Low Cost Early Production System Using MODU as MOPU

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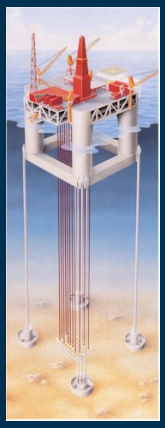
Overview

- Typical deepwater field development options and challenges
- Forecast drilling rig demand and availability
- Fast-track deepwater field development solution

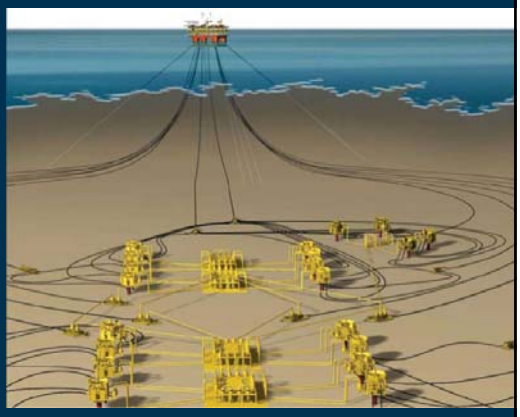
Dry Tree Facilities



- Well access at the surface
- Platform Solutions
  - Jacket platforms (several)
  - Compliant towers (several)
  - TLPs (16 installed, 3 in progress, 1 more to be awarded)
  - Spars (14 installed)
- Deepest dry tree facility installed to date
  - Perdido Spar – 8000ft, GoM
  - Magnolia TLP – 4700ft, GoM
  - *Big Foot TLP – 6000ft, GoM (to be installed)*

Wet Tree Facilities

- Subsea trees attached to a host facility
- Typical host facilities
  - Semi-submersibles
  - Compliant towers
  - TLPs
  - Spars
  - FPSOs
  - FPUs

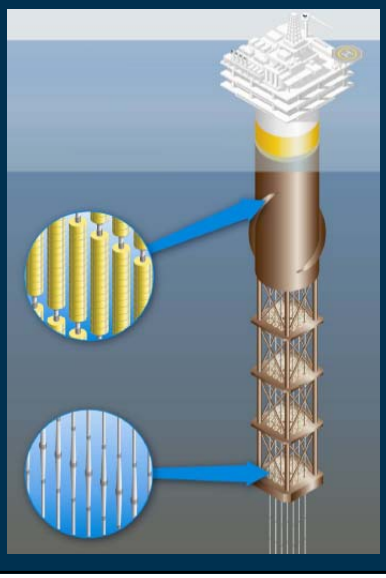


- In-field developments and long distance tie-backs
- Implemented in water depths of up to 7,000ft Atlantis, GoM

Design Benefits and Challenges for Concept Selection

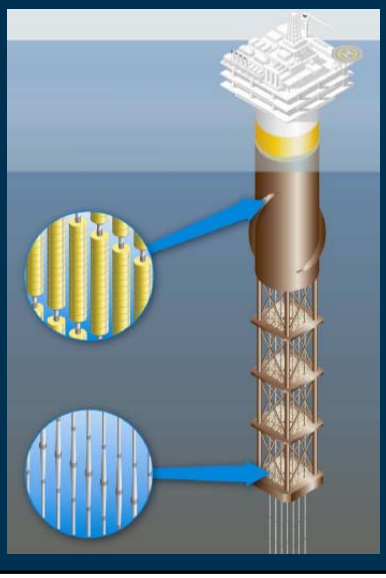
Dry-tree System Benefits

- Tree and well control at surface in close proximity of people
- Drilling conducted from the facility – reduced CAPEX
- Direct vertical access to wells for future intervention activities
- Minimal offshore construction
- Enable future drilling and expansion



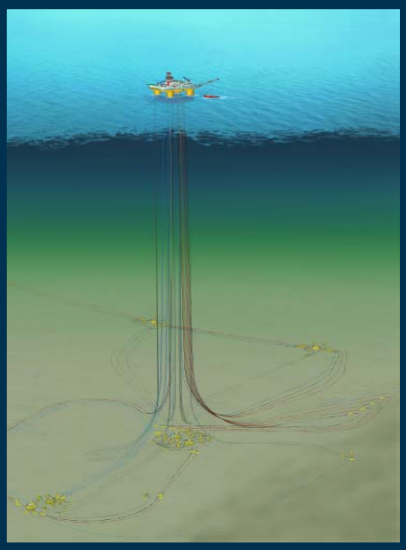
Dry-tree System Challenges

- **Large vessel payloads** due to the need for supporting risers
- Require **high CAPEX** vessels such as Spar, TLP due to design sensitivity to vessel motions
- **Complex riser design** issues
  - Limited by existing riser tensioner capacity
  - Riser interface with vessel require speciality joints, e.g. keel joint, tapered stress joint
- **Heavy lift** requirement for riser installation
- **Long lead times** for award to first oil



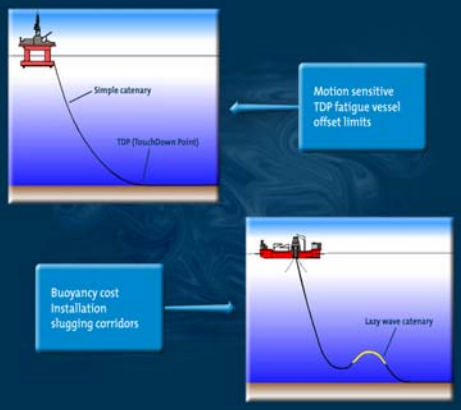
Wet Tree System Benefits

- Tree and well access at the seabed isolated from people
- Full range of hull types can be used
- Low cost hull forms are feasible
- Simplified riser/vessel interfaces



Wet Tree System Challenges

- Drilling and workover will need a separate MODU or require hull with drilling/workover capability increasing the **overall CAPEX**
- Potentially **large vessel payloads** due to risers
- Flow assurance may be a challenge due to potentially long tie-in
- **Long lead time** for flexible risers
- **High spec pipe-lay vessels** required to install risers and flowlines



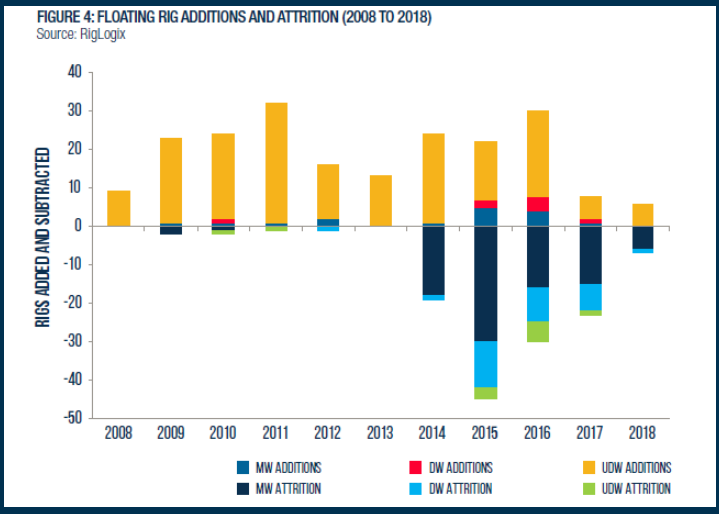
Wet Tree vs Dry Tree Comparison

Feature	Dry Tree Development	Subsea Development
Drilling Cost	From facility	Requires MODU
OPEX Costs	From facility	Requires MODU
Facilities CAPEX Cost	High cost hull	Choose least cost hull
Offshore Construction	Heavy lift requirements	Depends on riser system
Development Flexibility	Restricted due to hull form	Minimal vessel impact
Riser/Vessel Interfaces	Complex interaction	Simpler interaction
Vessel Flexibility	Restricted to Spar or TLP	Full range
Shut in location	In well bay close to people	Seabed Isolation and Offset
Flow Assurance	Shortest Flow Path	Potentially long tie flowlines

Deepwater and Ultra Deepwater Rig Demand

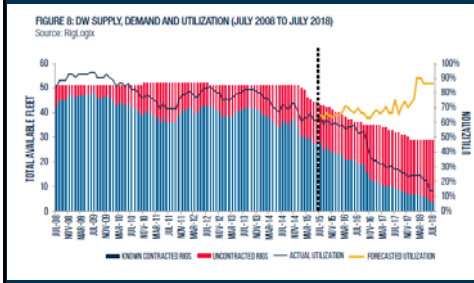
Source: RigLogix

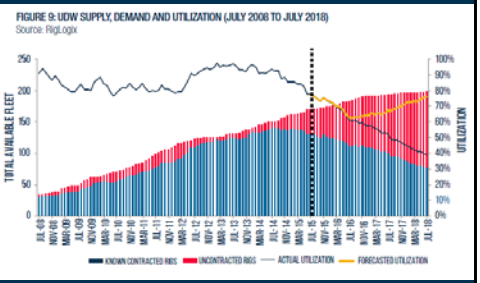
Rig Additions and Attrition



Projected Deepwater Rig Demand

- About 25-30 deepwater and 5-10 ultra-deepwater drilling rigs retired through 2015-17 will be available for re-use in future field developments





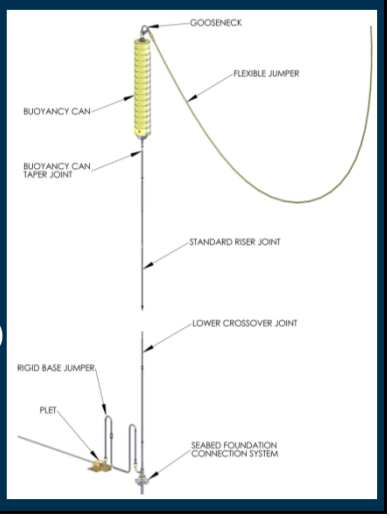
Enabling Solution

Permanent Moored Drilling Vessel

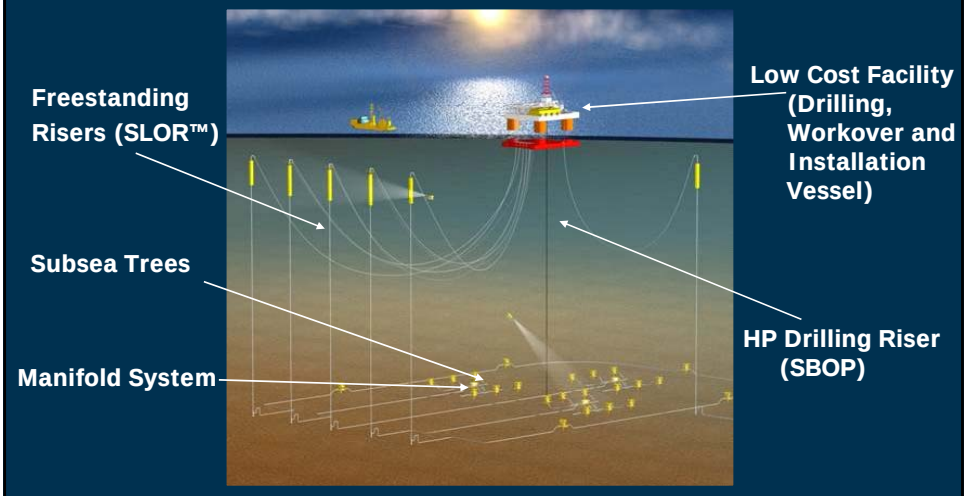
- Take advantage of current overcapacity in the drilling vessel market
- Purchase an idle drilling vessel at a low cost compared to a new build Dry tree/wet tree facility with drilling rig
- Produce through subsea trees located under the drilling vessel to enable access for through life drilling and workover to maximize recovery rates
- Offloads to a leased FPSO providing an overall low CAPEX field development solution
- Utilise Flexible riser in shallow water depth, or, Freestanding riser in deepwater for production fluid transfer to FPSO

Deepwater Riser Option - SLOR's

- **Exxon Kizomba A (5 SLOR's)**
  - 3No. Water Inj. (12 inch)
  - 2No. Gas Inj. (8 inch)
- **Exxon Kizomba B (2 SLOR's, 3 COR's)**
  - 2No. Production (12 x 15 inch PIP)
  - 1No. Test (8 x 11 inch PIP)
  - 2No. Water Inj. (8inch & 12inch)
- **Petrobras P52 -18 inch export SLOR**
- **BP Block 31 – 10 SLOR's**
- **Petrobras Cascade EPS, GoM (5 SLOR's)**
- Total Block 32 – 18 SLOR's
- Exxon – Kizomba Satellites (2-3 SLORs)
- Block 15 – Gas Export SLOR



Permanently Moored Drilling Vessel Based Production System



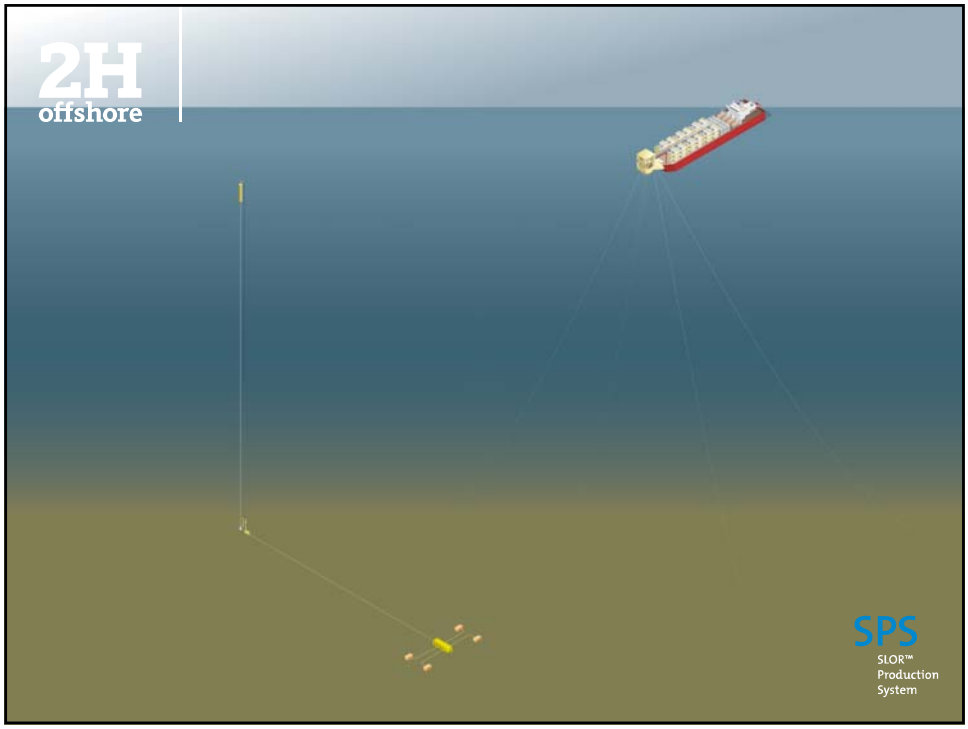
Key Advantages

- CAPEX reduction of up to 50% (~US$1bn) assuming
  - MODU with an leased FPU replaces an equivalent dry tree vessel such as a TLP
  - Freestanding risers replaces the Dry tree riser system
  - Installation of vessel and SURF included
  - MODU conversion with permanent moorings included
- Faster SCHEDULE to first oil
  - 4.5 years to first oil with a conventional dry tree field development with TLP construction of 3 years on the critical path, vs.
  - 3.5 years to first oil with riser system delivery and MODU conversion on the critical path
- Maintain life of field workover capability
- Enable phased field development
- Retrievable and relocatable riser system and vessel

Fast-track Field Development Installation Sequence

Primary Features (1)

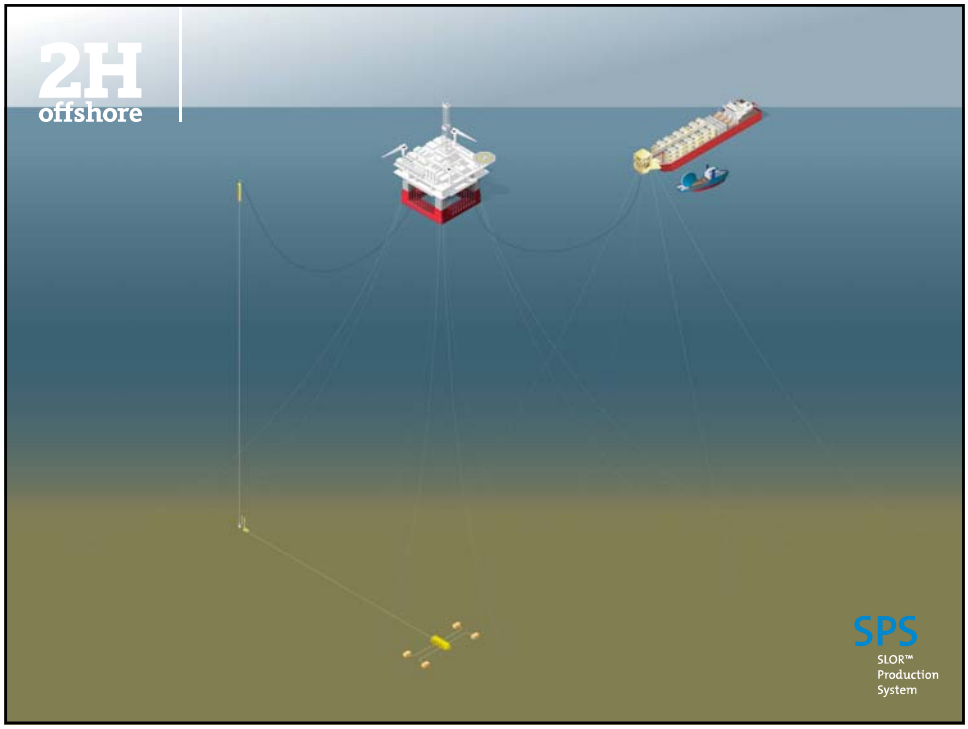
- Pre-installation
  - Schedule flexibility
  - Using permanently moored MODU in the field



2H offshore

Primary Features (2)

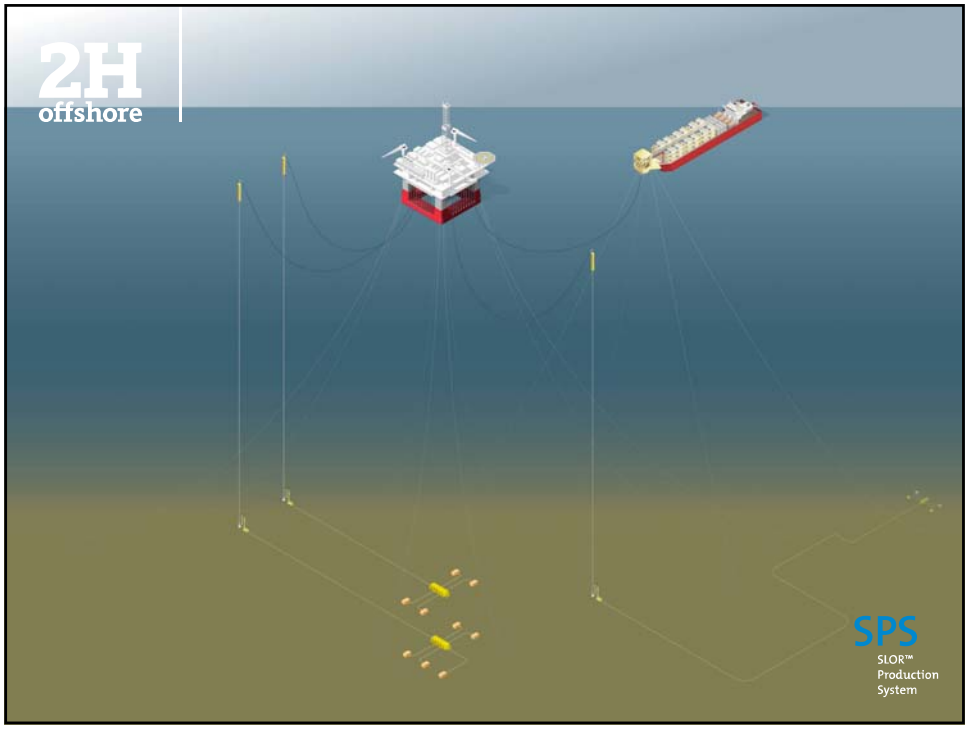
- Shorter schedule to first oil
  - FPU already commissioned before arrival
  - FPU stationed with pre-set moorings
  - Only Production jumper, umbilical and fluid transfer lines to hook up
  - Production from pre-drilled wells within 7-10days.



2H offshore

Primary Features (3)

- Organic Field Expansion
  - New wells drilled from permanently moored rig
  - Expansion subsea equipment installed from same rig assisted by small work vessel
  - Well access for workover and side tracks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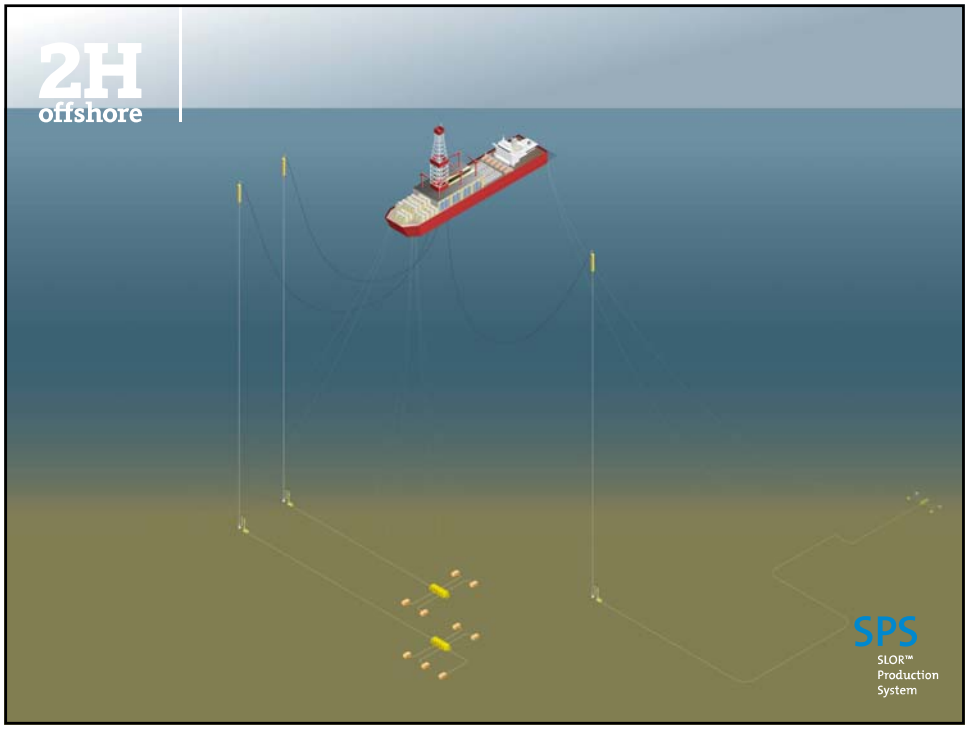
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Track Record of Similar Solution

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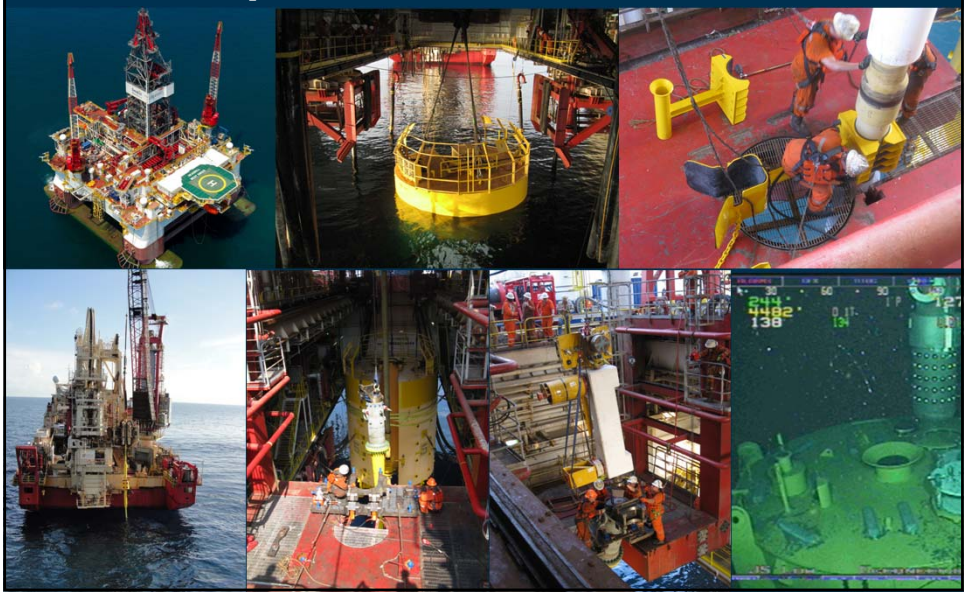
Track Record of Drilling Rigs Converted to Production Units

Vessel	Field	Startup	Region	Notes
Argyll FPU	Argyll Oil Field	1975	UK North Sea	First MODU Floating Production Platform Transworld 58'. Transworld 58 transferred to Innes field in 1985 until 1987.
Buchan A	Buchan oil field	1981	UK North Sea	Converted from Drillmaster MODU for BP
P-09	Corvina Oil Field	1983	Brazil	Conversion Aker H-3e design drilling rig
P-15	Pirauna	1983	Brazil	Conversion Mitsubishi MD-503 design
P-12	Linguado / Badejo Oil Field	1984	Brazil	Aker H-3e design
P-21	Badejo / Salema Oil Fields	1984	Brazil	Conversion of *Sedco Staflo* drilling rig
Deepsea Pioneer FPU	Argyll & Duncan Oil Fields	1984	UK North Sea	Converted from Deepsea Saga drilling rig.
P-22	Morela	1986	Brazil	Conversion of drilling rig *Sedco 135F*
P-07	Bicudo Oil Field	1988	Brazil	Converted from Aker H-3 drilling rig *Bendoran*
Veslefrikk B	Veslefrikk Oil Field	1989	Norwegian Sea	Converted from *West Vision* drilling semi.
AH001	Ivan Hoe Rob Roy Oil Field	1989	UK North Sea	Converted from *Sedco Philips SS* First OSV/Safety Vessel
P-20	Marlim	1992	Brazil	GVA4000 design. Converted from Russian built *Illad* drilling semi.
P-08	Marimba Oil Field	1993	Brazil	Converted drilling rig *Songa Star / Belford Dolphin*
P-13	Bijupira / Salema Oil Field	1993	Brazil	Conversion
P-14	Coral / Esrela / Caravela Oil Fields	1993	Brazil	Conversion
Nan Hai Tiao Zhan	Luihua	1995	South China Sea	Converted Sedco700 drilling rig West Stadrill for Amoco
P-25	Albacora II Oil Field	1996	Brazil	Conversion of Zapat-4000 drilling rig
P-27	Voador	1996	Brazil	Conversion of Penrod drilling rig *Pardill 71*
Tahara	PY-3	1997	Indian Ocean	Conversion Sedco-135 design
P-19	Marlim	1997	Brazil	Converted from Enhanced Pacesetter drilling rig.
Janice A	Janice Oil Field	1999	UK North Sea	Converted from Aker H3.2 drilling vessel
P-36	Roncador	2000	Brazil	Converted from drilling rig *Spirit of Columbus* and sank in 2001
SS-11	Coral	2003	Brazil	Conversion
P-40	Marlim Sul	2004	Brazil	Conversion of DB-100 design drilling rig
ATP Innovator	Gomez Oil Field	2006	Gulf of Mexico	Converted from Rowan *Midland* semi-sub
Northern Producer FPF	Originally Galley Oil Field now at Don Oil Field	2009	UK North Sea	Re-use of Emerald Producer FPU, converted Aker H-3 vessel *Alibaba* in 1989.

GoM Rig Installed FSR for Oil Spill Containment



Summary

- Surplus rigs in the drilling market is an opportunity to reduce CAPEX by up to 50% and time to first oil by one year compared to an equivalent TLWP
- There have been many drilling rig conversions over the last 35 years, mostly to production platforms
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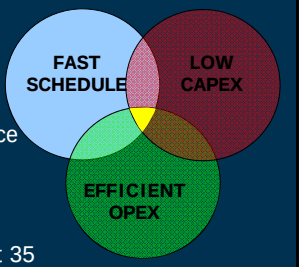
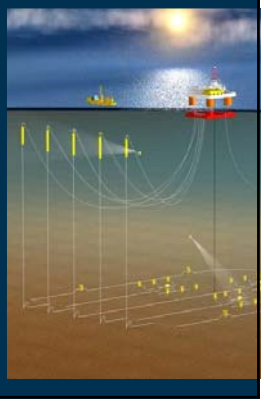
- Subsea trees and freestanding risers enable a MODU to be repurposed as a permanent moored drilling and workover vessel for deepwater
- Arrangement provides expansion flexibility to minimize upfront CAPEX and protect against reservoir uncertainty
- Risers and vessels can be retrieved and relocated
- The drilling vessel and a MSV can be used to install the freestanding risers to avoid the use of an expensive heavy lift installation vessel





Thank you

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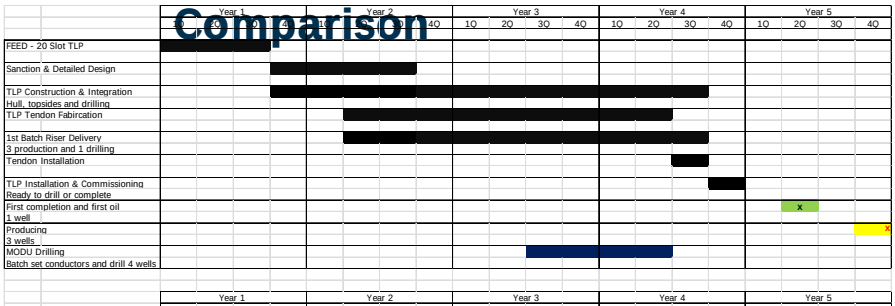
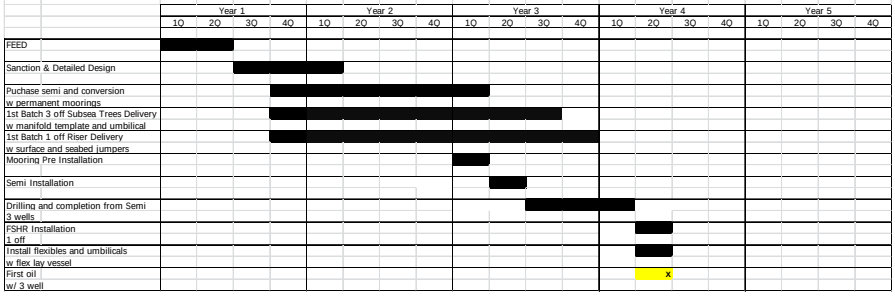
Preliminary Schedule Comparison





Preliminary CAPEX Comparison

FEED - 20 Slot TLP		
Sanction & Detailed Design		$90,000,000
TLP Construction & Integration Hull, topsides and drilling		$1,000,000,000
TLP Tendon Fabircation		$90,000,000
1st Batch Riser Delivery 3 production and 1 drilling		$40,000,000
Tendon Installation		$25,000,000
TLP Installation & Commissioning Ready to drill or complete		$39,000,000
First completion and first oil 1 well		
Producing 3 wells		
MODU Drilling Batch set conductors and drill 4 wells		$93,250,000
	sum	$1,377,250,000

FEED		
Sanction & Detailed Design		$35,000,000
Puchase semi and conversion w permanent moorings		$290,000,000
1st Batch 3 off Subsea Trees Delivery w manifold, well jumpers and umbilical		$35,500,000
1st Batch 1 off Riser Delivery w surface and seabed jumpers		$25,000,000
Mooring Pre Installation		$5,250,000
Semi Installation		$6,500,000
Drilling and completion from Semi 3 wells		
FSHR Installation 1 off		$12,500,000
Install flexibles and umbilicals w flex lay vessel		$7,500,000
First oil w/ 3 well		
	sum	$417,250,000

Costing Assumptions		West Africa
	Day rate	Mob/Demob
J-lay vessel	$500,000	$3,500,000
Flex-lay MSV	$250,000	$5,000,000
5th Gen MODU	$250,000	$2,000,000
Crane Barge	$175,000	$3,000,000
ROV survey vessel	$150,000	$2,000,000
Anchor Handler	$75,000	$500,000
Field Support Vessel	$50,000	$500,000

Note: costs do not include day rate for drilling crew and consumables