Cathexis Consultancy Services Ltd.

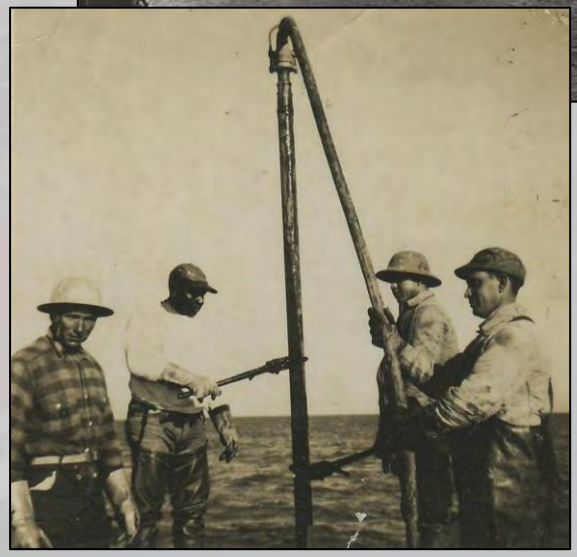
Floating Production, Storage and Offloading (FPSO) Facilities

Presentation Content

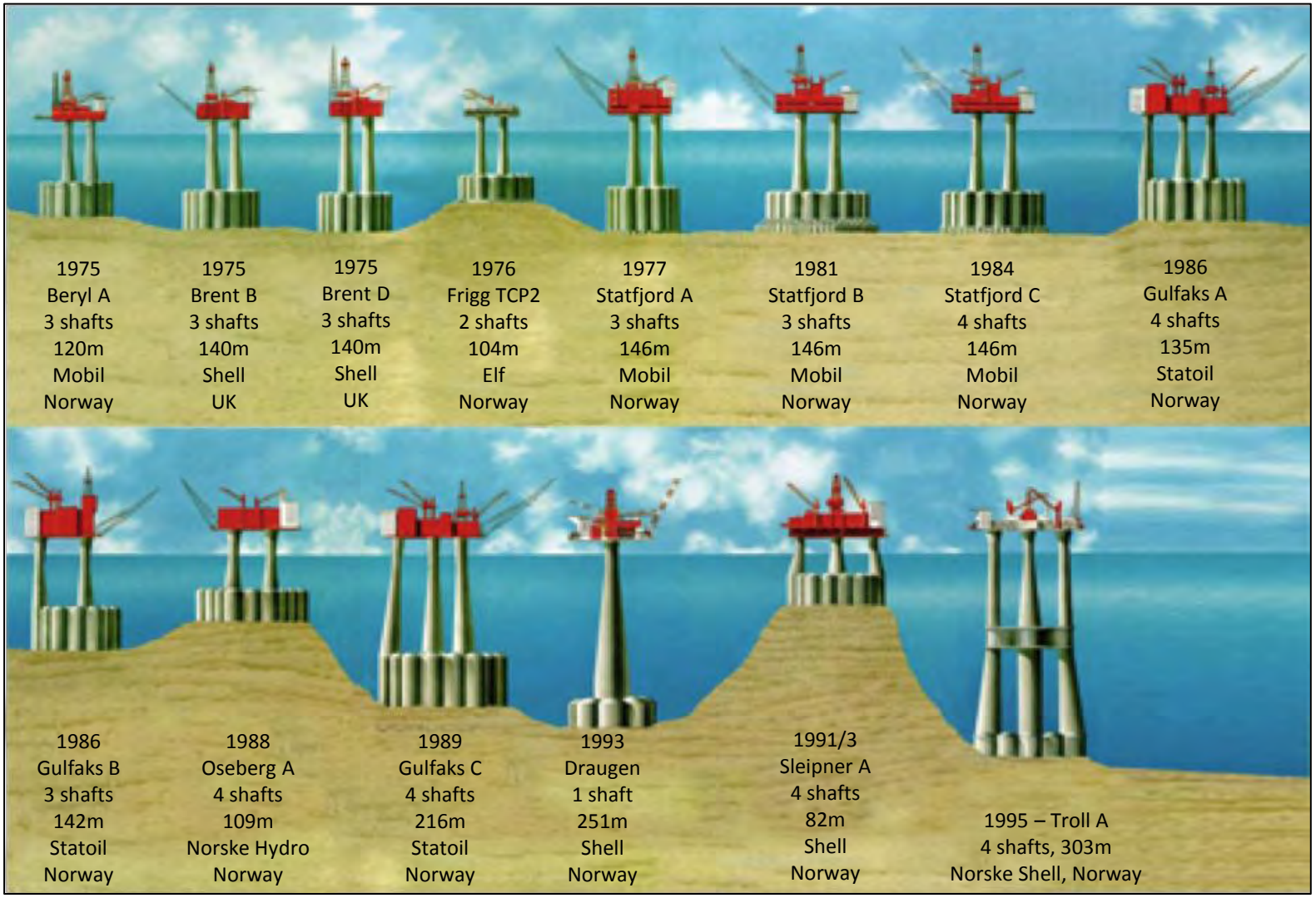
- History of Floating Production Systems
- Introduction to Field Layouts
- What is an FPSO..?
- Advantages of an FPSO
- Types of Processing Unit
- Major milestones affecting FPSO use
- Demand for FPSOs
- Examples of FPSO records; largest, smallest etc.
- Summary

History

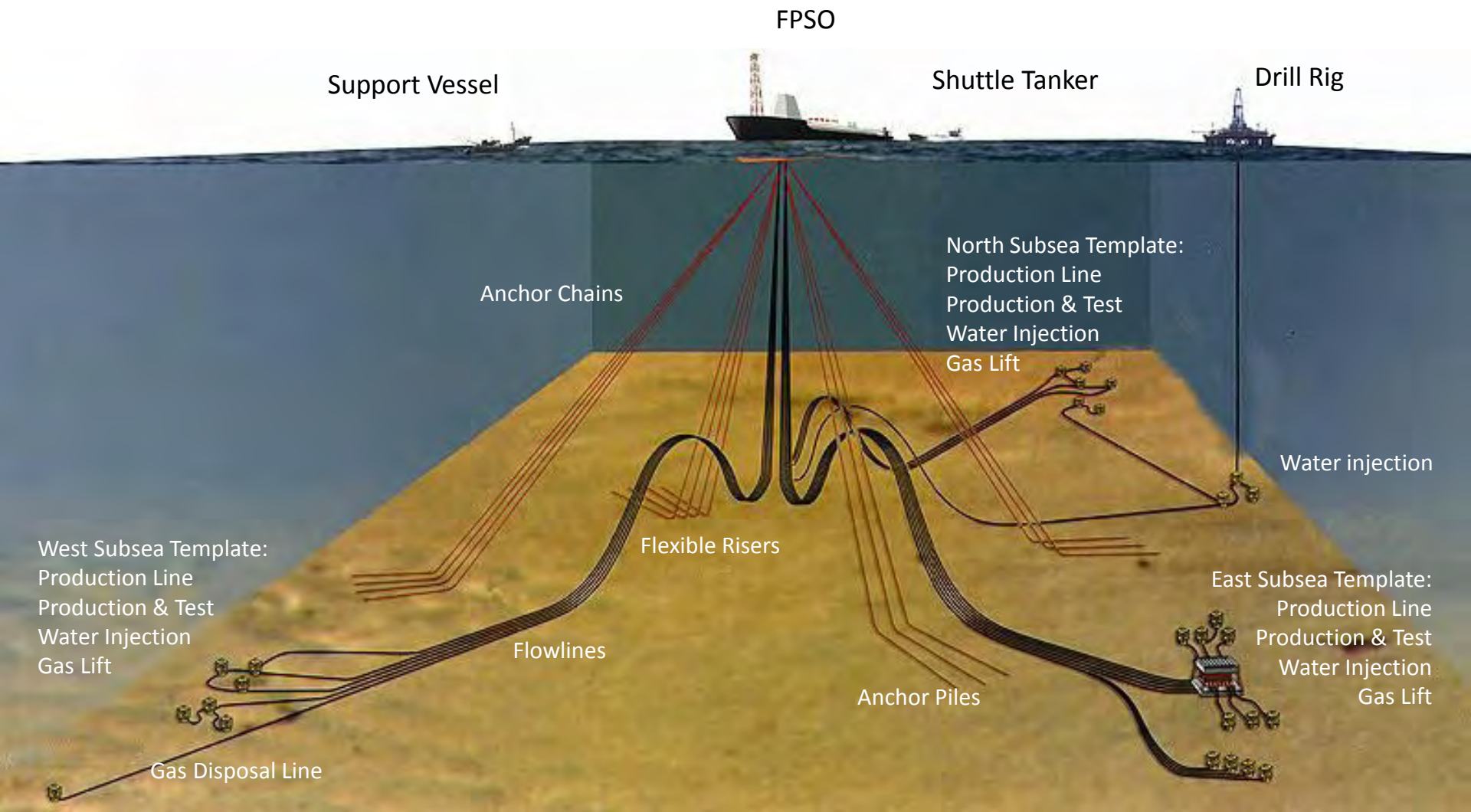
- Offshore locations have been producing oil since the late 1940s
- Originally all oil platforms sat on the seabed in shallow water and exported via tanker or pipeline
- As exploration moved to deeper waters in the 1970s Condeeps and Floating production systems came into use



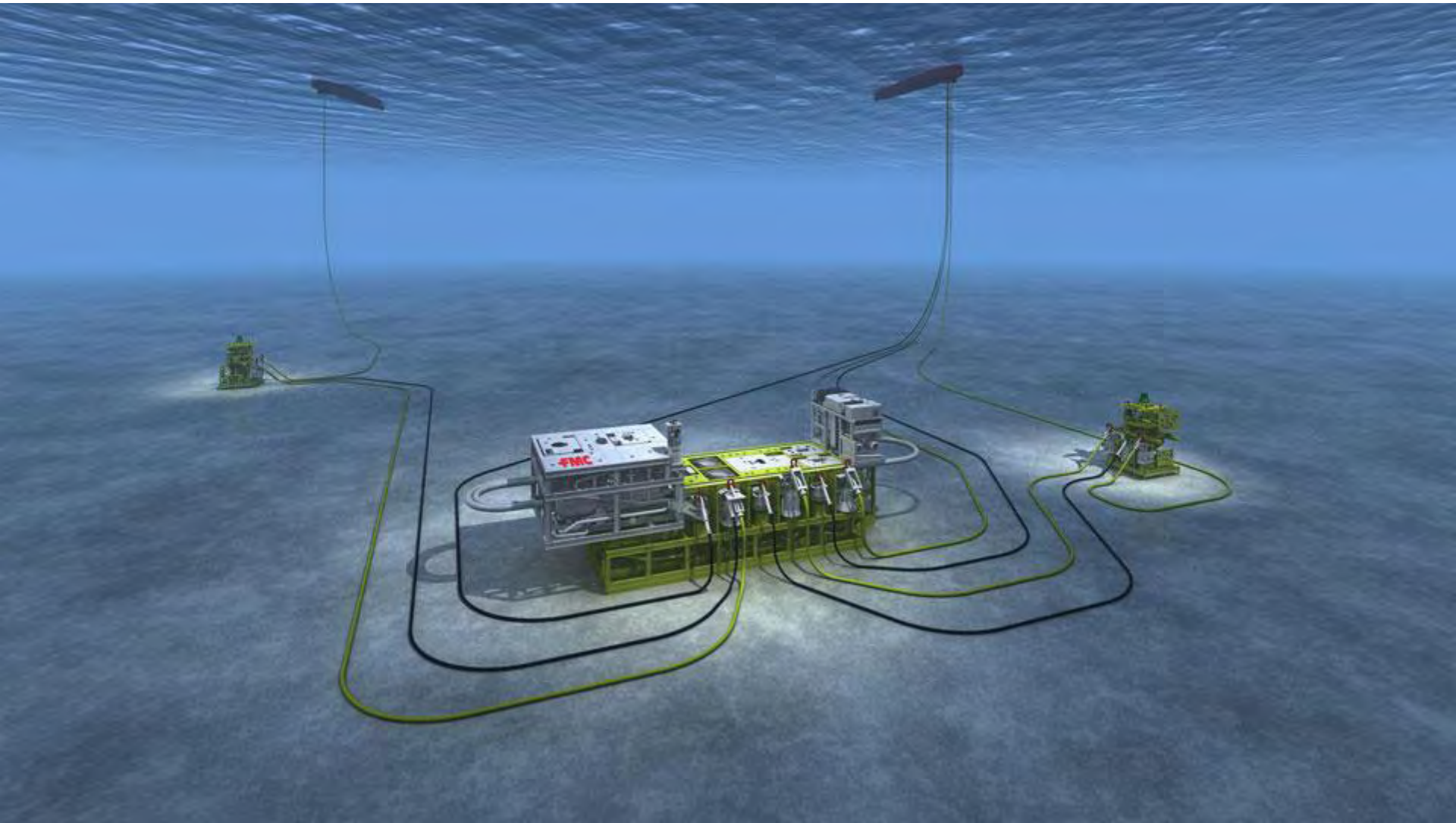
Condeep Concrete Platforms



Example Field Layout

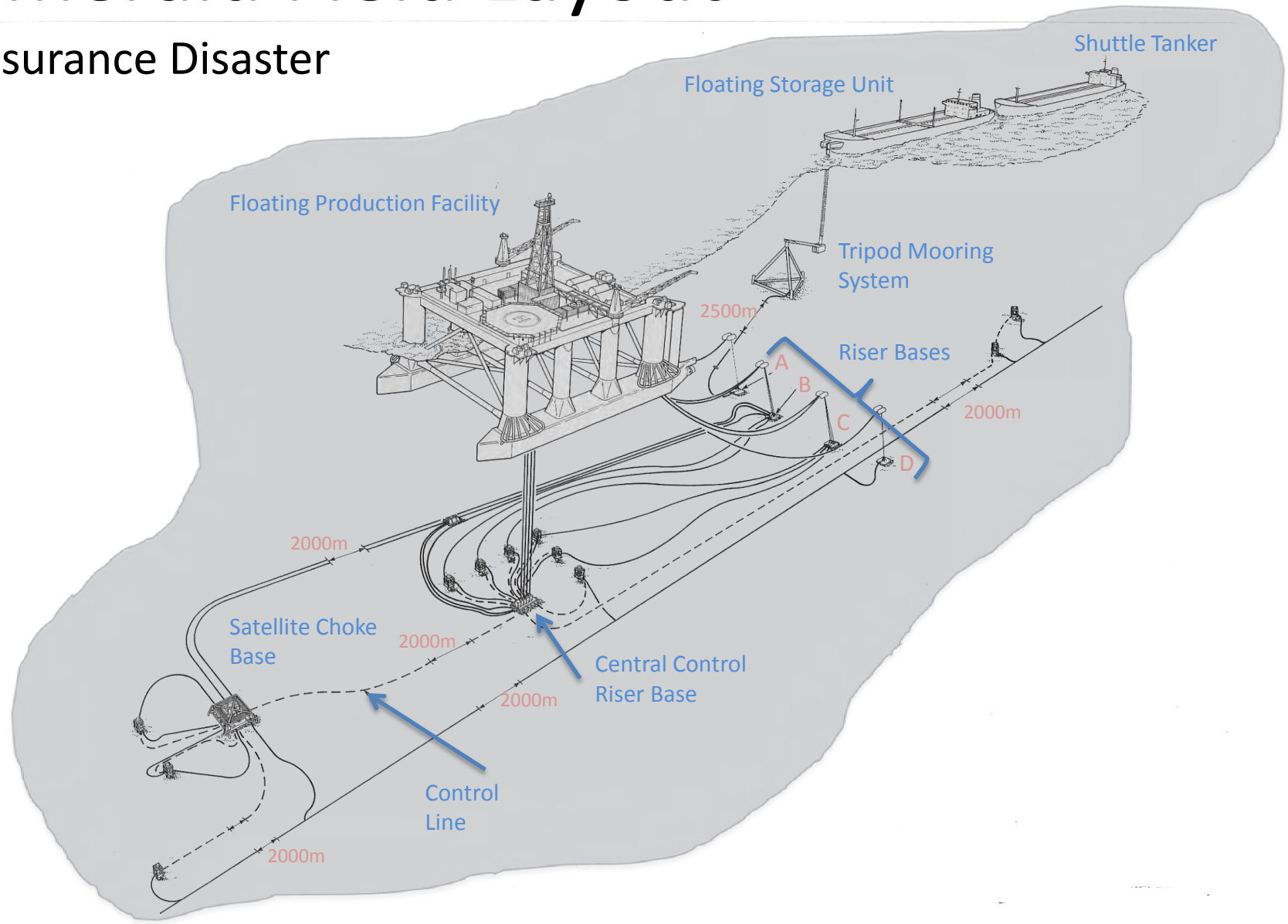


Subsea Production Template



Emerald Field Layout

Insurance Disaster



What is an FPSO..?

- A converted tanker or purpose built vessel
  - may be ship shaped, multi-hull production semi-submersible or a cylindrical shaped production spar / Mono Hull
- Hydrocarbon processing facilities are installed on board
- Processes well stream fluids into Oil, LPG or LNG
- Units without processing facilities are referred to as an FSO or Floating Storage & Offload Unit

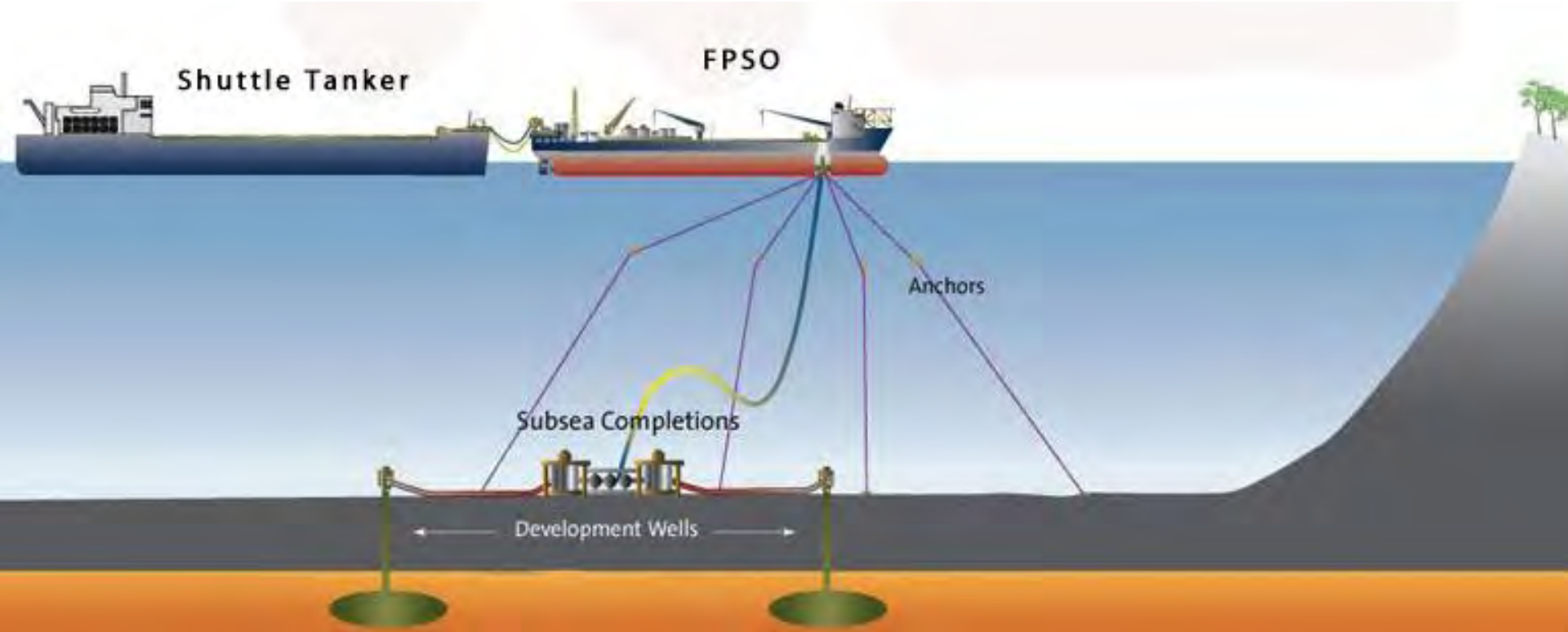
Xikomba – offloading to shuttle

Girassol – Multi-hull semi-sub

Sevan Voyageur – Mono-Hull spar type

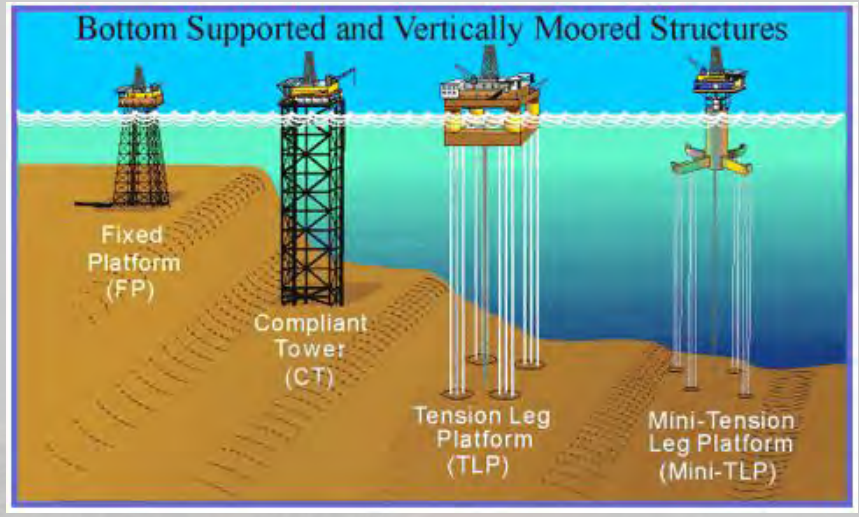
What does an FPSO do..?

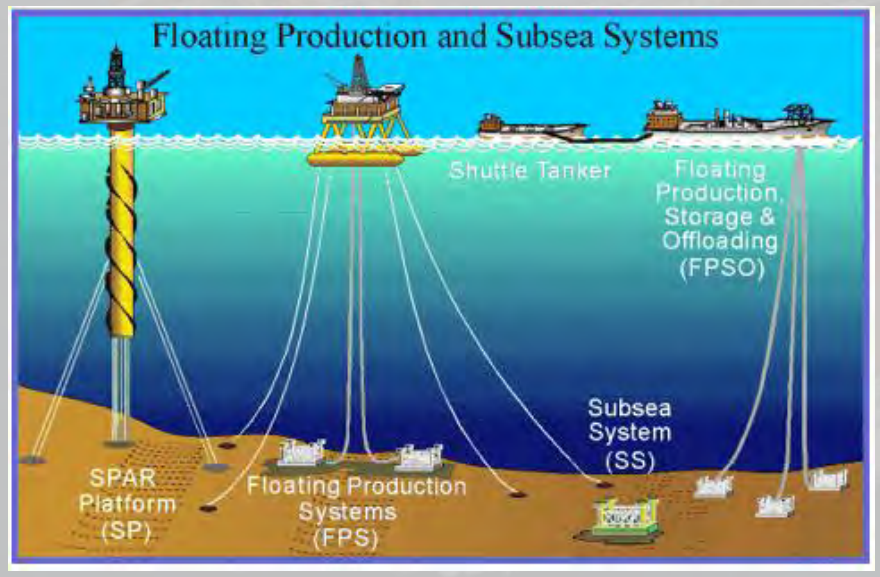
- Processes hydrocarbons received from local production wells i.e. from a platform or subsea template
- Well stream is processed & stored on the vessel, offloaded to a shuttle tanker or exported via a pipeline



Why use an FPSO..?

- Fixed platforms enable production to an average max depth of 1,400 feet (425m)
- FPSOs allow production far deeper than fixed platforms



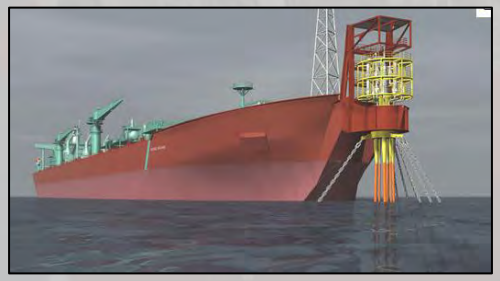


- FPSOs allow development of short-lived, marginal fields in remote locations where a fixed platform is impractical & uneconomical
- FPSOs can be relocated to new locations and reused

FPSO Mooring Systems

- There are three main types;
  - Spread Mooring
    - FPSO is moored in a fixed position
  - Single Point Mooring (SPM) Systems
    - FPSO Weathervanes around a fixed point
  - Dynamic Positioning (DP)
    - Does not require anchor wires/chains or piled/seabed anchors. This system is the most accurate for station keeping but the most expensive to operate

Spread Mooring



Single Point Mooring

Azimuth Thrusters for DP vessels

FPSO Advantages

- They eliminate the need for costly long-distance pipelines to an onshore terminal
- Particularly effective in remote or deep water locations where seabed pipeline are not cost effective

- In bad weather situations (cyclones, icebergs etc.) FPSOs release mooring/risers and steam to safety.
- On field depletion FPSOs can be relocated to a new field

Types of Processing Units

Process/Product Types

- OIL – oil, gas & water from the well stream are separated. Gas & water may be injected into well to increase reservoir pressure or gas may be exported
- LPG – has onboard liquid petroleum gas processing and export facilities
- LNG – takes well stream and separates out the natural gas (primarily methane and ethane) and produces LNG

FPSO Milestones

- First Oil FPSO built in Spain in 1977 – Shell Castellon
- First Liquid Petroleum Gas (LPG) FPSO build completed 2005 – “Sanha”, operates on the Chevron/Texaco Sanha Field in Angola
- First Liquid Natural Gas (LNG) FPSO was conversion of LNG Carrier Golar by Keppel in Singapore in 2007

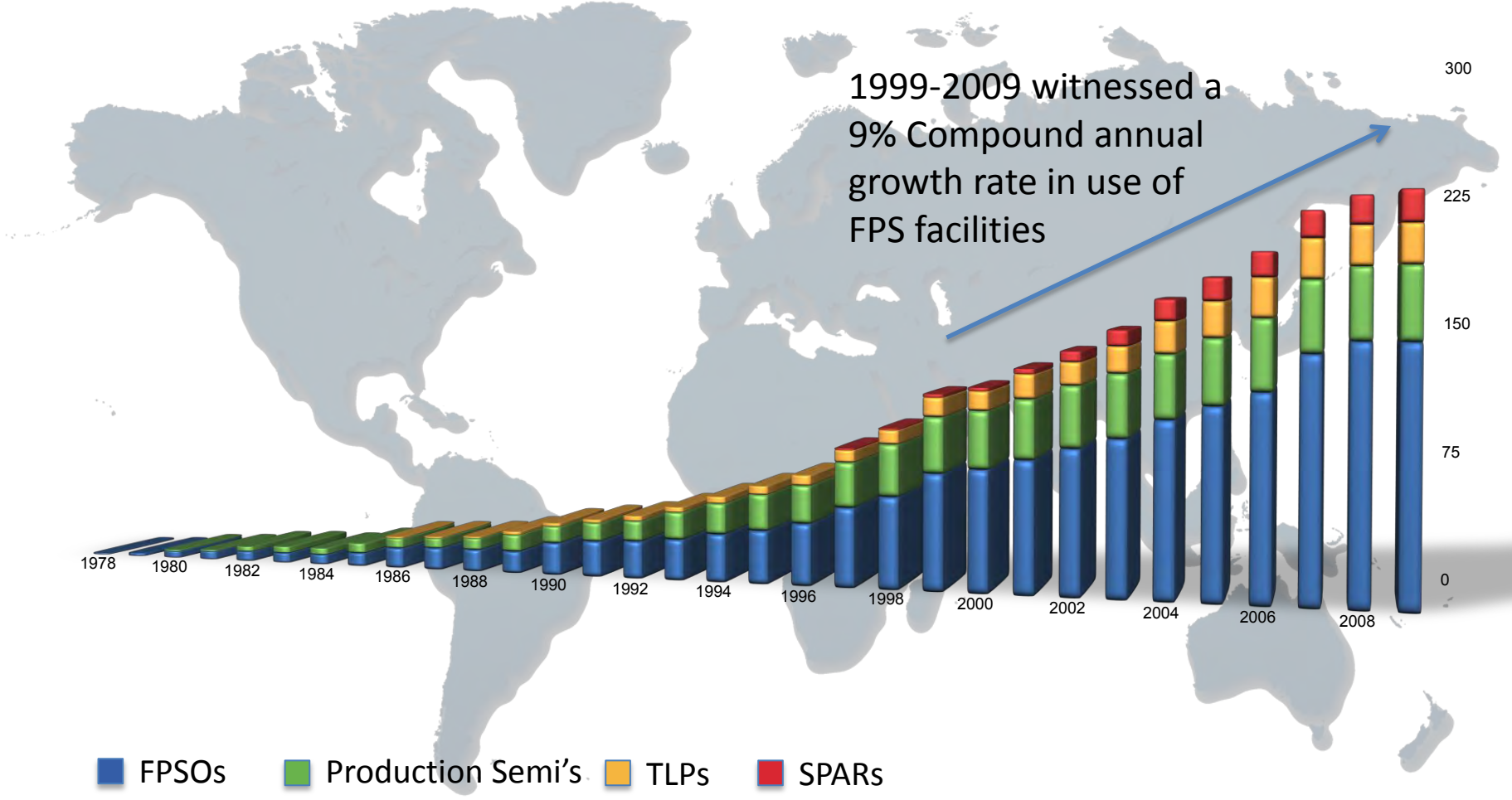
Sanha LPG FPSO – Angola

Golar FLNG

Growth in Demand

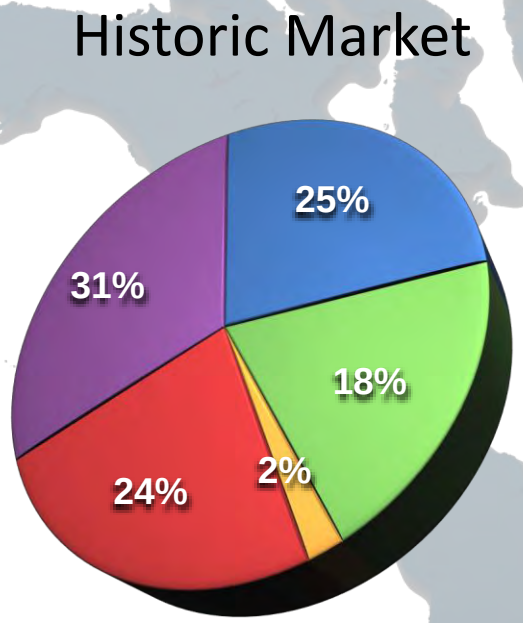
- Global demand is expected to double this decade
- 127 of the planned 200 projects in next 8 years will use FPSOs
- Brazil is the fastest growing development area with 28 FPSOs in service and 41 currently in the tendering or planning phase
- Since Jan 2010 there have been 11 FPSO contracts awarded in Brazil
- Even in the mature region of the North Sea there remains an active FPSO market
- Harsh weather and proliferation of smaller, marginal fields lends itself to the use of FPSOs
- There are currently 22 FPSOs in operation with a further 28 planned projects, up from only 15 projects one year ago

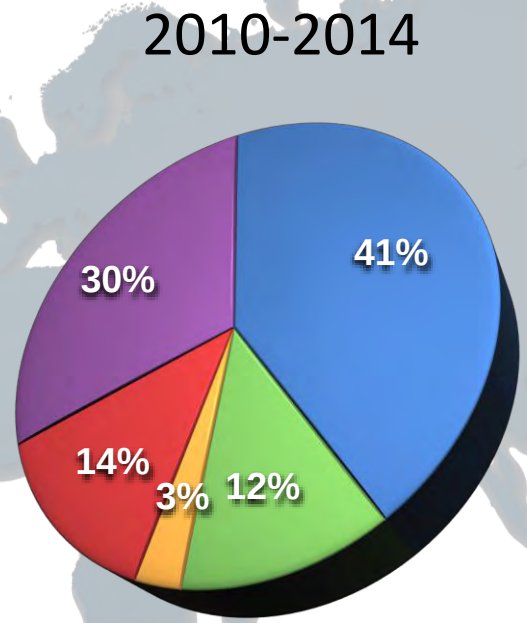
FPS Facilities Installed



Data courtesy of Infield Data Analysts

Change in Demand

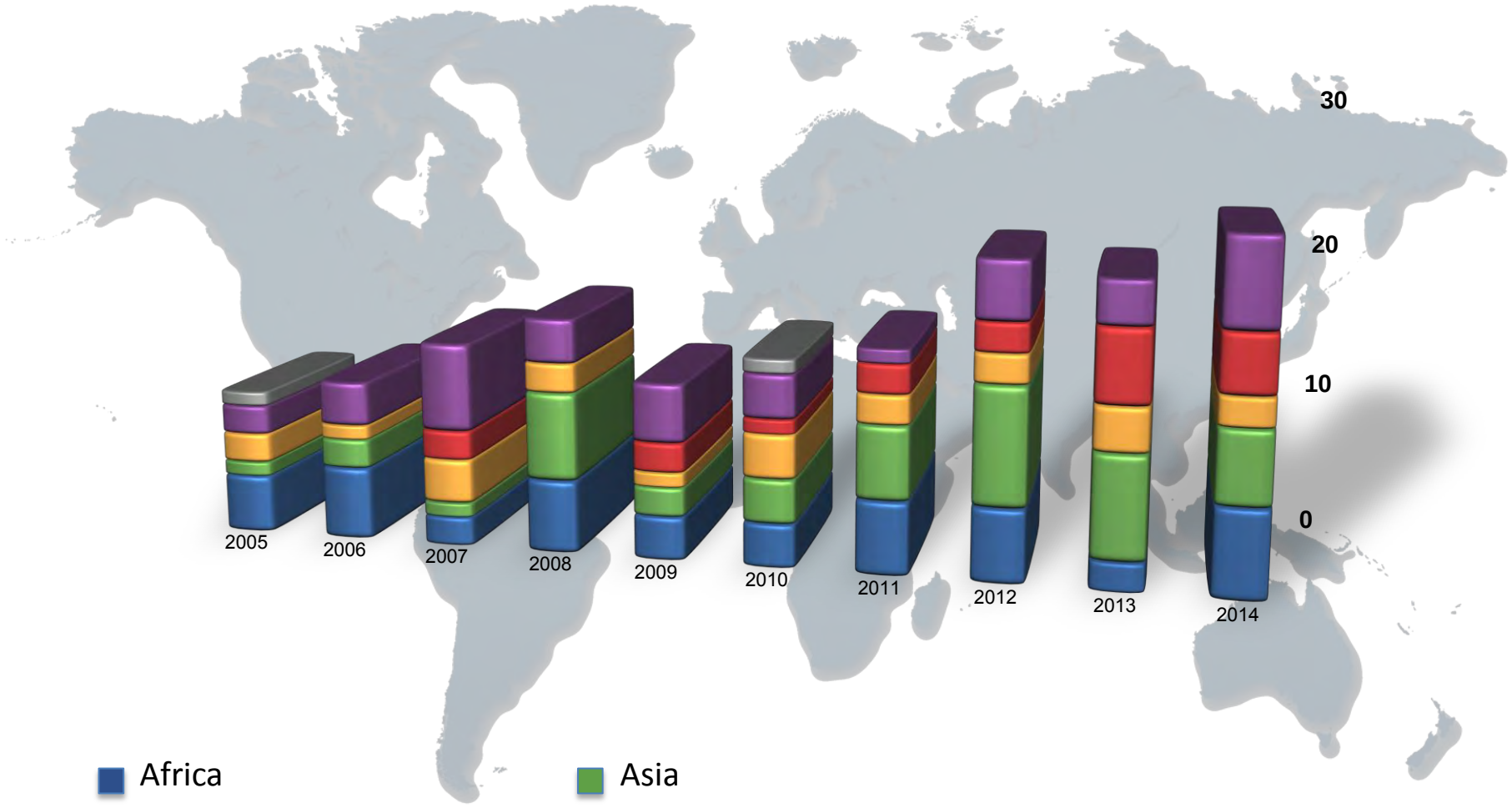




- Small Independent
- Large Independent
- Leased Operator
- Major
- NOC

Data courtesy of Infield Data Analysts

New FPSOs by Region



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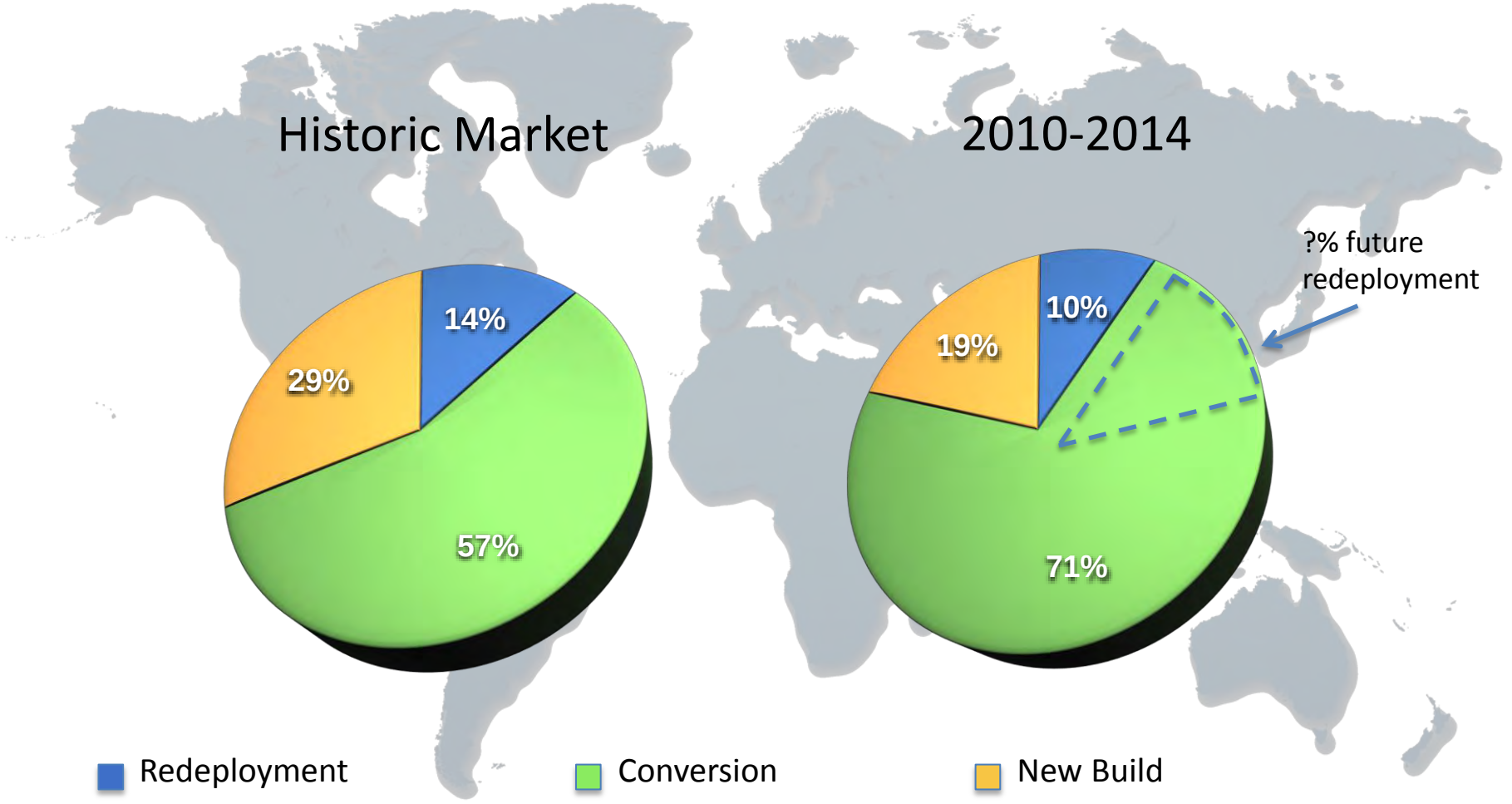
Deployment of FPSOs



Data courtesy of Infield Data Analysts

Records – Deepest Water

- FPSO Pioneer
  - BW Offshore operated on behalf of Petrobras Americas Inc.
  - 8,530 feet (2,600m) depth of water (DOW) in Gulf of Mexico
  - 100,000bbl/d (16,000 m^3/d)
  - EPIC contract was awarded 2007
  - First oil Q3 2011
  - FPSO conversion at Keppel Shipyard in Singapore
  - Vessel has disconnectable turret so it can disconnect for hurricanes and reconnect with minimal downtime

Records – Shallowest Water

- FPSO Armada Perkasa
  - Located in Okoro field in Nigeria, West Africa for Afren Energy
  - 43 feet (13m) DOW in the Bass Strait between Australia and Tasmania
  - Spread moored (fixed orientation)
  - Uses 100mm, 150mm and 200mm bore DeepFlex non-steel flexible risers in a double lazy wave formation to offset extreme waves and currents

Records – Biggest FPSO

- FPSO Kizomba
  - Operated by Esso Exploration Angola (Exxon Mobil)
  - 3,940 feet (1,200m) DOW in Atlantic Ocean off Angola
  - 2.2 million barrels (350,000 m^3) storage capacity
  - Built by Hyundai Heavy Industry in Ulsan, Korea
  - Weighs 81,000 tonnes
  - 935 feet (285m) long, 207 feet (63m) wide and 105 feet (32m) high

Records – Smallest FPSO

- FPSO Crystal Ocean
  - Operated by AGR Asia Pacific on behalf of Roc Oil (Sydney based E&P company)
  - 450 feet (137m) DOW in the Bass Strait between Australia and Tasmania
  - 5,000 bbl/d (790 m^3/d) production

Records – Longest FPSO

- FPSO Girassol
  - Operated by TotalFinaElf
  - Located of NNW Luanda, Angola - 1350m of water
  - 300m Long x 59.6m Wide, 30.5m High
  - Average draught 23m
  - Displacement 396,288 tons

Records – Most Advanced

- FPSO Scarv
  - Developed & engineered by Aker Solutions for BP Norge
  - Gas condensate and oil development
  - Ties in 5 sub-sea templates with several smaller wells in future
  - Handles 19 million cubic metres/day of gas
  - 292m long, 50.6m wide & 29m deep
  - Accommodates 100 people in single cabins

Scarv during construction in Korea

Records – Largest Conversion

- FSO Ailsa Craig
  - Largest FSO/FSU conversion when carried out
  - Converted tanker with external turret
  - Used on the Emerald Field, North Sea

View from forward to aft while under construction in Rotterdam

Records – Largest FSU/FSO

- FSO Khalij-E-Fars
  - Largest purpose built FSU/FSO
  - Registered in Bushehr
  - 335m long, 60m breadth, 33m deep & draft of 10m
  - Built in China 2011
  - Due to sail from Dallian to Iran April 2012

Vessel nearing completion in STX Yard at Chang Xing island China

Records – Largest Planned

- Shell Prelude FLNG
  - Due on station 2017, North-western coast of Australia in 820 feet (250m) DOW (25 years permanently moored)
  - Built by Samsung Heavy Industries (SHI)
  - SHI & Technip consortium will engineer, procure, construct & install Capable of producing 5.3 million tons per annum (Mtpa) of liquids – 3.6Mtpa of LNG, 1.3 Mtpa of condensate and 0.4 Mtpa of LPG
  - 1,600 feet (488m) bow to stern (longer than four soccer fields
  - 243 feet (74m) wide
  - 600,000t when loaded, 260,000t of which will be steel
  - Six times heavier than the worlds largest aircraft carrier
  - Chills natural gas to -162^{o}C shrinking the volume by 600 times
  - Worlds largest floating offshore facility

Summary

- Demand for FPSOs continues to rise at a healthy rate of approximately 9% compound annually
- Five year forecast shows capex for production floater orders is expected to total between $80 billion to $115 billion
- Between 24 and 35 units annually over the next five years, 80% of which will be FPSOs (120 to 175 FPSOs total)
- LNG and LPG FPSOs are increasing in numbers faster than ever
- Demand for FPSOs most prevalent in Brazil, Asia and West Africa
- Following the 2009 slump FPSO orders have recovered well

Thank You

CCSL

Cathexis Consultancy Services Ltd.

info@cathexis.biz