdido 8,008 ft<br>Alaminos Canyon 857 |
| Construction: | 5 |
| Locations: | Gulf of Mexico, Malaysia,<br>Norway (future) |

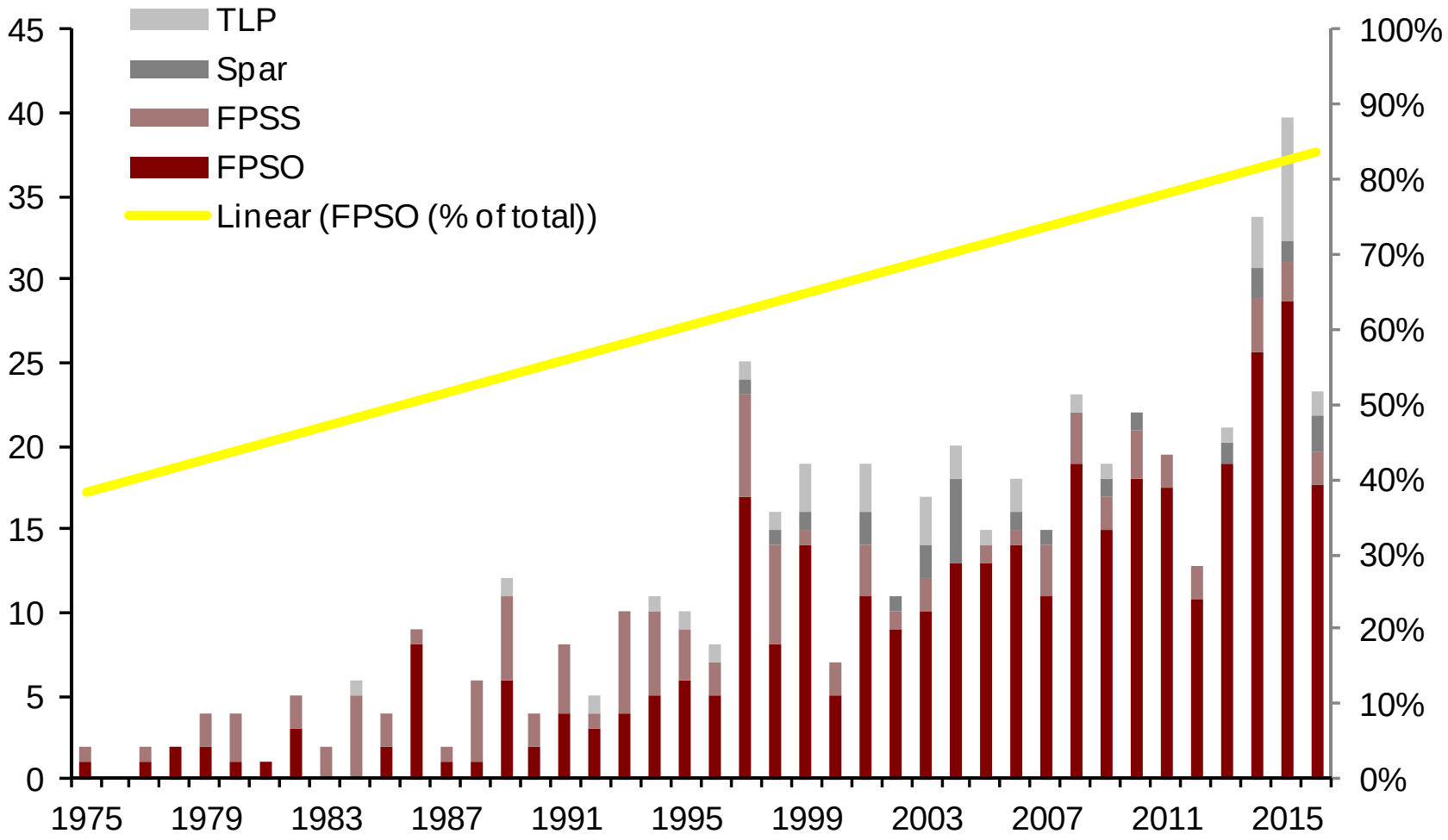


# Optimum Application Ranges




*Source: FloaTEC*

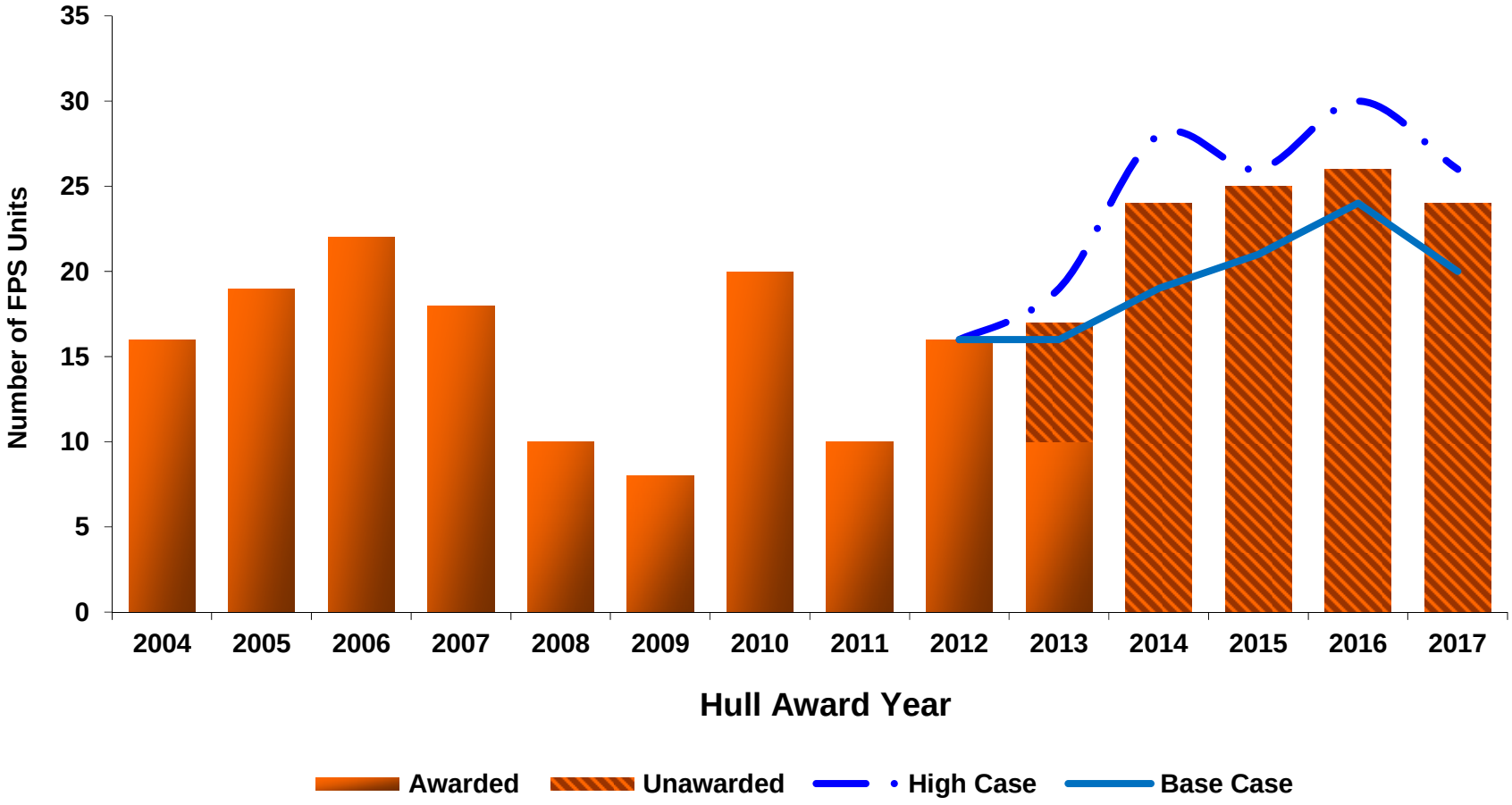
# FPS By Type




*Source: Douglas-Westwood*

# Worldwide FPS Forecast Awards 2004 – 2017 (e)

*By Award Status (Mean Case)*

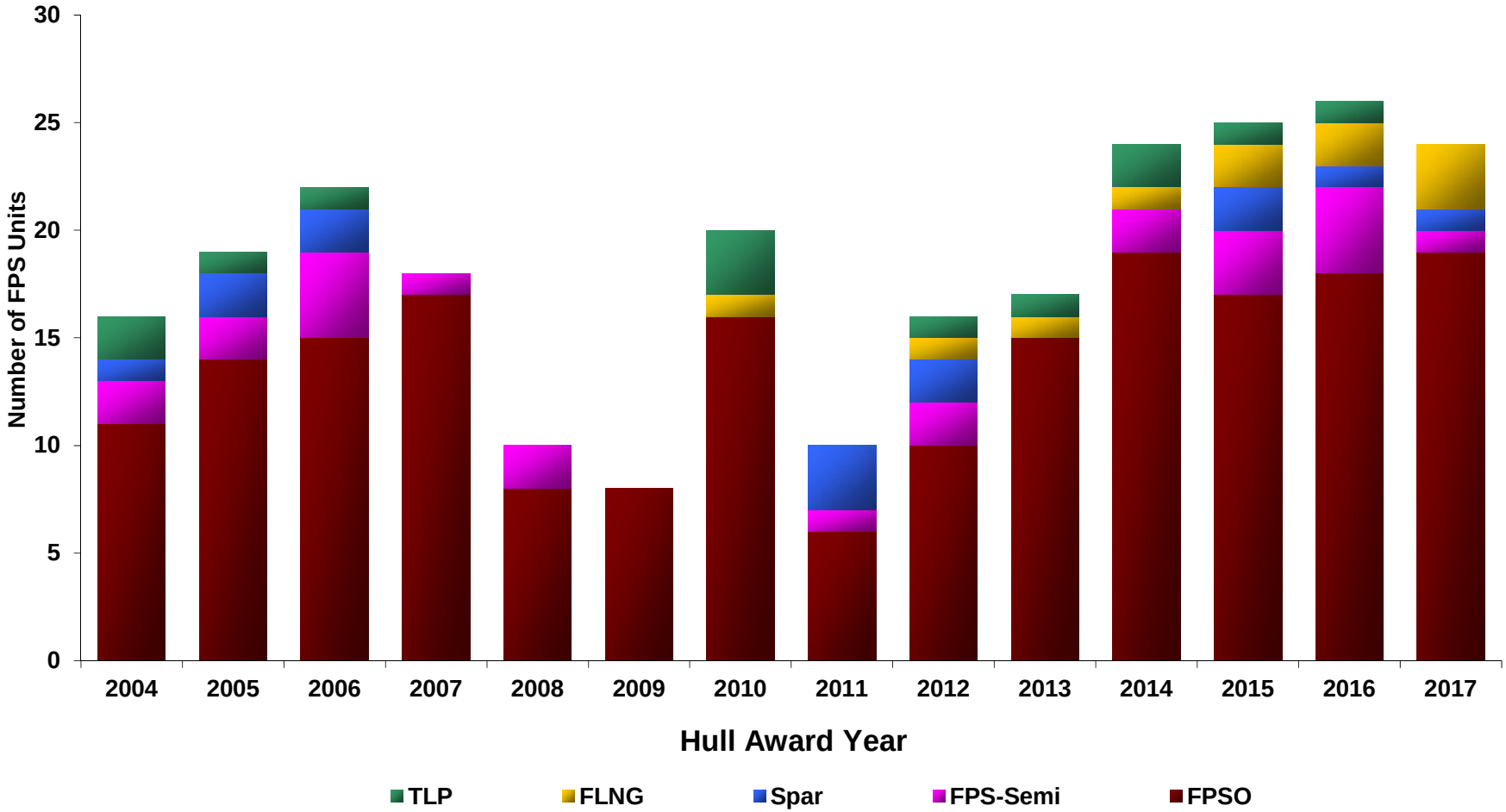



Source: Quest Offshore Resources, Inc.

# Worldwide FPS Awards 2004 – 2017 (e)

## (Mean Case)

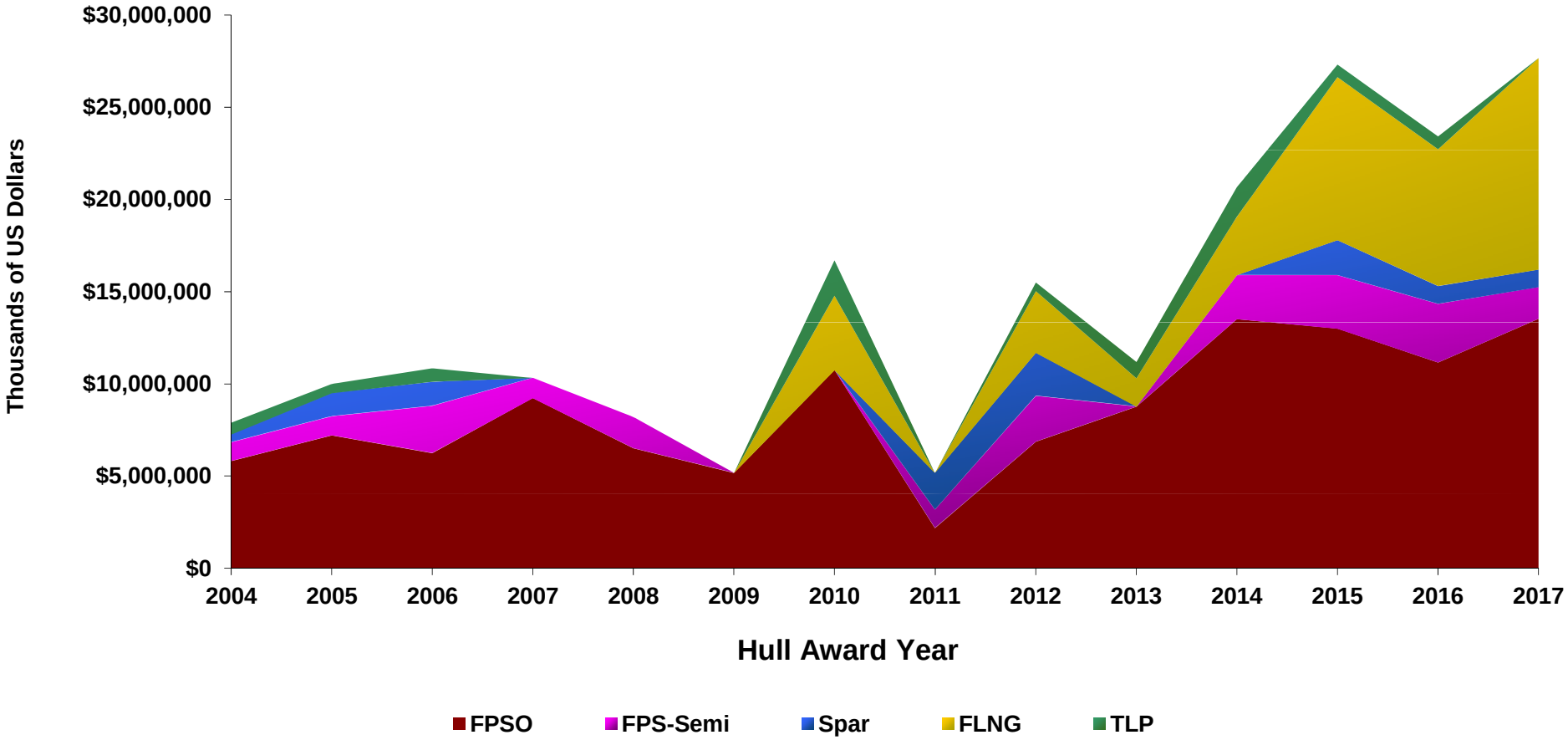
*By FPS Type*




Source: Quest Offshore Resources, Inc.

# Worldwide Forecast FPS Spending by Year

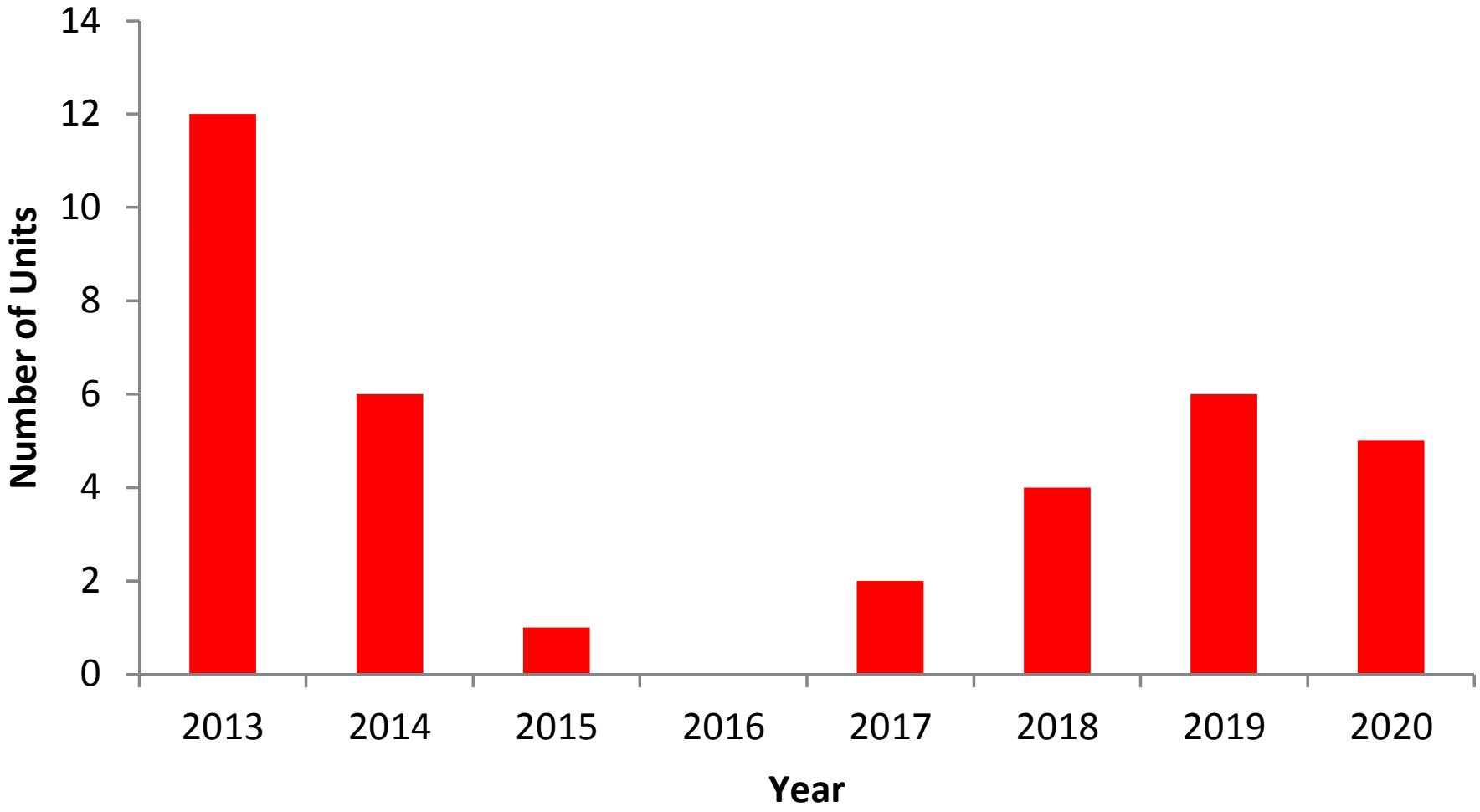
## *Type Contribution Thousands of US Dollars by FPS Award Year*




Source: Quest Offshore Resources, Inc.

# Forecasted Off Contract FPS Leased Fleet Availability

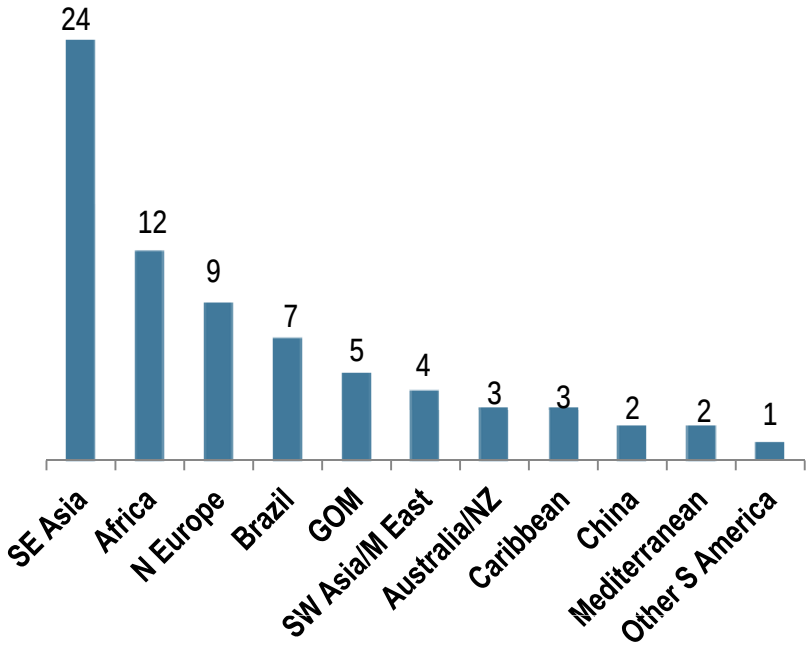
*By Year Current -2020 (Likely to be retired and EWT excluded)*



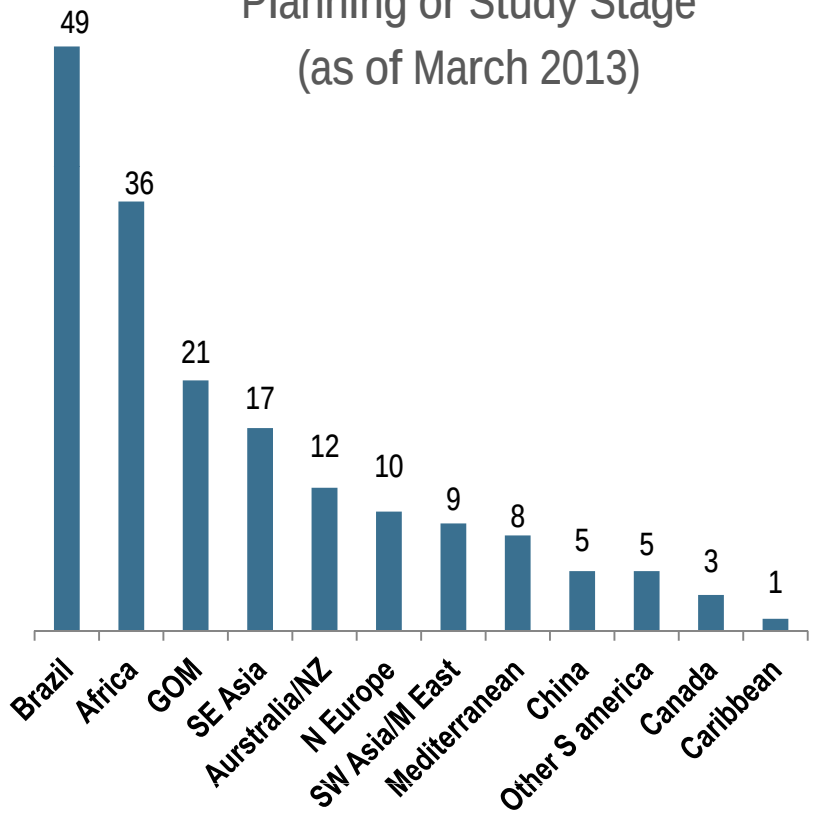

Source: Quest Offshore Resources, Inc.

# Floater Projects Planned or Under Study = 248

72 Floater Projects are in Bidding and Final Design Stage (as of March 2013)




176 Floater Projects are in the Planning or Study Stage (as of March 2013)




*Source: www.imastudies.com*

# Growth of Floating Production, Storage and Offloading Systems (FPSO)

FPSOs were originally considered an economical solution for the production of marginal fields that otherwise might not be produced.

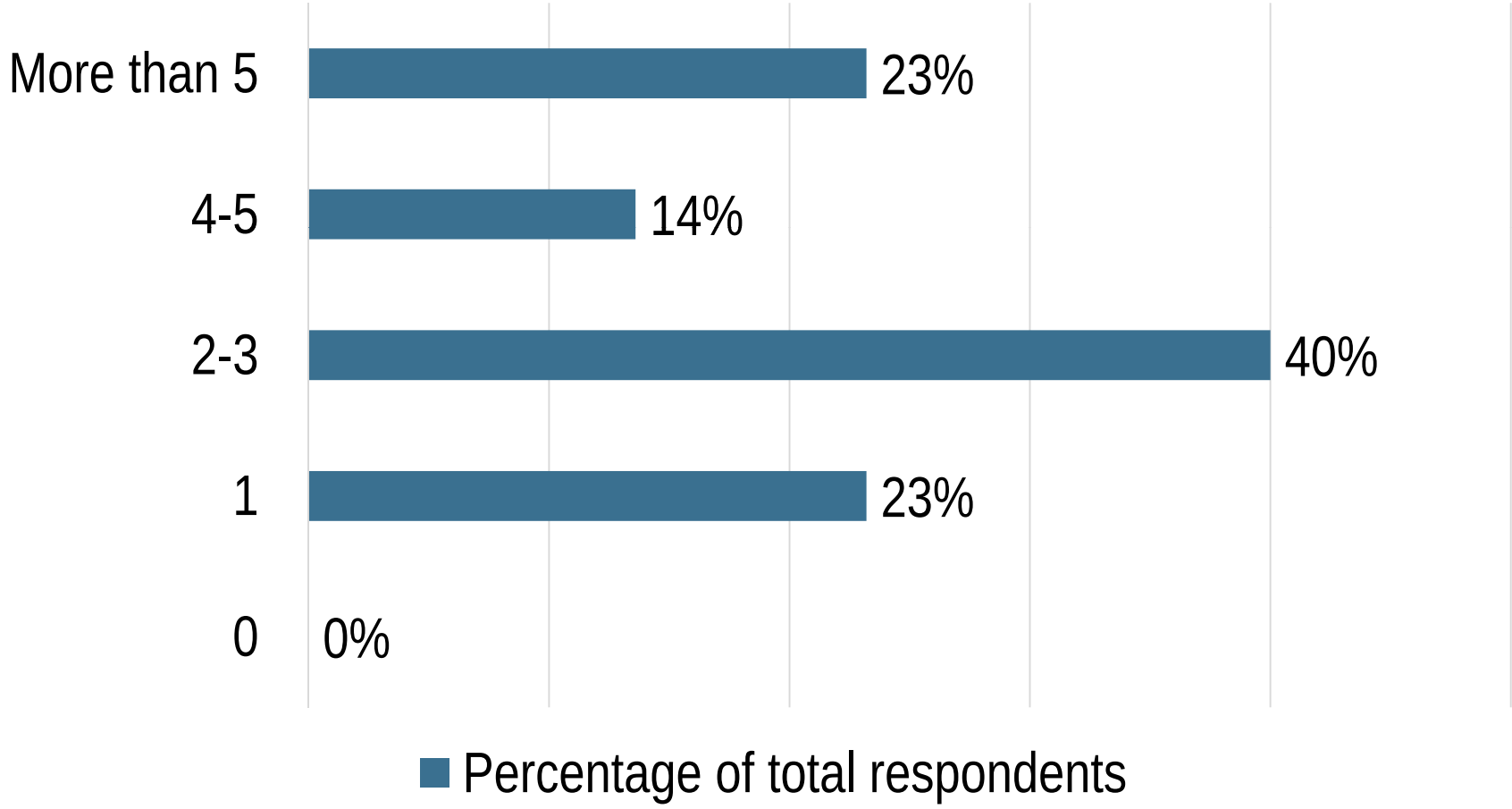
Later, FPSOs became an essential component in developing remote offshore fields as Early Production Systems (EPS) with increasing production capacity, numbers of risers, and ever increasing water depths which now allow their utilization as full field production facilities.

Source: Quest Offshore Resources, Inc.

# FPSO Survey Results

- Gulf Research Panel--Joint venture of Gulf Publishing and Gelb Consulting:
  - Opt-in database of 45,000+ World Oil and Hydrocarbon Processing readers used exclusively for industry surveys
  - Since 2001, annual multi-client surveys on marketing effectiveness, brand equity, technology needs and HR issues in the oil and gas industry (upstream and downstream)
- Respondents to this survey have current and/or recent experience in FPSO projects
  - 125 qualified respondents out of 27,000 surveys
  - Margin of error +/- 8.74%

# How many FPSOs have you been involved with in your career?

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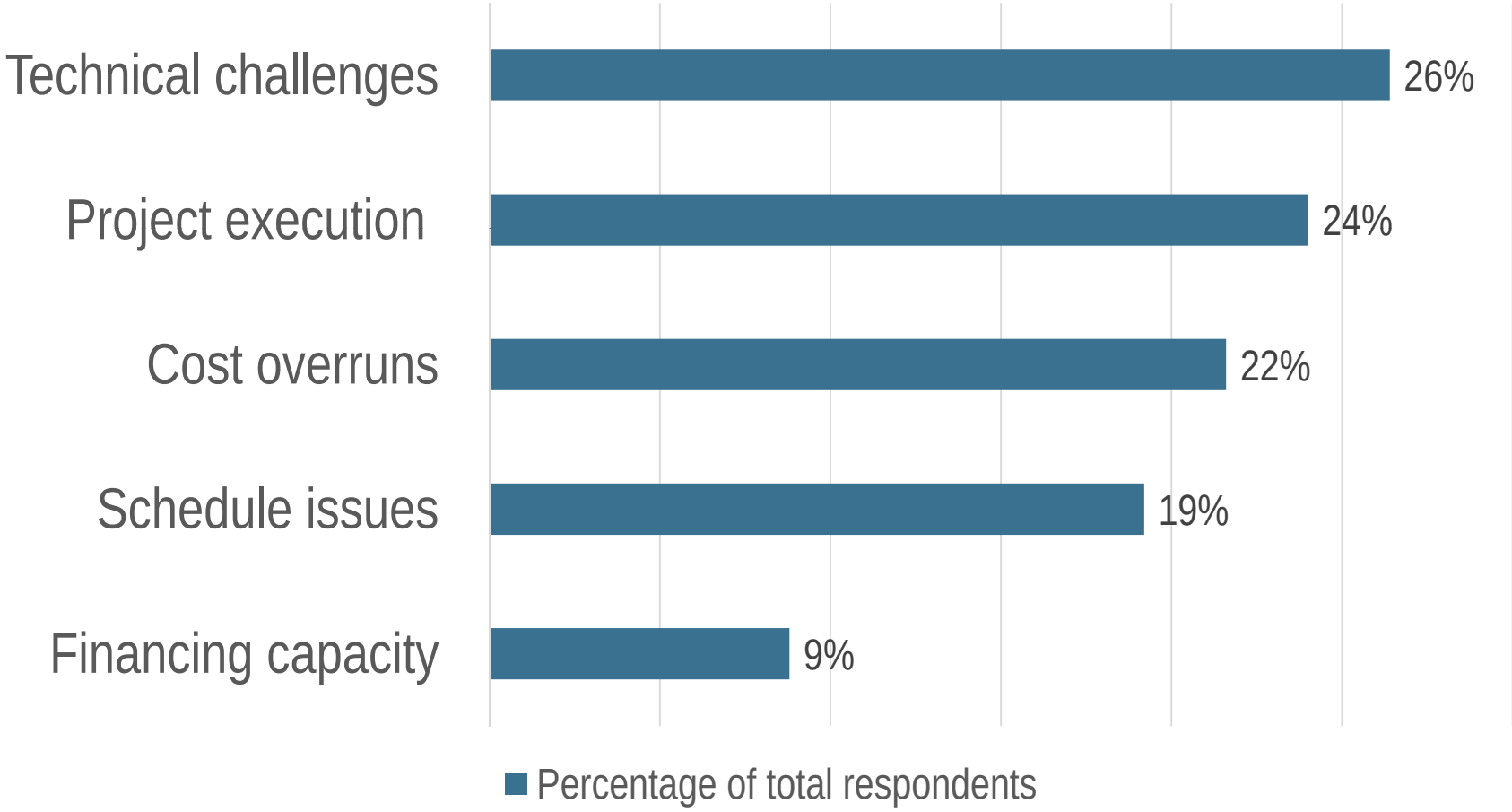
# What is the nature of the biggest challenge we are facing today in our FPSO Industry?

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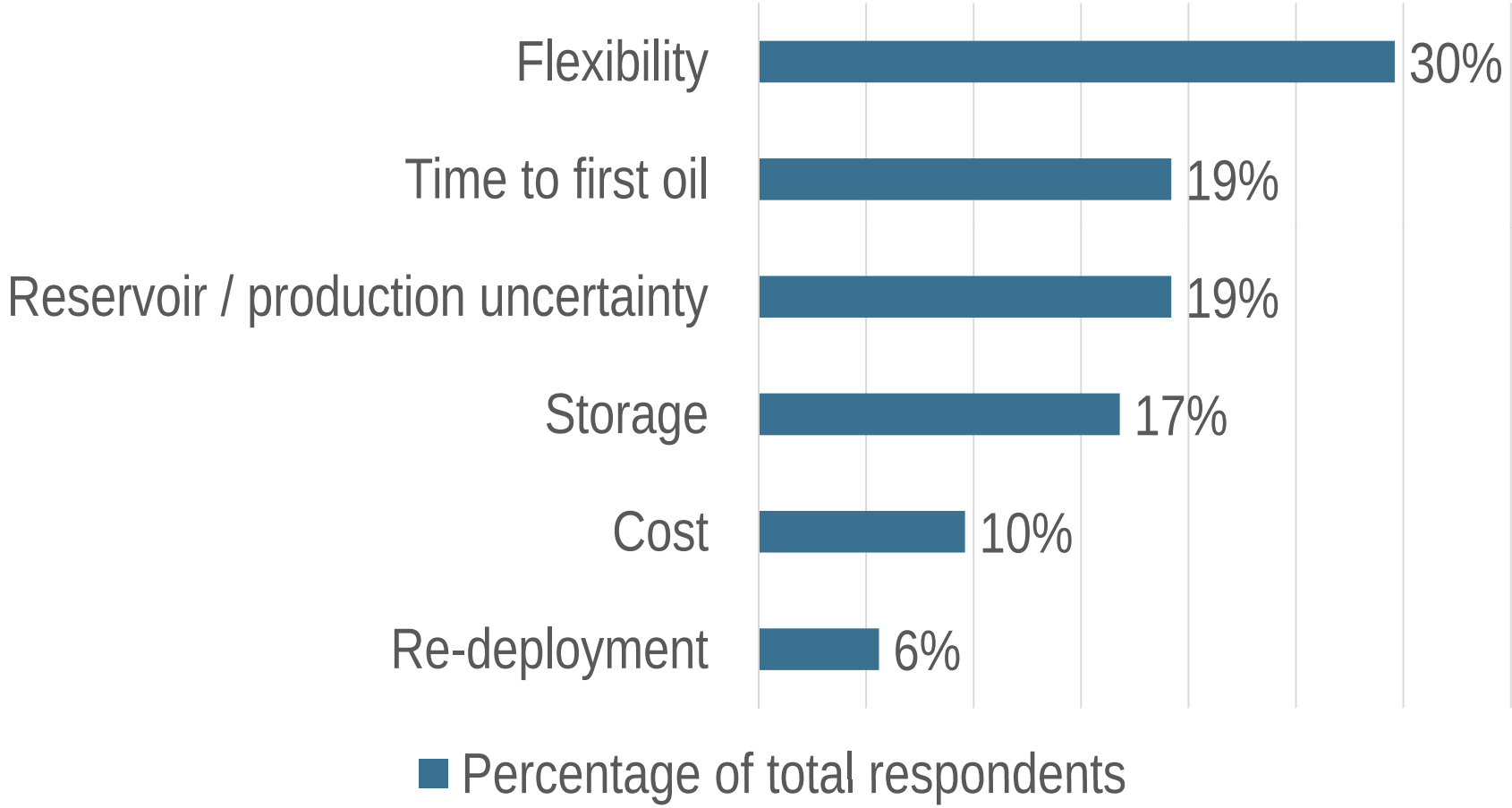
# What do you see as the main driver for use of an FPSO?

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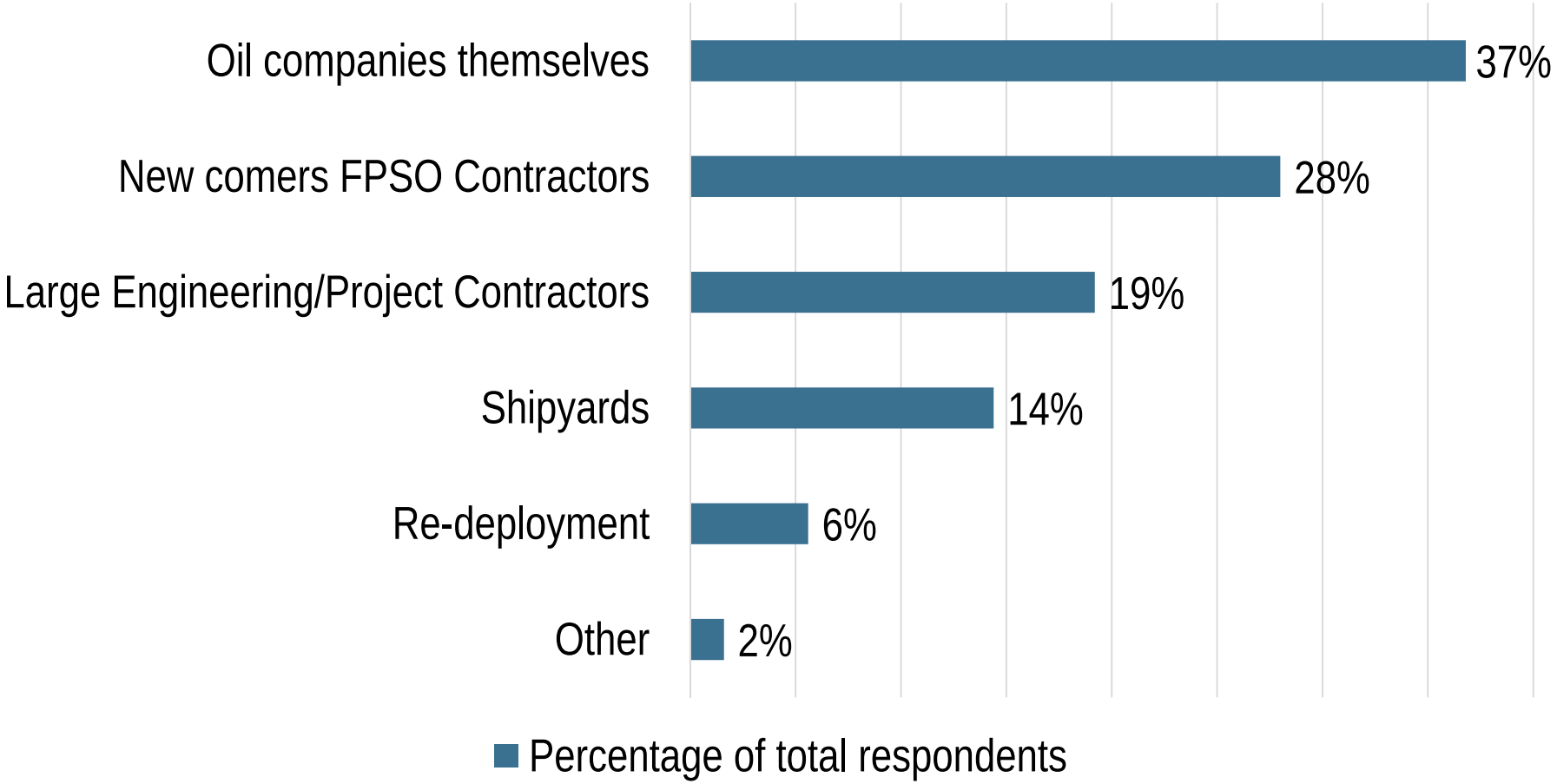
# Given the gap between demand for FPSO from the Oil companies and supply capacity from the FPSO Contractors, which party shall mostly provide for the missing FPSOs?

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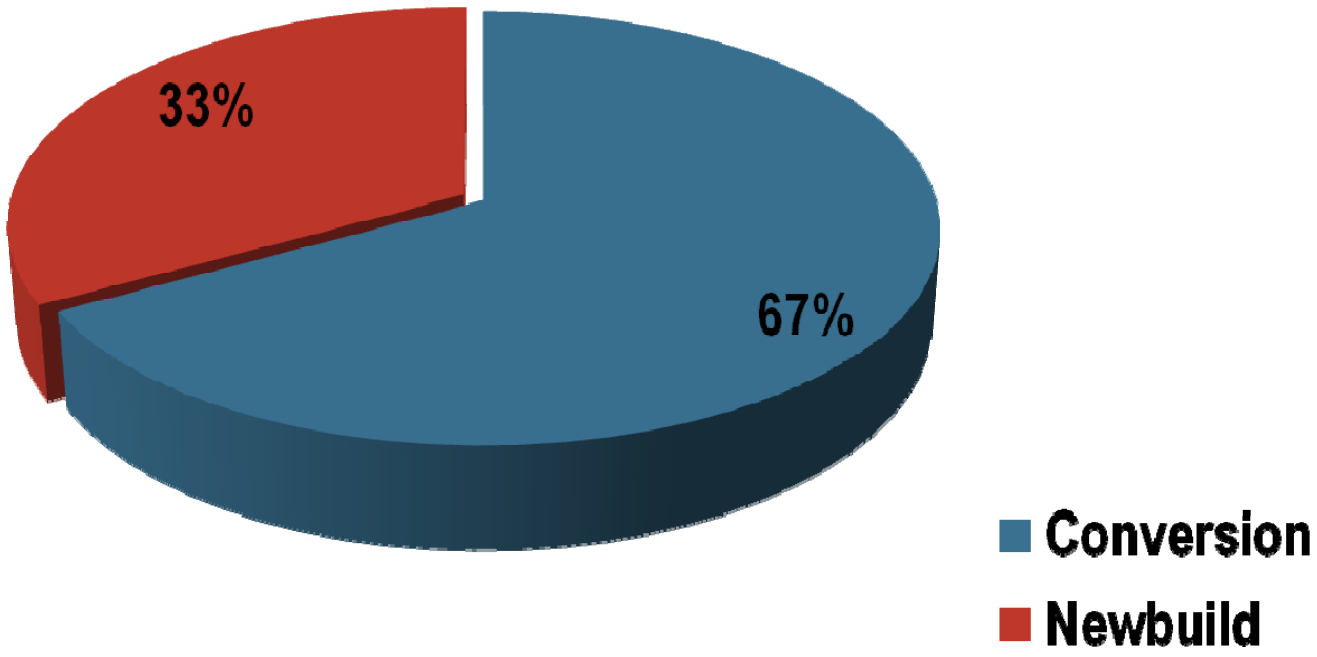
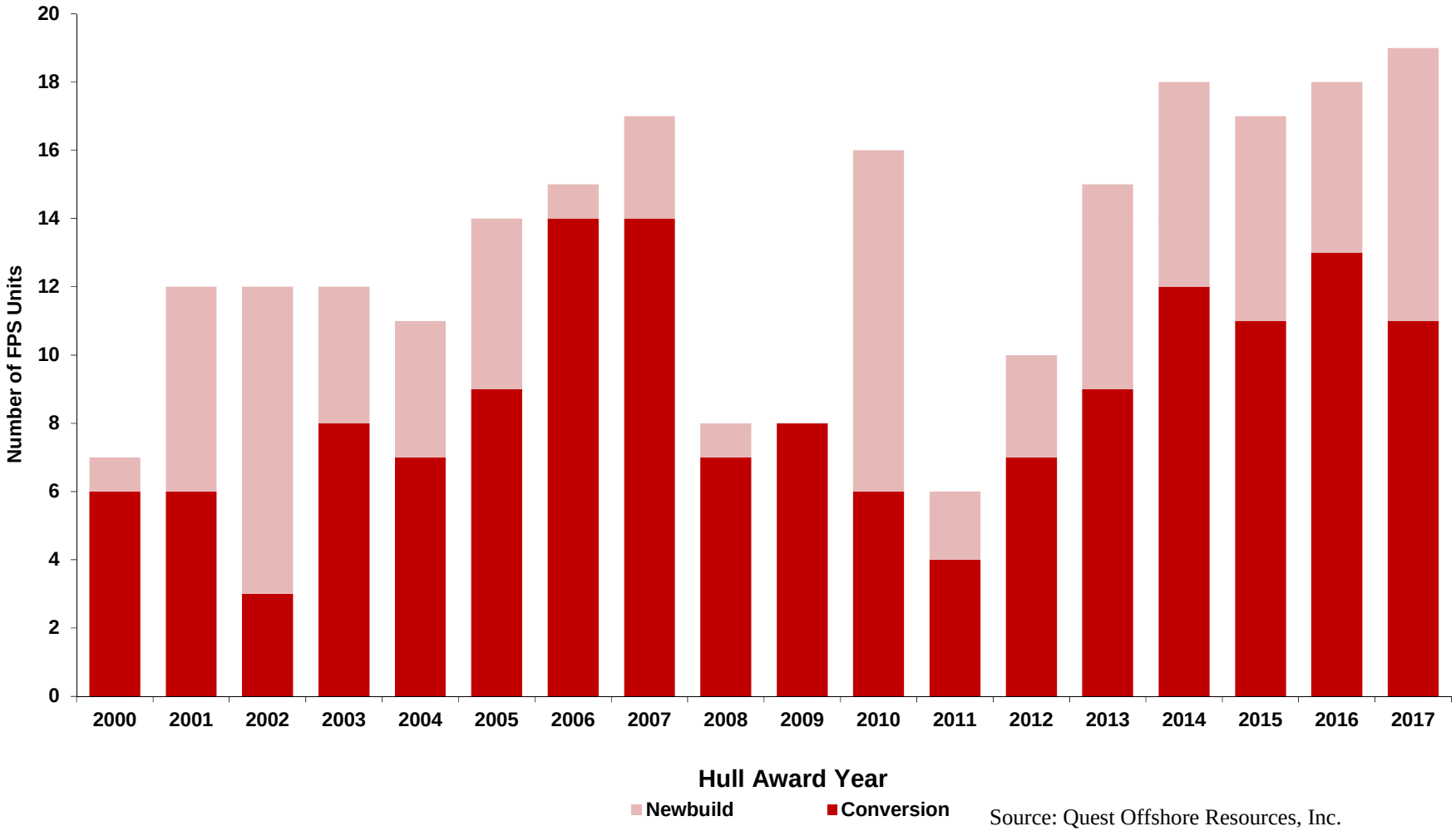
# FPSO Construction Type



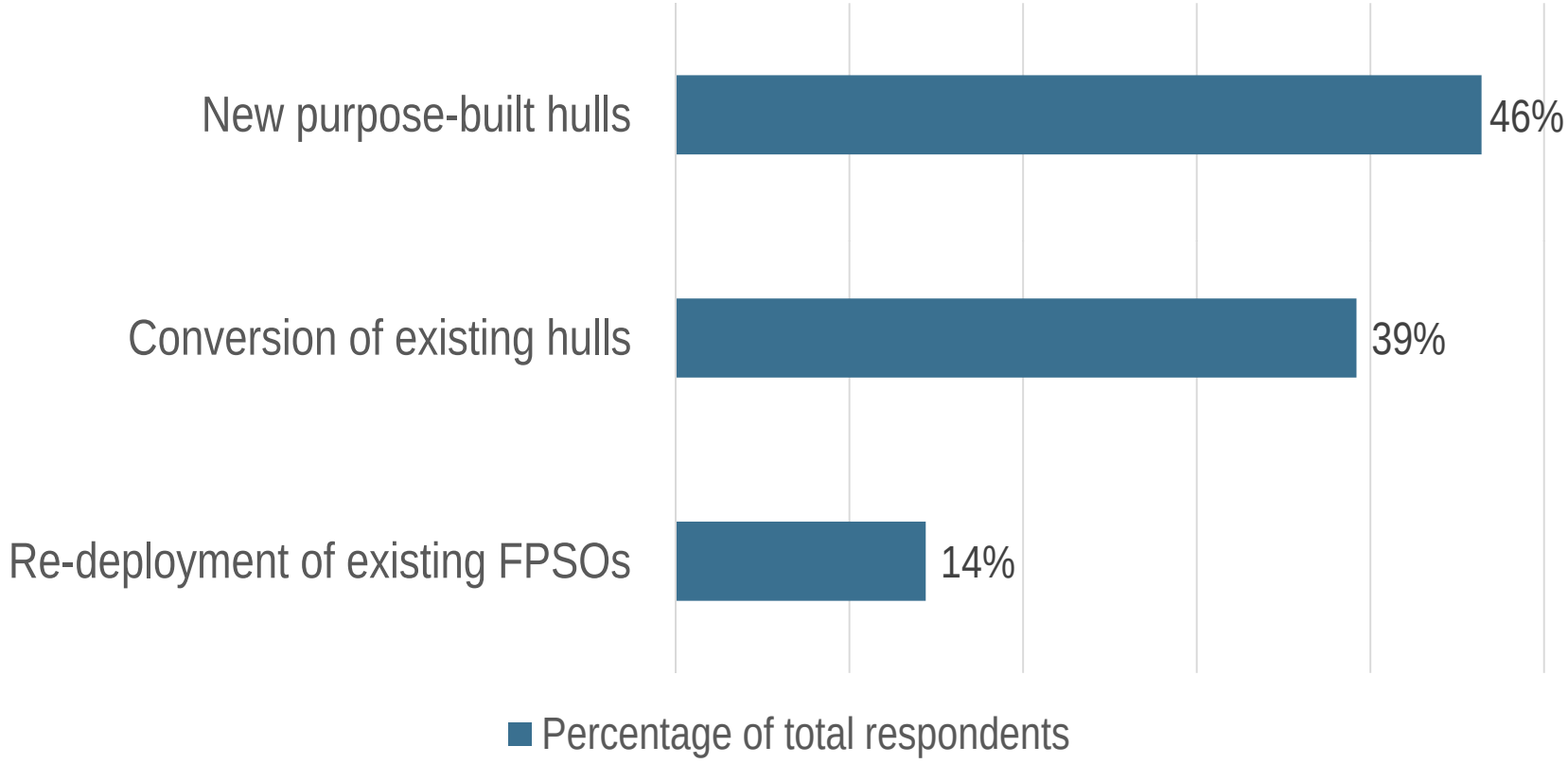
# Worldwide FPSO New Build vs. Conversion

*2000 to 2017 (e) (Mean Case)*




Source: Quest Offshore Resources, Inc.

# Where do you feel the FPSO market is heading in terms of hull forms?

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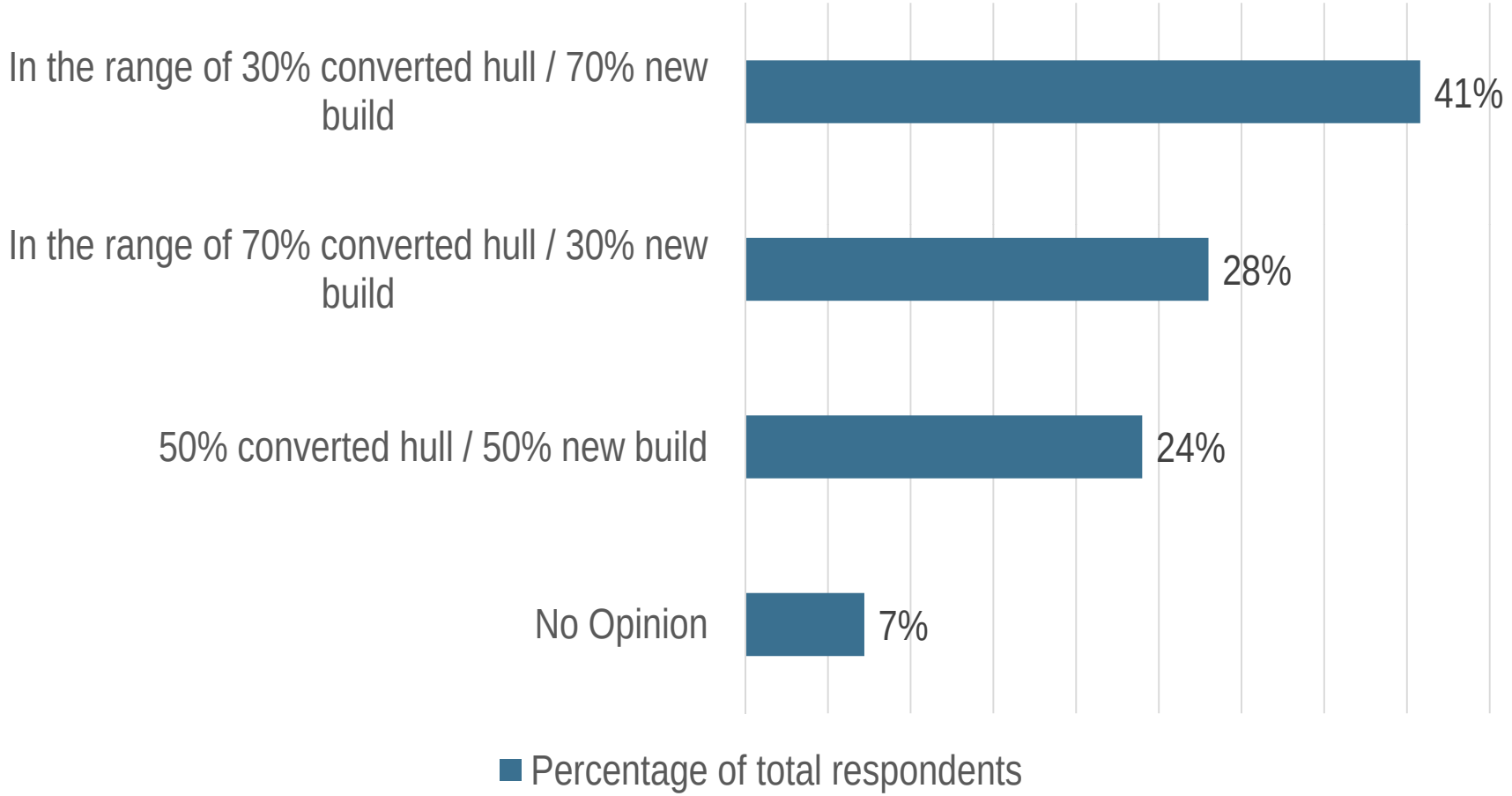
# Converted hull versus new-build FPSO: What will be the ratio 10 years from now?

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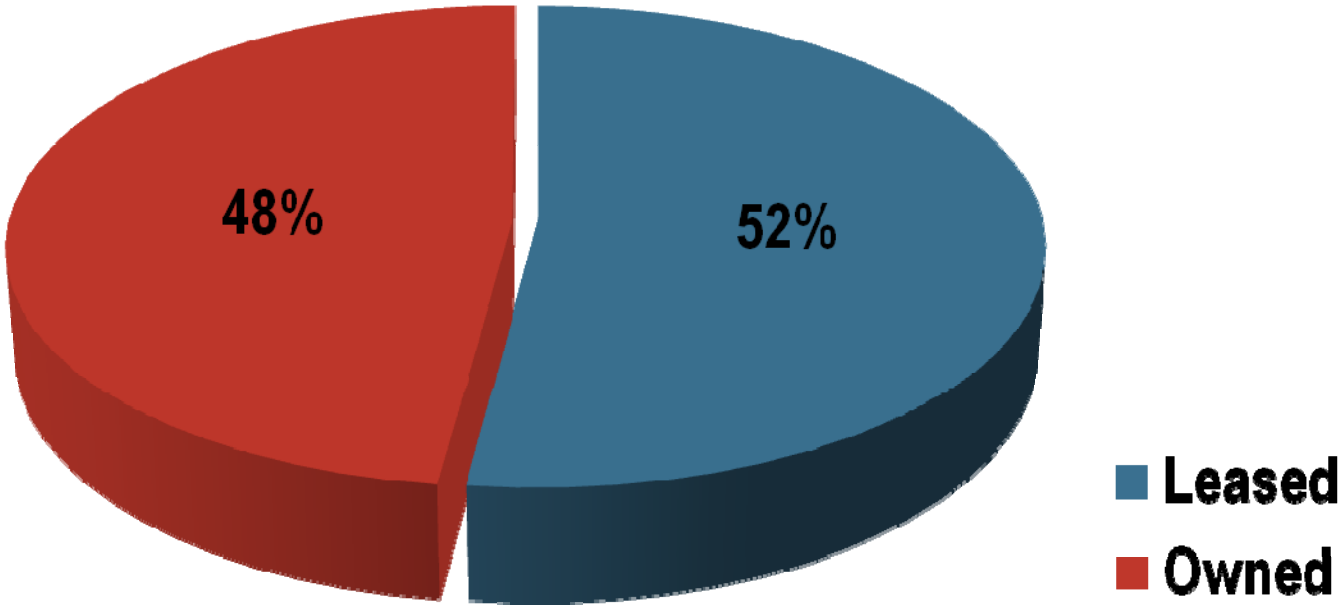
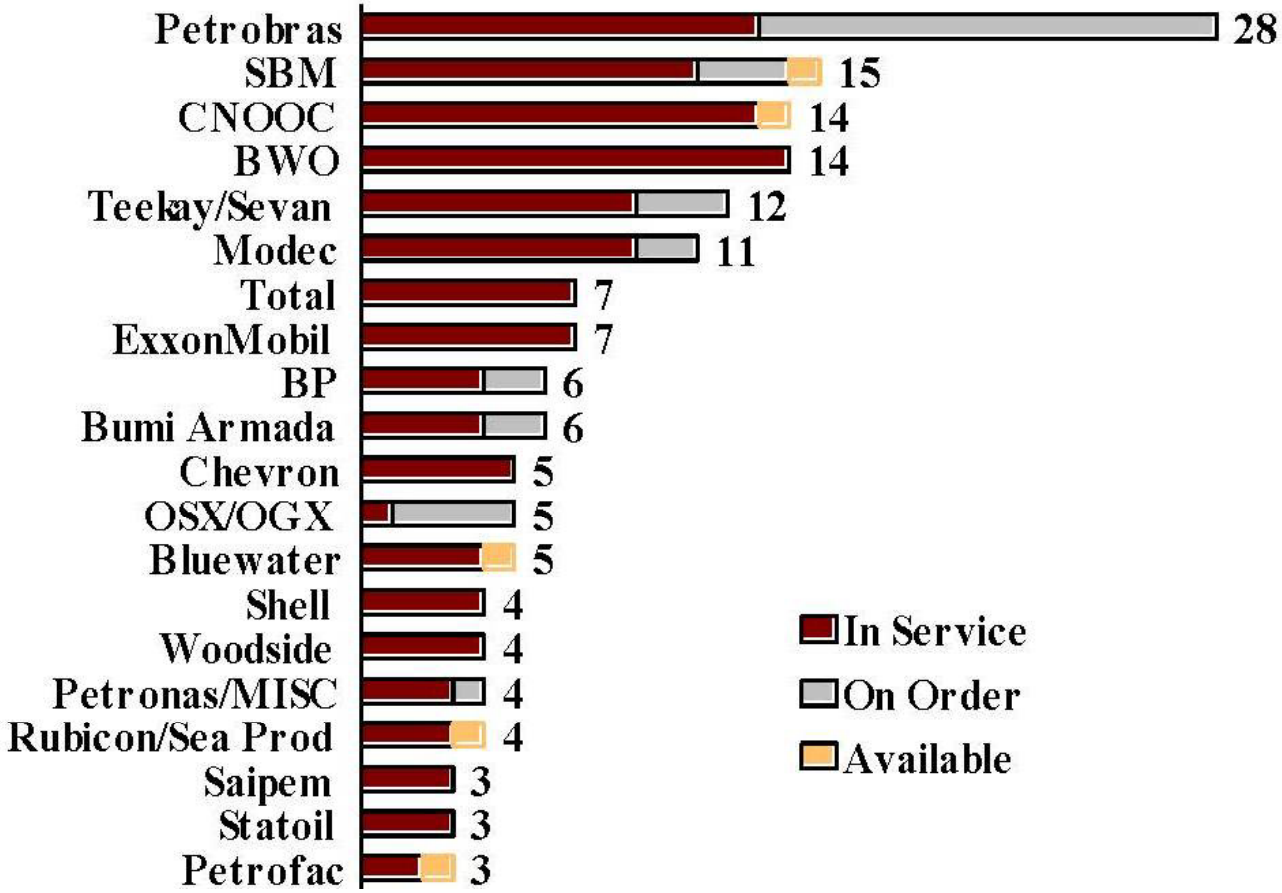
# FPSO Ownership

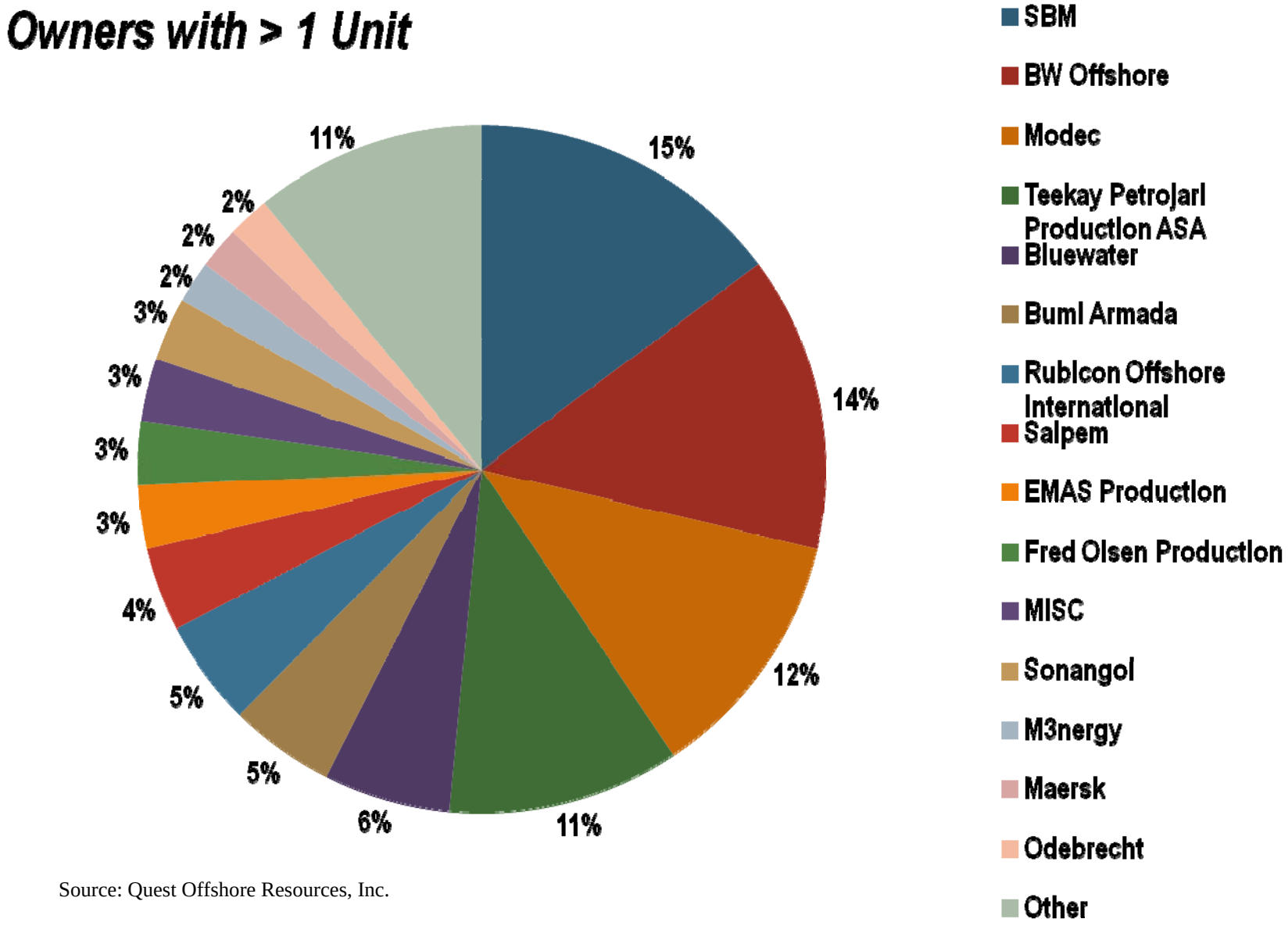


# FPSO Owners (Three or More Units)



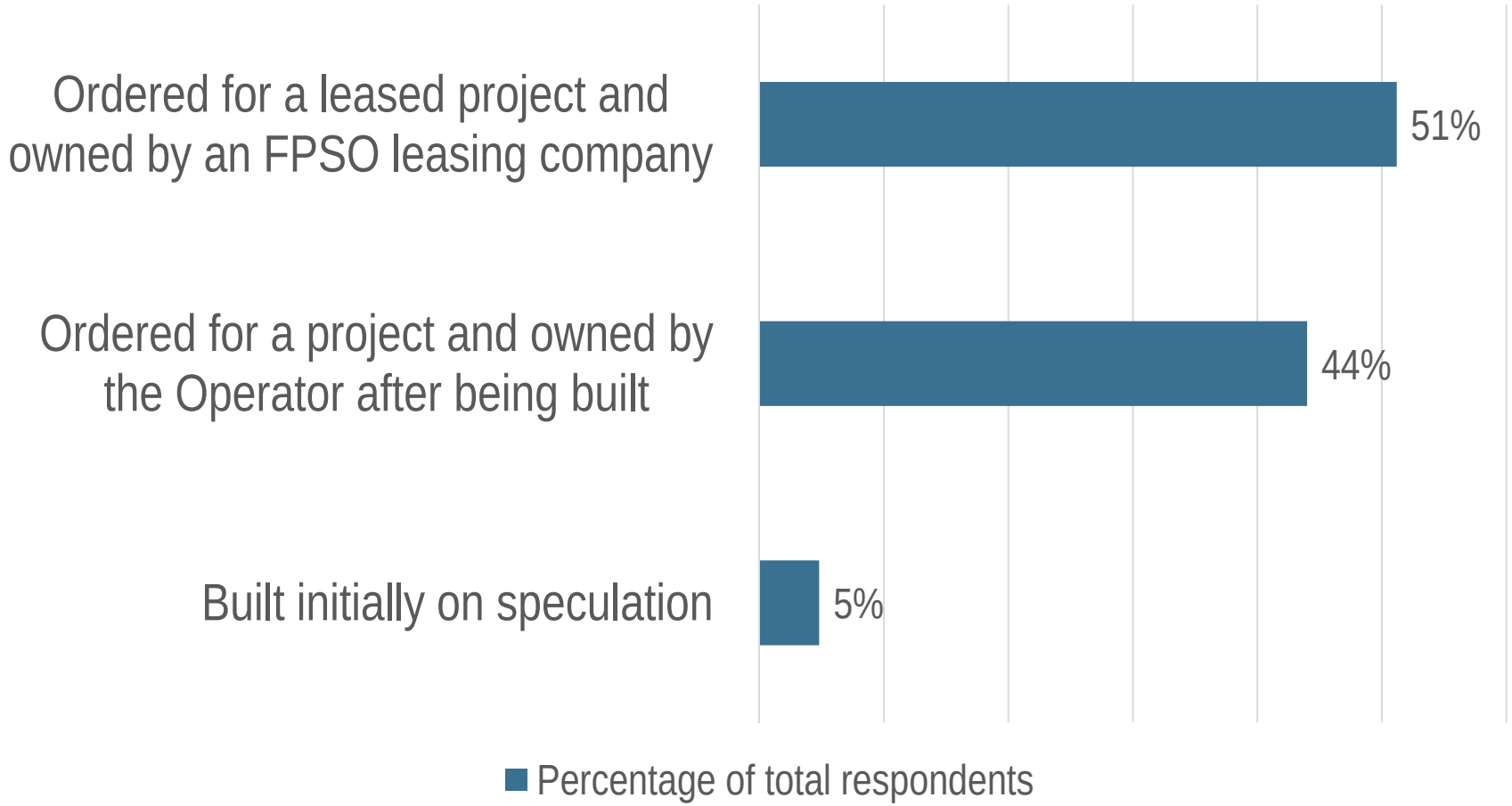

*Source: www.imastudies.com*

# Leased FPSO Market Share by Owner




Source: Quest Offshore Resources, Inc.

# Do you expect new build FPSOs to be:

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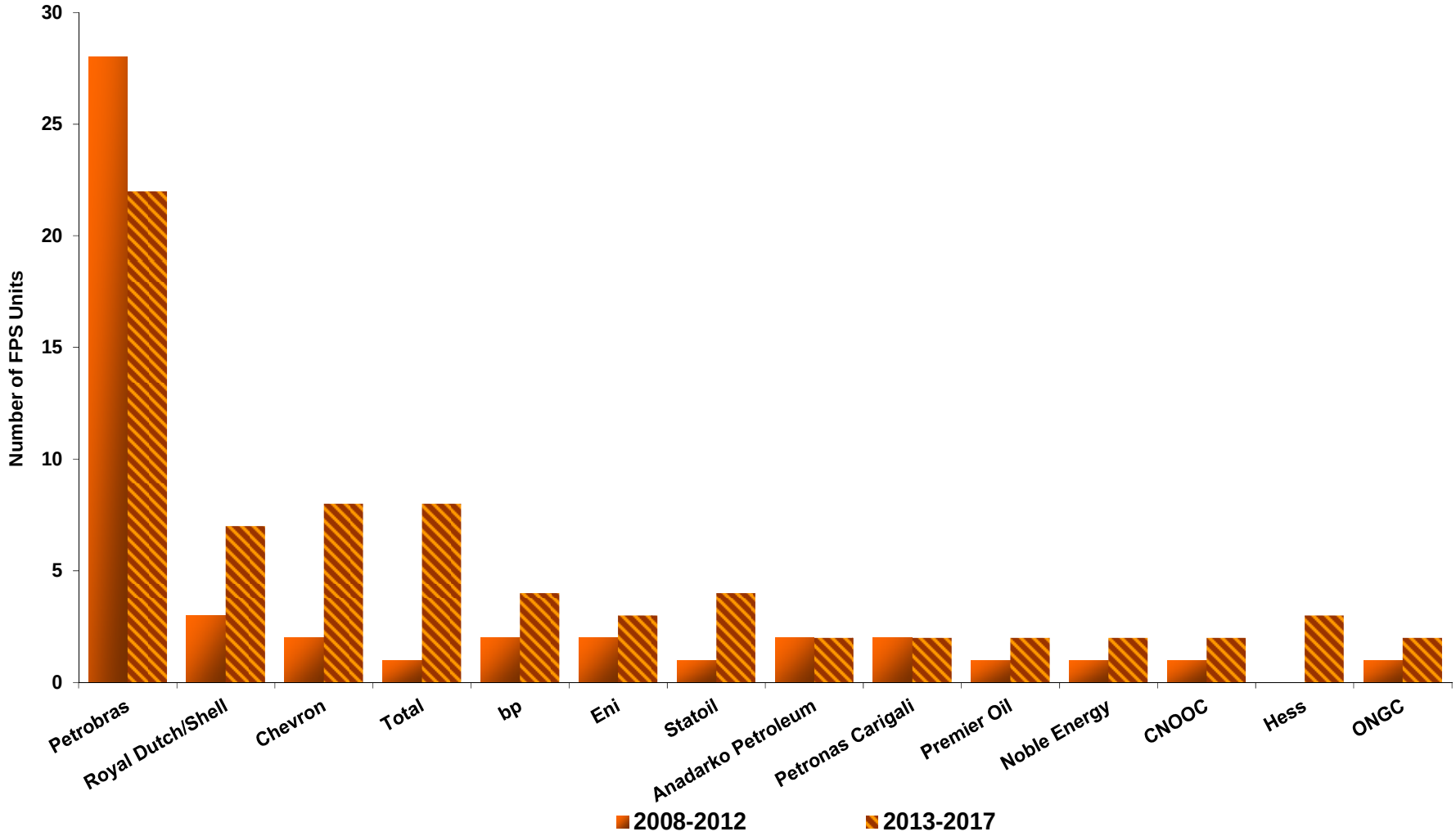
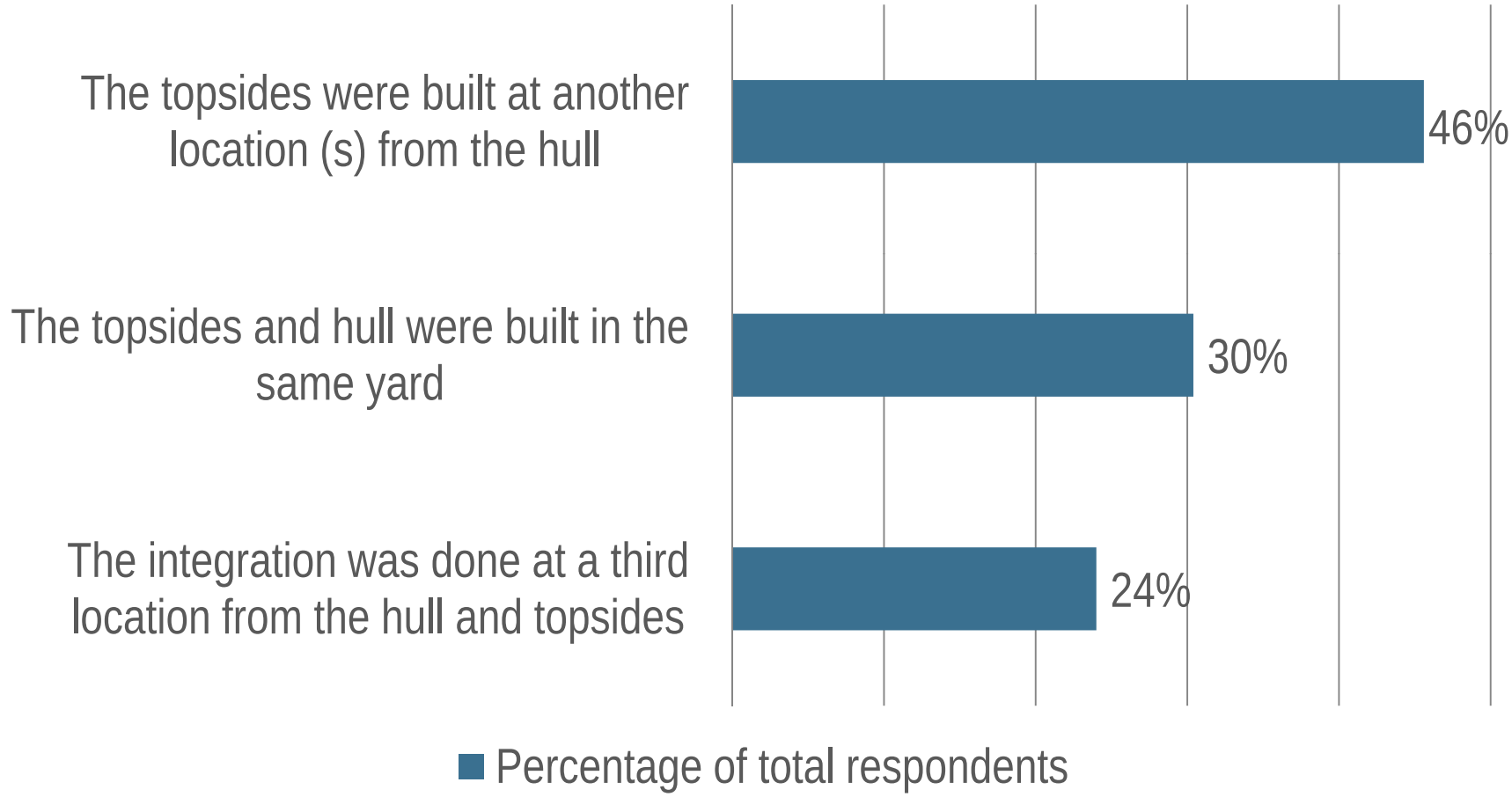
# Worldwide FPS Top Operators

## 2008 to 2017 Top 14 Operators




Source: Quest Offshore Resources, Inc.

# Do you expect New Build Projects to be:

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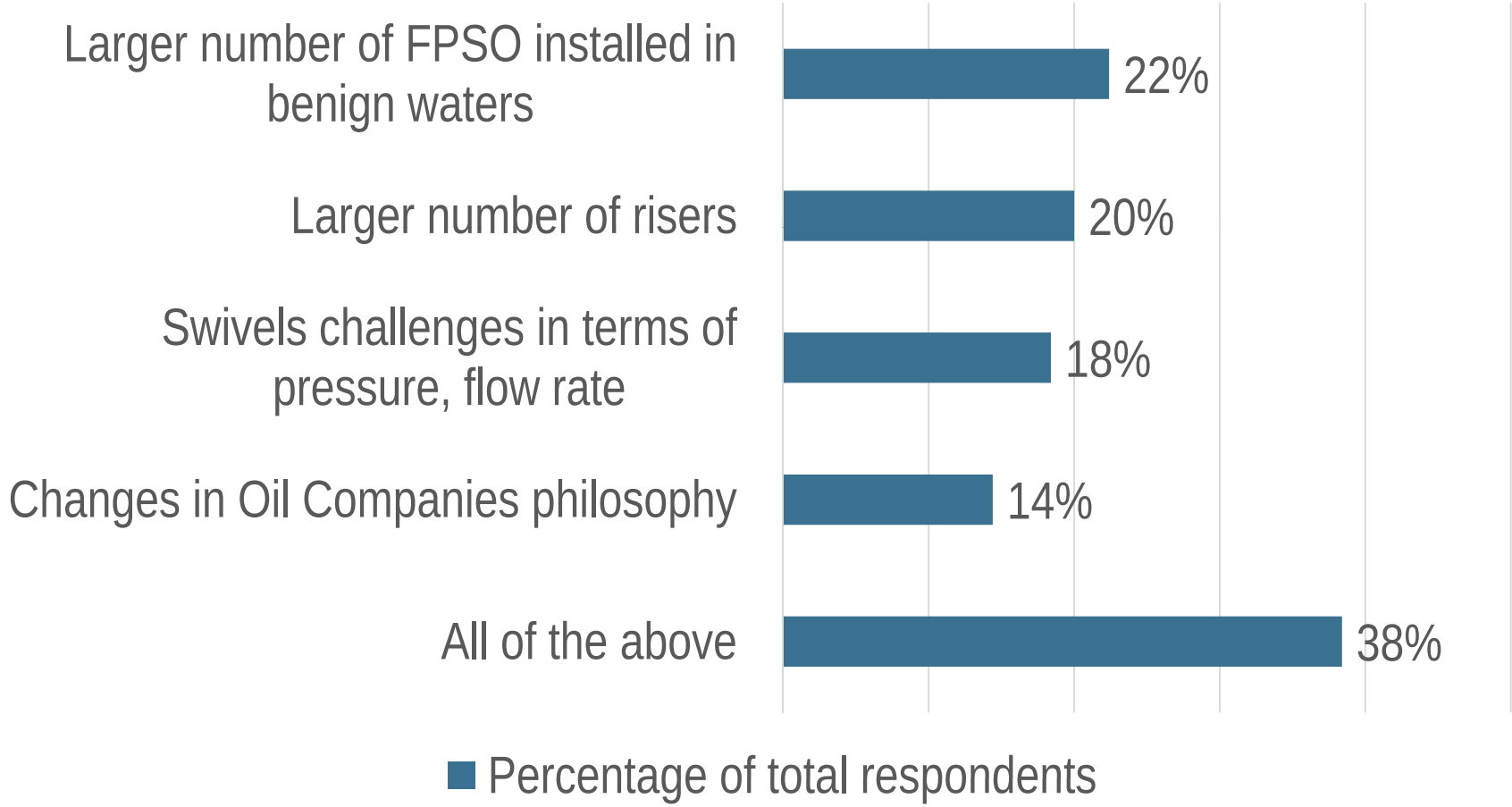
# The ratio of global Spread moored versus Turret moored FPSO is increasing, why?

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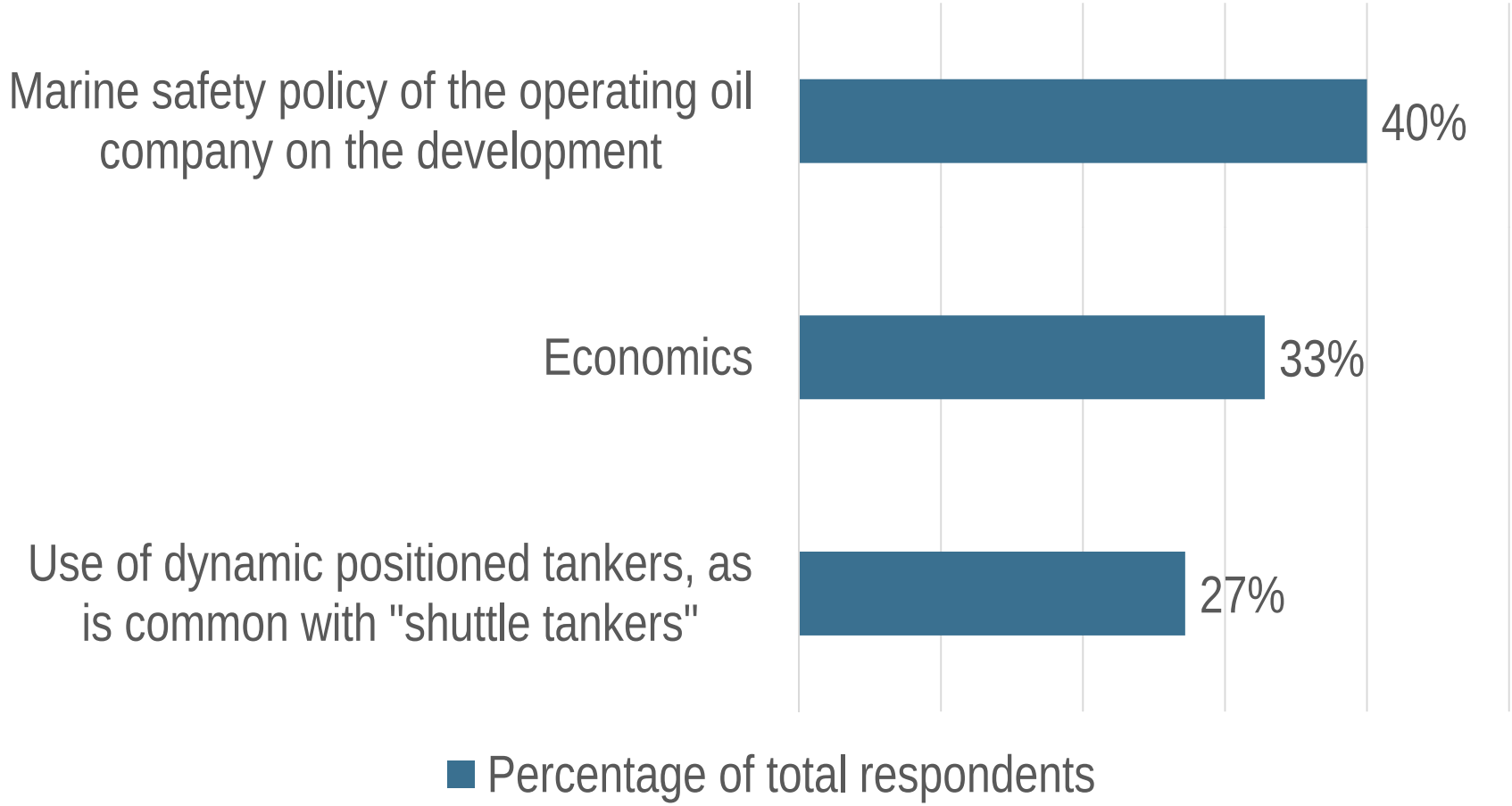
# What do you think is the most important factor in designing and operating an offloading system?

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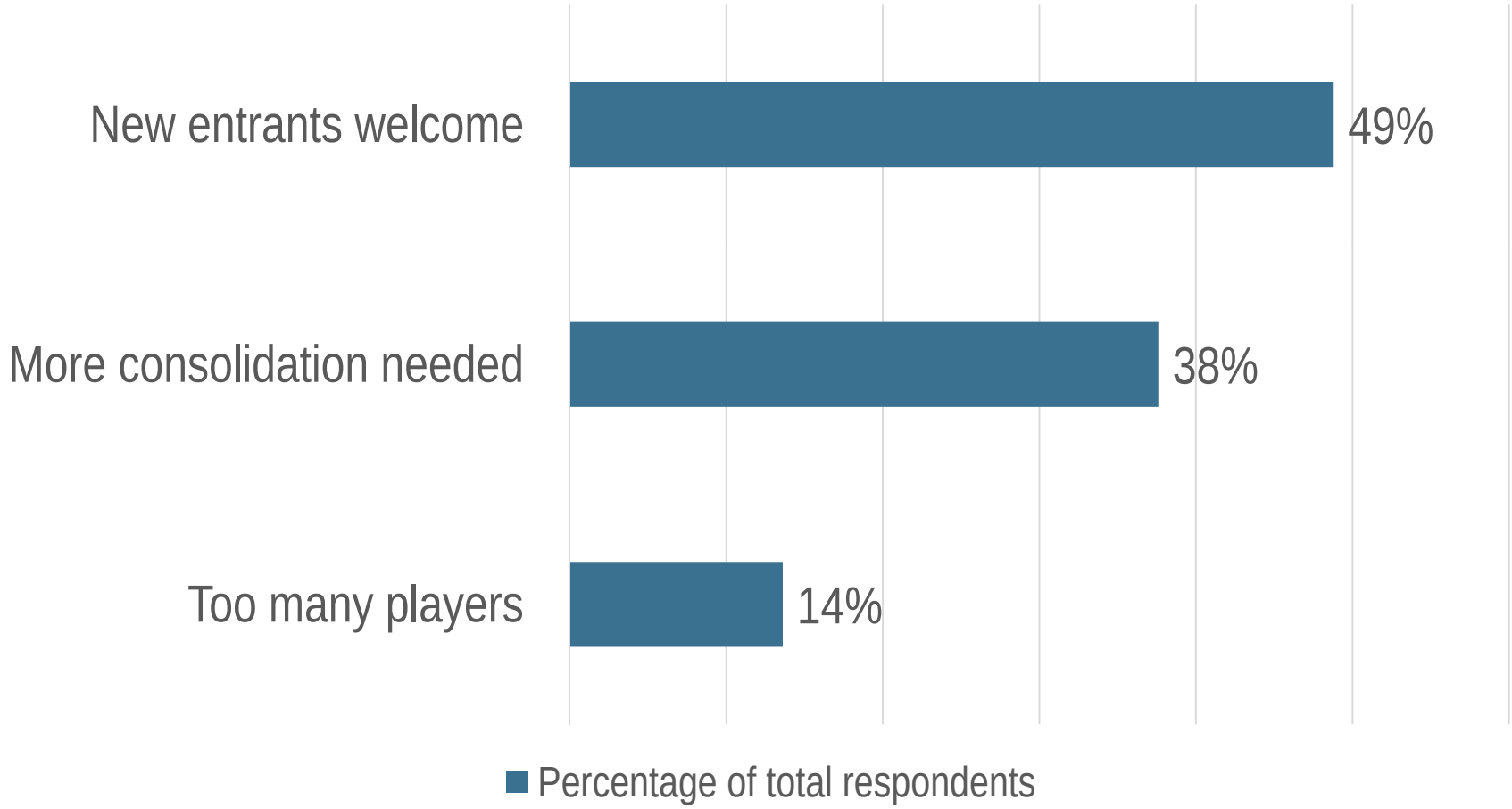
# Where do you feel the market is in terms of players?

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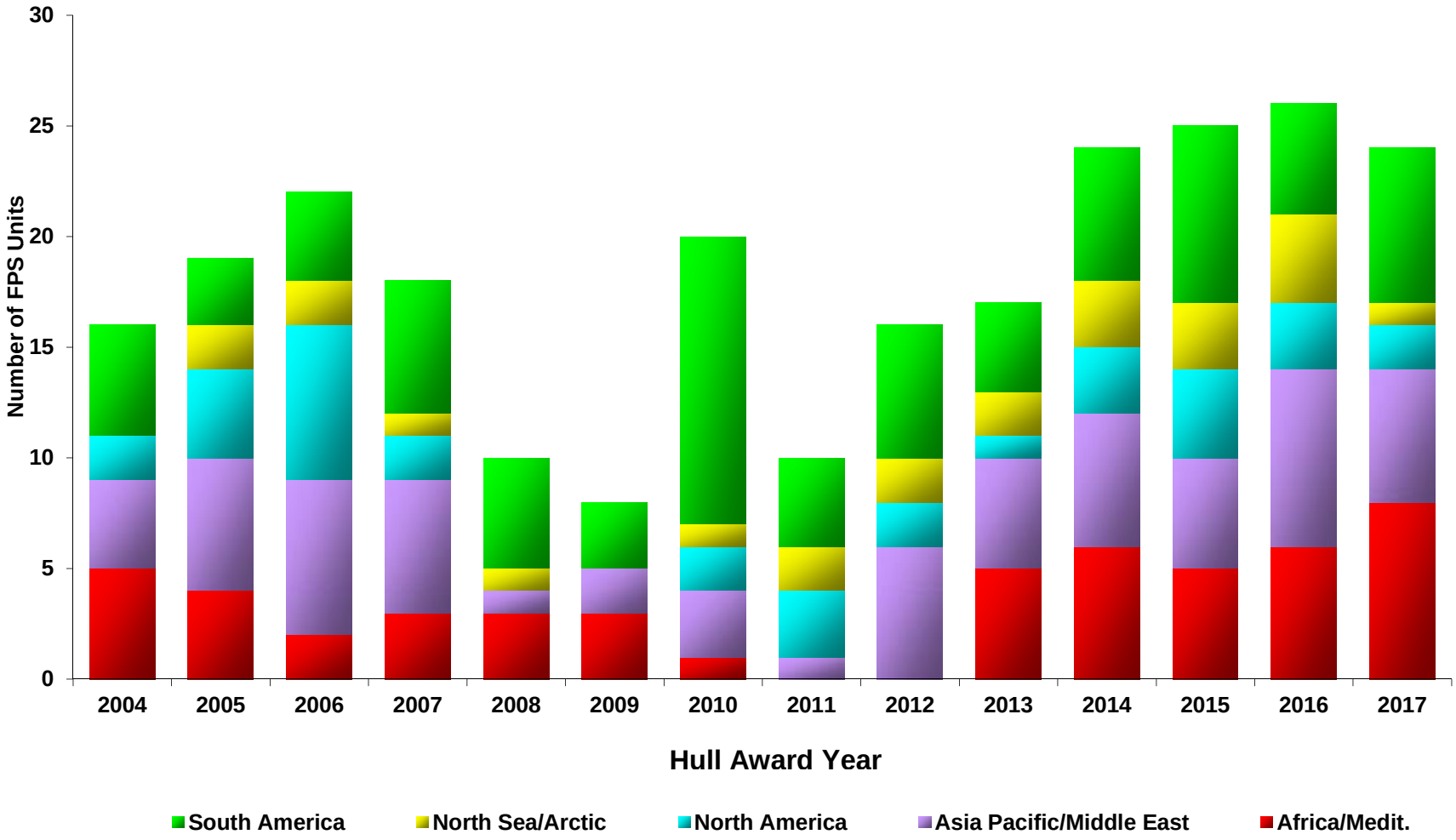
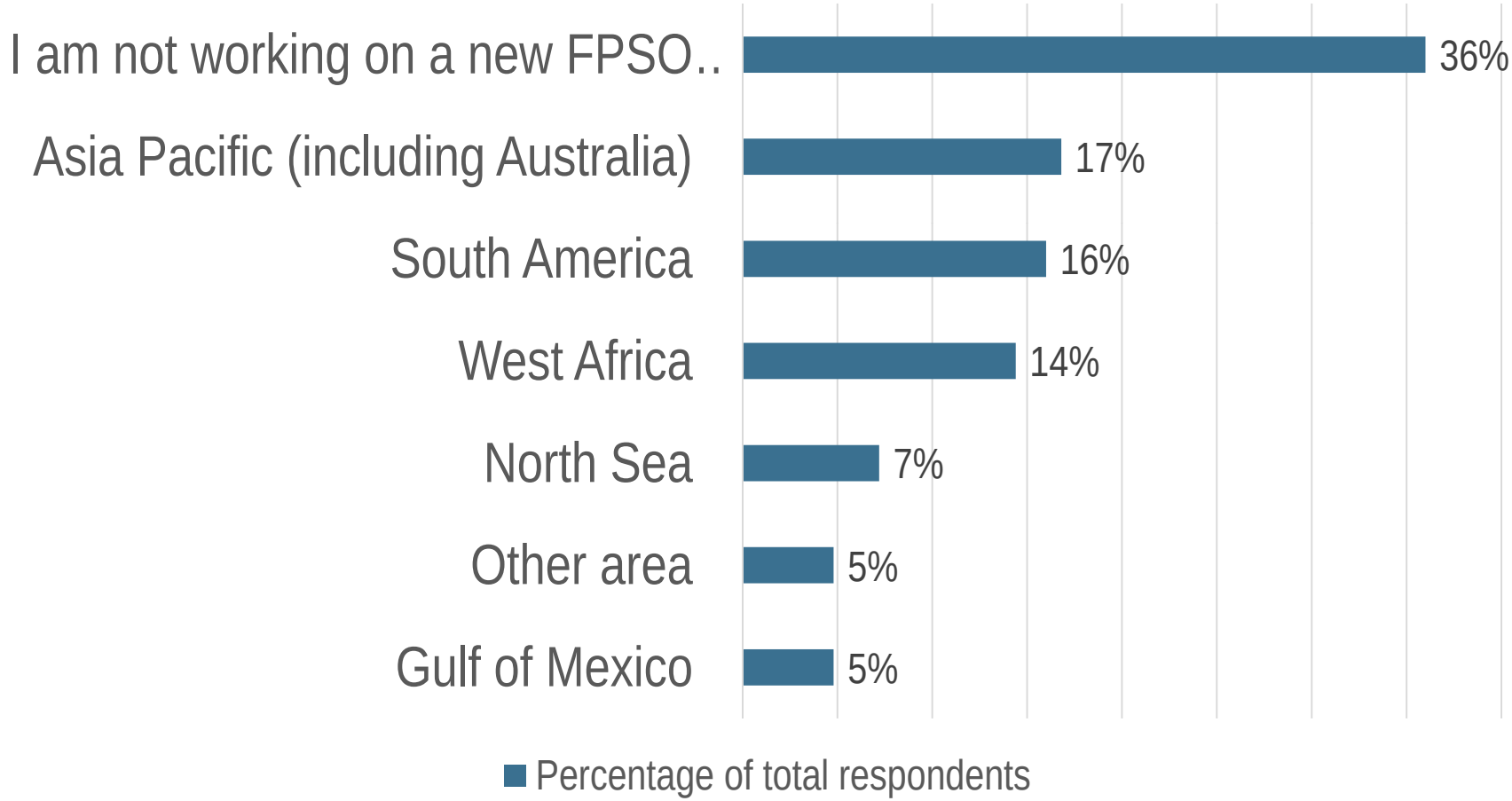
# Worldwide FPSO Awards 2004 – 2017 (e)

*(Mean Case)*




Source: Quest Offshore Resources, Inc.

# Are you currently working on a new FPSO project and, if so, for what geographic area?

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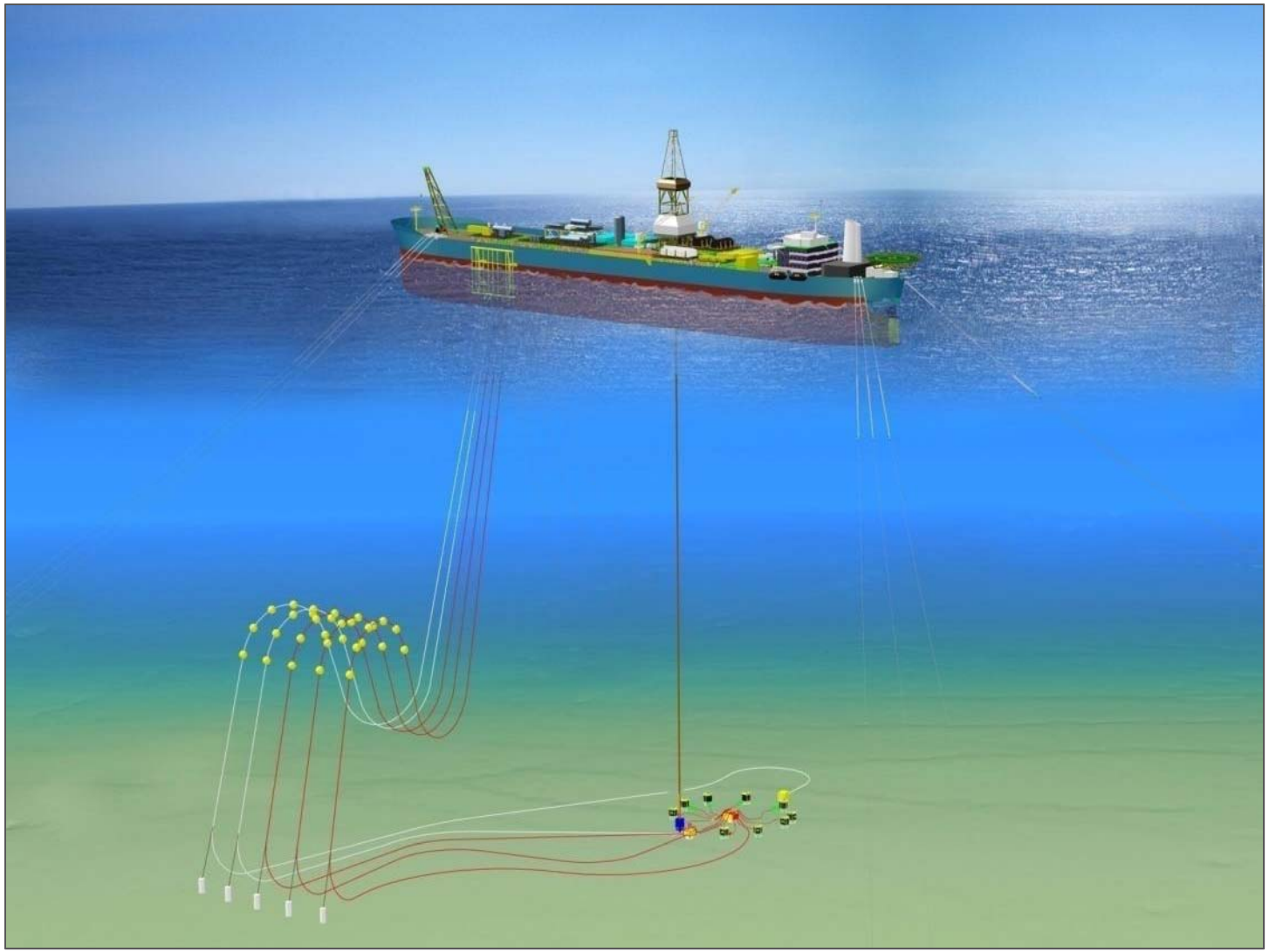
# Are all FPSO's Shipshaped ?

# Sevan Piranema Technical Data

| | |
|---|---|
| Operator, Field, Location | Petrobras, Piranema, Brazil |
| Date Built / Converted | 2007 |

| | |
|---|---|
| Owner | Sevan Marine |
| Operating Water Depth | 1,090 meters (1,600 - Phase 2) |
| Number of Locations | 1 |
| Max Liquid Handling | 30 MBOPD |
| Oil Storage Capacity | 250 MBBLs |
| Mooring System Type | 9 Point Spread |

# Azurite Graphic - FDPSO



# San Jacinto Technical Data

| | |
|---|---|
| Operator, Field, Location | Conoco - Kepiting, Ikan Pari, Sembilang - Indonesia |
| Date Built / Converted | 1986 Built / 1994 Upgraded |

| | |
|---|---|
| Owner | ? Coldstacked |
| Operating Water Depth | 91 meters, Sembilang |
| Number of Locations | 3 |
| Max Liquid Handling | 11,000 bpd |
| Oil Storage Capacity | 53,000 bbls |
| Mooring System Type | 8 Point Spread |

# Zafiro Producer Technical Data

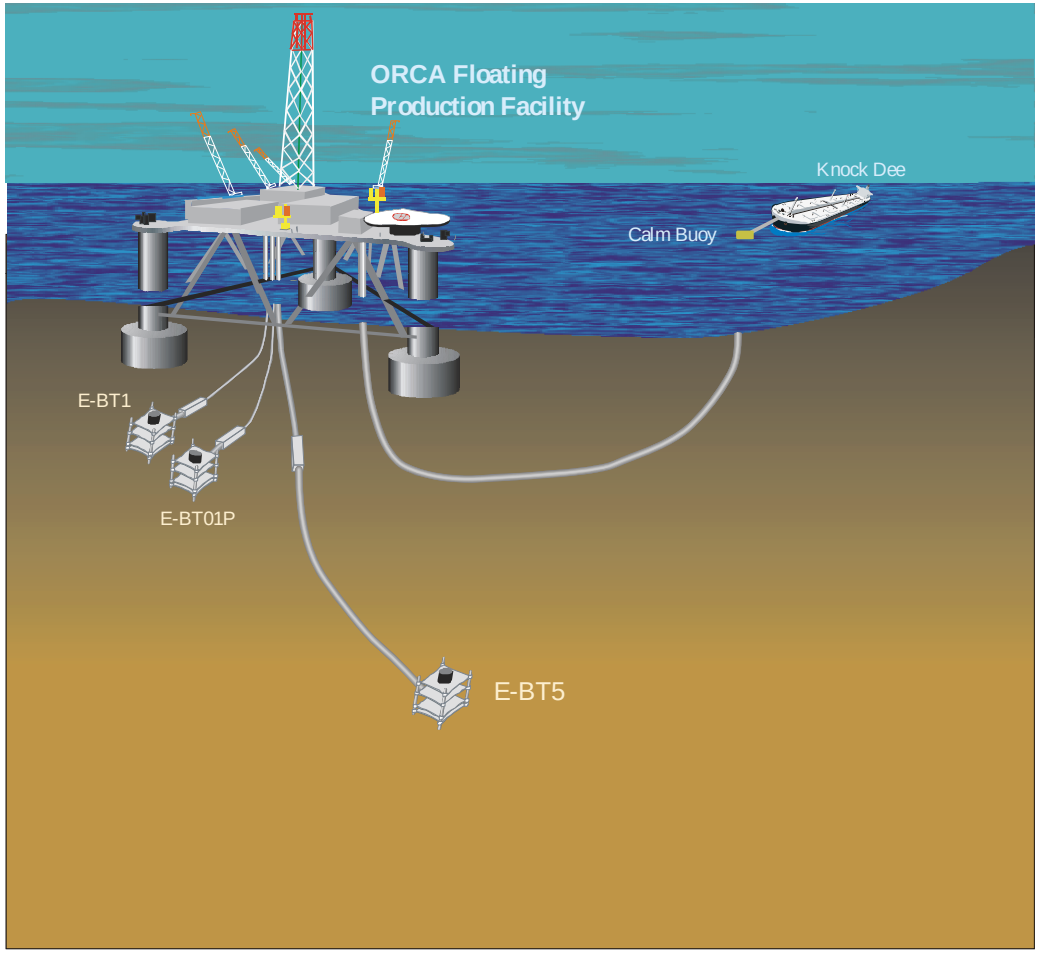
| | |
|---|---|
| Operator, Field, Location | ExxonMobil, Zafiro Block B, Equatorial Guinea |
| Date Built / Converted | 1973 / 1996 |

| | |
|---|---|
| Owner | ExxonMobil |
| Operating Water Depth | 180 meters |
| Number of Locations | 1 |
| Max Liquid Handling | 80,000 BOPD |
| Oil Storage Capacity | 1.9 Million Barrels |
| Mooring System Type | 12 Point Spread |

# Zafiro Producer

# ORCA

## ORIBI Development



# ORCA Technical Data

| | |
|---|---|
| Operator, Field, Location | PetroSA, Oribi, South Africa |
| Date Built / Converted | 1970 Halifax Canada / 1997 Conversion |


| | |
|---|---|
| Owner | PetroSA |
| Operating Water Depth | 120 meters |
| Number of Locations | 1 |
| Max Liquid Handling | 30,000 BOPD |
| Oil Storage Capacity | 34,000 Barrels |
| Mooring System Type | 9 Point Spread |

# Conclusions

- Floating Production Systems have become THE solution for water depths over 1000 feet and for many marginal fields
- FPSO's make up the majority of the FPS's now and forecasted for the future
- Our industry continues to develop innovative solutions
- Subsea production is the common method for developing wells for FPS solutions
- The size and cost of FPS units continue to grow significantly
- Our industry is near full capacity and more projects are coming !

# About Bruce Crager

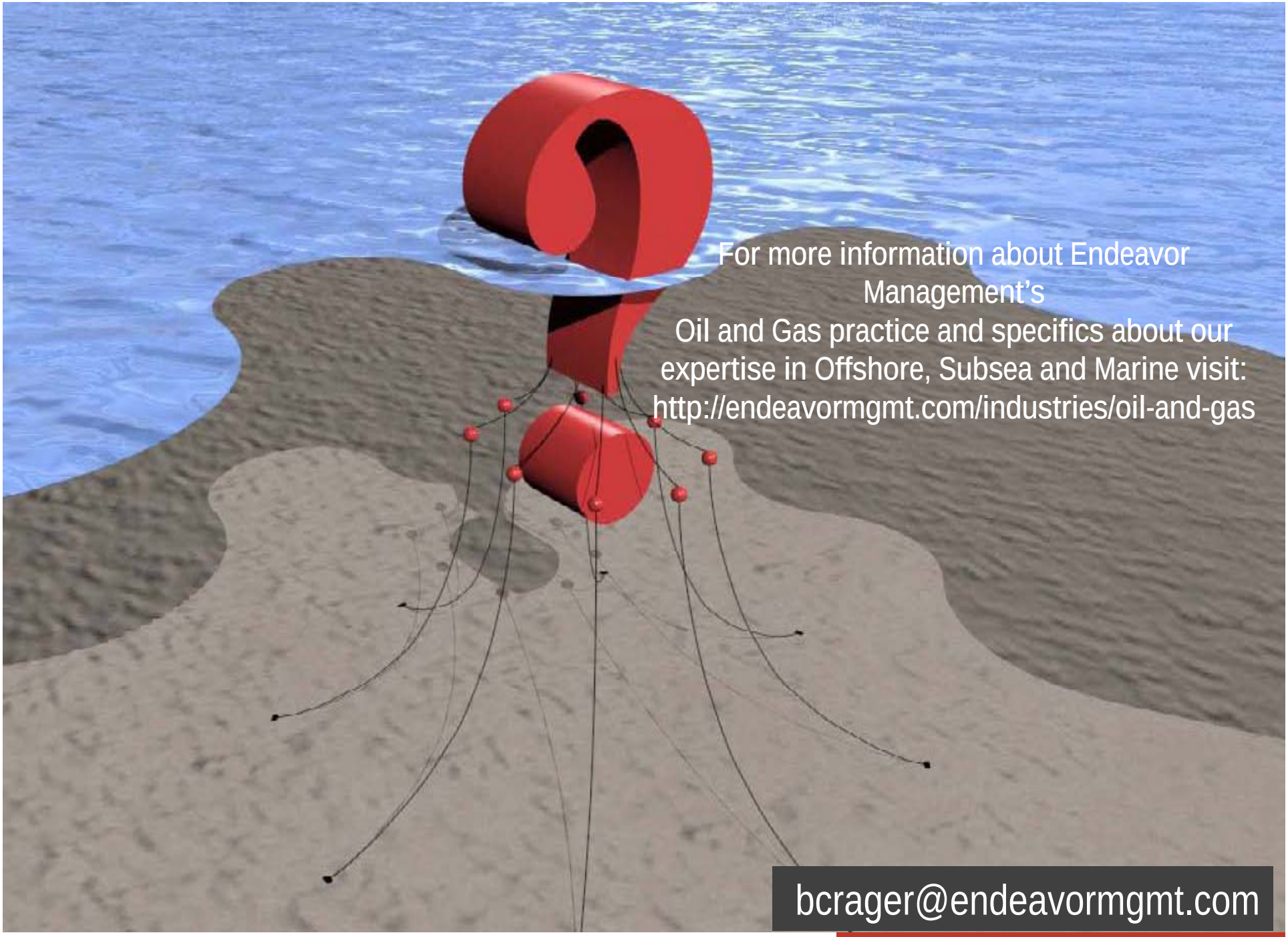
## Managing Director – Offshore, Subsea and Marine

Bruce has over 38 years experience in offshore drilling and production activities, primarily in management positions. This has included a significant amount of experience in evaluating and providing field development solutions based on floating production systems and subsea production equipment.

Bruce joined Endeavor in 2010 and is responsible for the development of an experienced team to support clients in the areas of strategy development, organizational change/development, decision analysis and in technical areas such as field development planning and operational improvement. Since joining Endeavor, Bruce has consulted to multiple clients, including Addax Petroleum, Audubon Engineering, Barra Energia, Cal Dive, Cameron, ENI, Lupatech, Maersk Oil, Pemex, Petrobras, Ridgewood Energy, T-Rex Engineering & Construction and VAALCO Energy.

Education:

Bachelor of Science – Ocean Engineering, *Texas A&M University*– College Station, Texas, 1975
Master of Business Administration, *University of Houston*– Houston, Texas, 1979



# Endeavor

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Endeavor Management is a management consulting firm that leads clients to achieve real value from their strategic transformational initiatives. Endeavor serves as a catalyst by providing the energy to maintain the dual perspective of running the business while changing the business through the application of key leadership principles and business strategy.

The firm's 40 year heritage has produced a substantial portfolio of proven methodologies, enabling Endeavor consultants to deliver top-tier transformational strategies, operational excellence, organizational change management, leadership development and decision support. Endeavor's deep operational insight and broad industry experience enables our team to quickly understand the dynamics of client companies and markets.

Combined with our Gelb Consulting experience (founded in 1965) we also offer clients unique capabilities that focus their marketing initiatives by fully understanding and shaping the customer experience through proven strategic frameworks to guide marketing strategies, build trusted brands, deliver exceptional customer experiences and launch new products. Our experienced consultants and analysts use advanced marketing research techniques to identify customer needs and spot high potential market opportunities.