



SPE Global Integrated Workshop Series:
**Maximising Value in Marginal and Brown Fields –
Cost Management**

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Optimising Marginal Field Developments

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Marginal Fields

What parameters define a marginal field?

- Size?
- Location?
- Profit?

A marginal field is any field that is economically challenging

- Definition depends on:
 - Oil or gas prices
 - Fiscal regime in place
 - Hurdle rate/cost of capital for the Operator
- Subjective and not a useful definition for field planning purposes



How do we define a marginal field?

Marginal Field Definition

Marginal fields typically have at least two of the following characteristics:

- Located in Deepwater (>120m water depth)
- Remote from existing oil and gas infrastructure (>150 km)
- Small recoverable volume (<100 Bcf or 20 MMbbl's)
- Compartmented (Low EUR/well) or low well deliverability (permeability in mD or nD)
- High proportion of inert or hazardous components such as N₂, CO₂, H₂S (>10%) or Hg (>50ppm)

Where two or more the characteristics are present in a development we will often find it will be marginal economically

Marginal Field Development Solutions

Development Challenges:

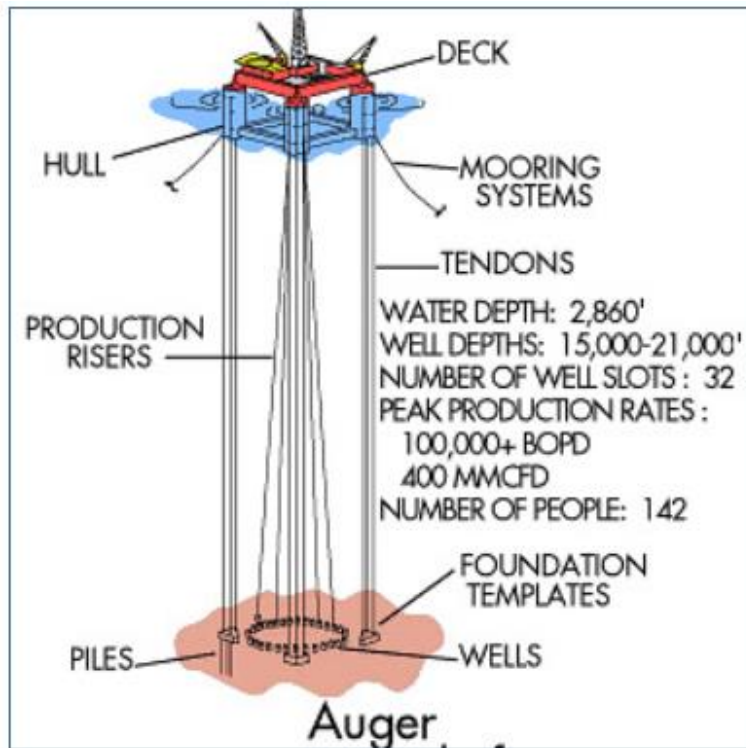
- Located in Deepwater
 - Subsea developments
 - Tension leg platform
- Remote from existing oil and gas infrastructure
 - FLNG/FPSO
 - MOPU
- Small recoverable volume (<100 Bcf or 20 MMbbl's)
 - Minimum facilities development
 - Aggregation of multiple fields
- Compartmented (Low EUR/well) or low well deliverability (permeability in mD of nD)
 - Long horizontal wells/multilateral wells
 - Hydraulic fracturing
- High proportion of inert or hazardous components such as N₂, CO₂, H₂S (>10%) or Hg (>50ppm)
 - Complementary processing (i.e. Methanol, Sulfuric acid)
 - Re-injection/sequestration

Subsea Developments

- Subsea developments are mainly used to access deposits in deep water. Can be short or long tiebacks to processing facilities
- Longest/deepest subsea tiebacks are:
 - Oil; 70km/2900m
 - Gas; 143km/2900m
- Subsea processing and compression are currently in field testing stage of development

	Snovhit	Gorgon/lo Janz	Halyard
Deep Water?	250m+	300-1000m	~60m
Remote?	160km	10km	~20km
Small size?	7 Tcf	20 Tcf+	~30 Bcf
Tight/ compartmented?	No	No	No
Contaminants?	~8% CO2	12%+ CO2	No
Solutions	Long Subsea tieback to shore	Long Subsea tieback to shore	Single well tieback to existing facility

TLP Developments



- Platform capable of drilling in very deep water
- Deepest TLP is Big Foot in 1600m water depth
- All TLP's to date have been installed in the GoM
- Typically used to develop large oil fields in deep water that require many wells (Low EUR/well)

	Mars	Auger Cluster
Deep Water?	1000m+	800m+
Remote?	180km	150km
Small size?	500 MMbbl's	200 MMbbl's +
Tight/ compartmented?	Yes	No
Contaminants?	No	No
Solutions	TLP	TLP and subsea

FLNG/FPSO Developments

- Subsea wells linked to vessel with processing and storage capability
- FPSO is mature technology with hundreds of installations
- FLNG is new technology with multiple vessels under construction
- Typically used to develop small or medium sized oil (or gas) fields in deep water in locations remote from other infrastructure
- Can be leased or owned
- Can be redeployed at end of field life

FLNG	Prelude	PFLNG (Kumang Cluster)
Deep Water?	~300m	80m
Remote?	1000km	180km
Small size?	2-3 Tcf	1-2 Tcf
Tight/ compartmented?	No	Multiple fields
Contaminants?	~10% CO2	No
Solutions	FLNG and subsea	FLNG and cluster development

FPSO	Sealion	Galoc
Deep Water?	~450m	300m+
Remote?	1000's km	200km
Small size?	200 MMbbl's	20 MMbbl's
Tight/ compartmented?	No	No
Contaminants?	No	No
Solutions	FPSO and subsea	FPSO and subsea

MOPU Developments

- Converted Jack-up drilling rig used as processing platform
- Wellheads are installed on the rig
- Derrick often retained but drilling capability is usually removed
- Typically used to develop small oil (or gas) fields in shallow water
- Can be leased or owned and redeployed at end of field life
- Self installing platforms are also now popular as MODU substitutes
- Old rigs/MOPU's can be purchased for as little as US\$20 million

	Maleo	Cendor	Yme	Legendre
Deep Water?	60m	72m+	95m	~50m
Remote?	10km	155km	100km	50km
Small size?	200 Bcf	20 MMbbl's	10 MMbbl's	40 MMbbl's
Tight/ compartmented?	No	No	Yes	No
Contaminants?	No	No	No	No
Solutions	MOPU	MOPU	MOPU and subsea tank	MOPU

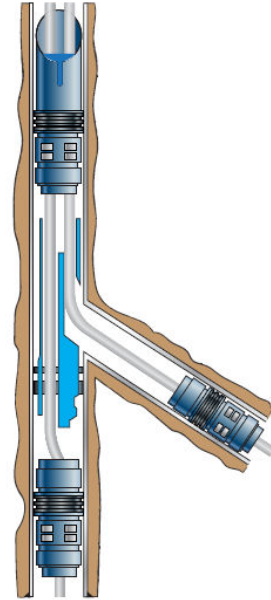
Minimum Facilities Developments

- Generally Wellhead platforms tied back to other facilities
- Typically used to develop small oil (or gas) fields in shallow water near to existing infrastructure
- Many different substructure designs depending on water depth. Innovations include;
 - Conductor platforms (Monopod)
 - Braced conductor legs
 - Guy supported structure
- Can be installed by Jack-up rig in many cases cutting installation costs
- Topsides weight minimised. Aim is to reduce topsides weight by 20-30% from traditional WHP

	Cliff Head	Peluang	Kambuna
Deep Water?	16m	60m	40m
Remote?	11km	10km	46km
Small size?	14 MMbbl's	32 Bcf	150 Bcf
Tight/ compartmented?	Yes	Yes	Yes
Contaminants?	No	No	No
Solutions	MFWHP	MPWHP	MFWHP

Long Horizontal/Multi-lateral wells

- Used to access multiple compartments or to increase well deliverability in tight reservoirs
- Used extensively onshore, particularly for unconventional developments
- Technology has improved significantly in both drilling and completing the wells with quad laterals of up to 1500m length now being used offshore
- Aim is to reduce well costs by 20-30% from traditional wells
- Horizontal section of up to 3km are now being drilled with wells steered to stay in thin sands
- Extended long reach records of over 10km have been set



	Vincent	Al Shaheen	Kambuna
Deep Water?	400m	60m	40m
Remote?	50km	70km	46km
Small size?	100 MMbbl's	100 MMbbl's	150 Bcf
Tight/ compartmented?	Yes	Yes	Yes
Contaminants?	No	No	No
Solutions	Multilaterals	Multilaterals	Long horizontals

Marginal Fields

Marginal fields require innovative thinking

- New technologies have been introduced specifically to enable marginal fields
 - FPSO, 1970's
 - Horizontal drilling + hydraulic fracturing, 1990's
 - FLNG, 2000's
 - Subsea Processing, 2010's
- Marginal field development planning requires close cooperation between subsurface and surface teams
 - Only a collaborative approach will yield the optimum development plan
- Major factors that can improve marginal fields include:
 - EUR/well; Horizontal drilling, multilaterals, optimised well placement
 - Facilities costs; Minimum facilities, eliminate pipelines (FPSO/FLNG/MOPU)
 - New technologies; Long subsea tiebacks, subsea processing



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