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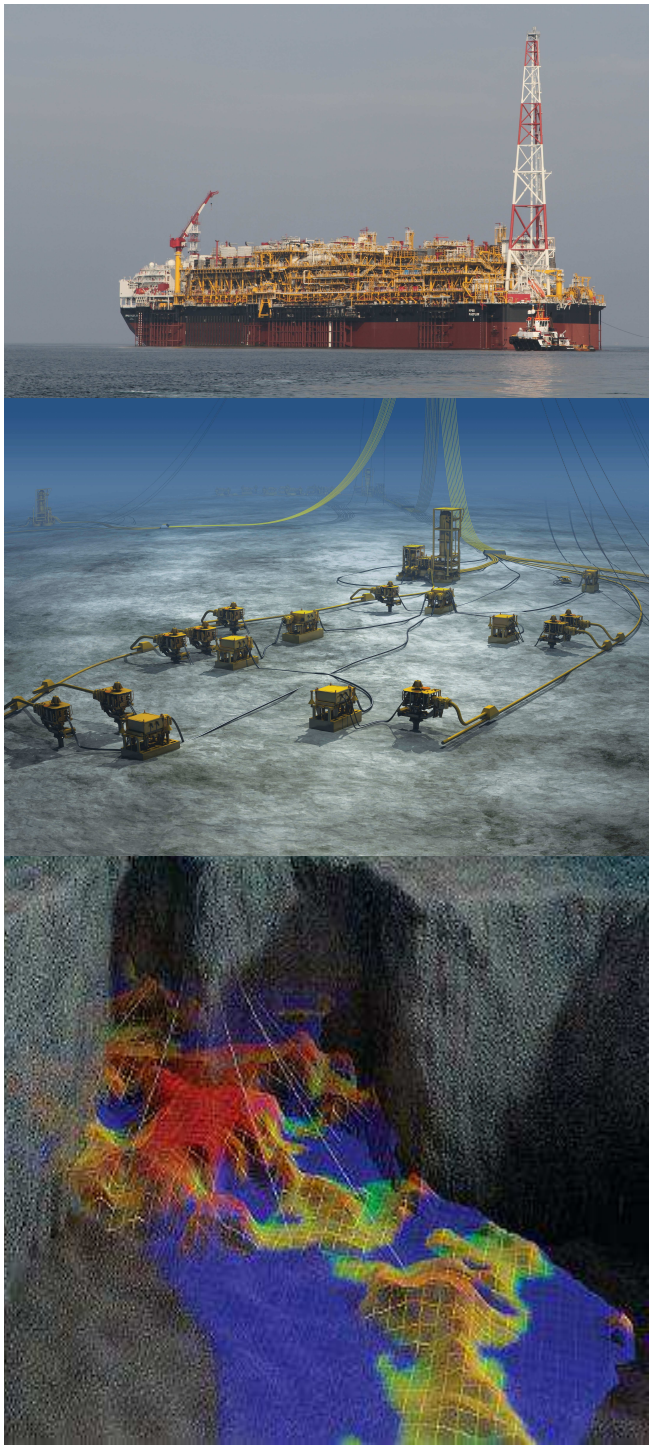
Deep offshore – a story of innovation



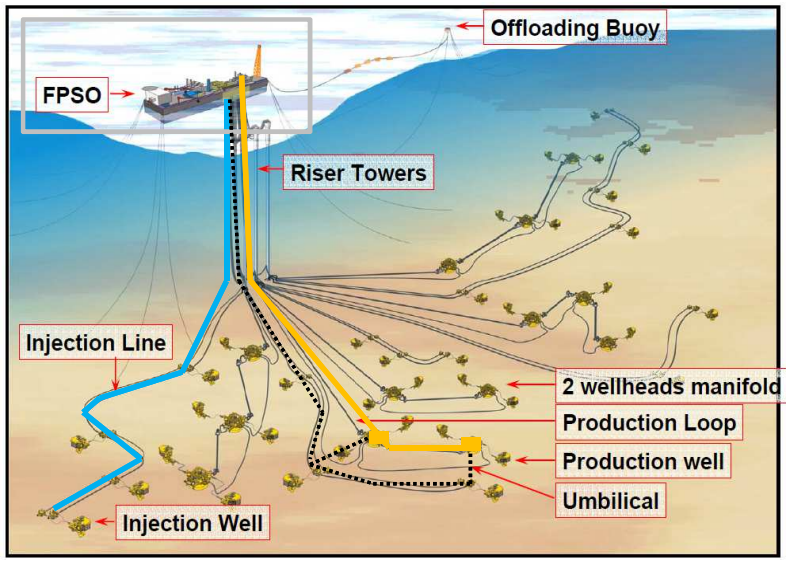
Philippe Muguerra

Subsea Factory Engineering - Innovation and conceptual study

Friday 22nd of January 2016

Deep offshore – a story of innovation

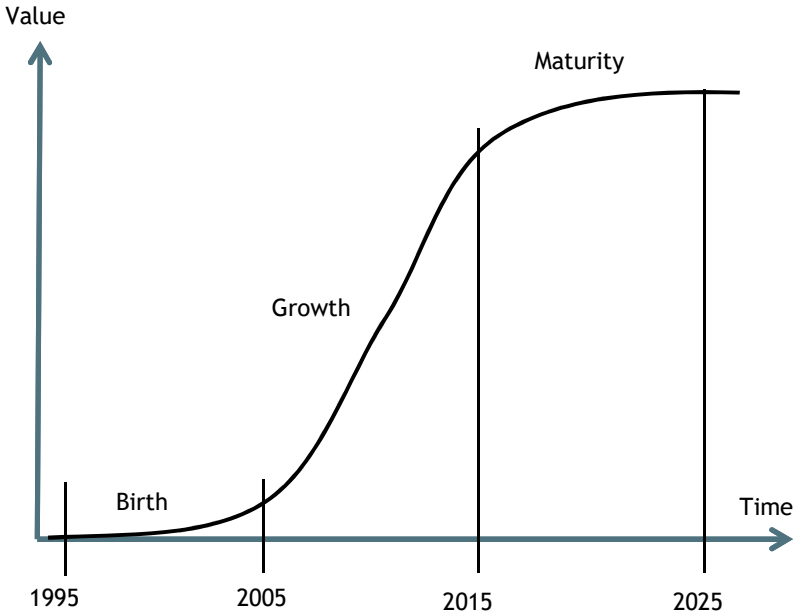
The Deep offshore « product »



Deep Offshore Typical Development scheme

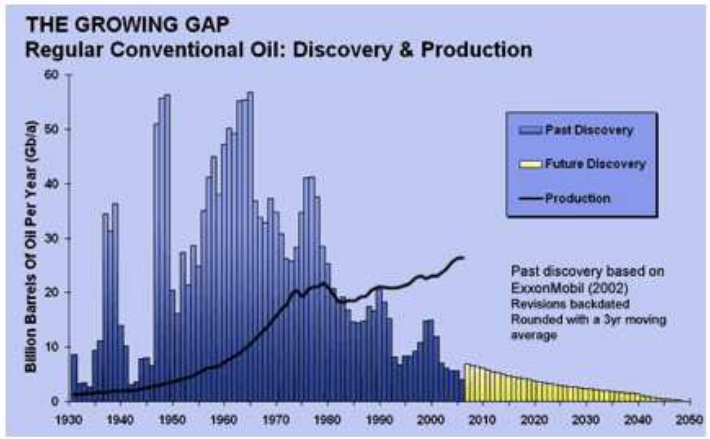
Deep offshore development can be considered like other product.

Since the beginning in 1990, it has grown, evolved following the market trends and technology development.



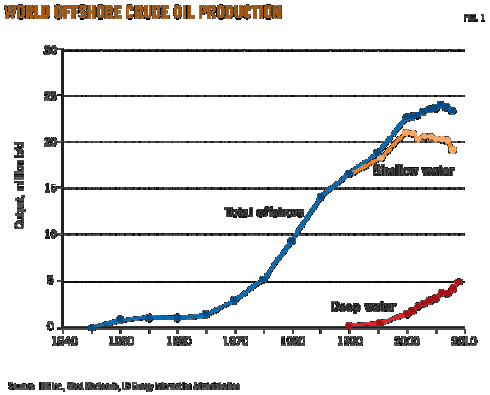
Deep offshore - a story of innovation

1995 - 2005: Birth - Context



Big and simple oil discoveries has been done
More difficult areas are in prospection in 1990 such as deep offshore

Political crisis in Middle East force countries to diversify their oil supply



DEEP WATER APPEARS TO BE THE NEW FRONTIER FOR OIL PRODUCTION

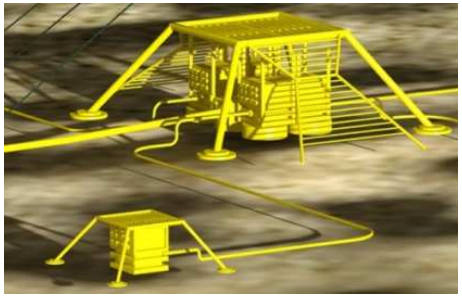
Deep offshore – a story of innovation

1995 – 2005: Birth – Challenges and innovations

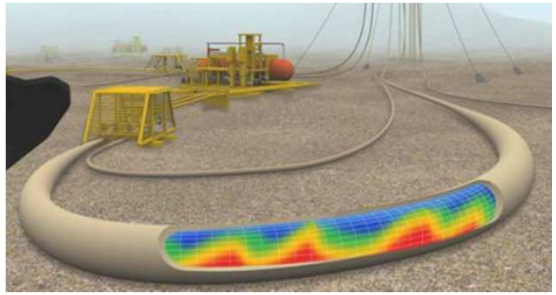
Master a harsh environment:

Offshore operation: Develop vessel and tools to build subsea network at 1500m WD

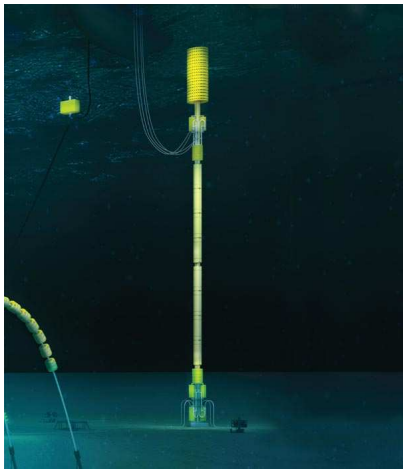
Floating offshore production development:
- Compacity
- Safety
- Autonomy



Subsea well heads:
- Safety
- Inspection
- Control



Flow assurance and subsea operation:
- Multiphase flow export
- Thermal management - Mitigation of Hydrate formation
- Transient operation: shut down and start up definition

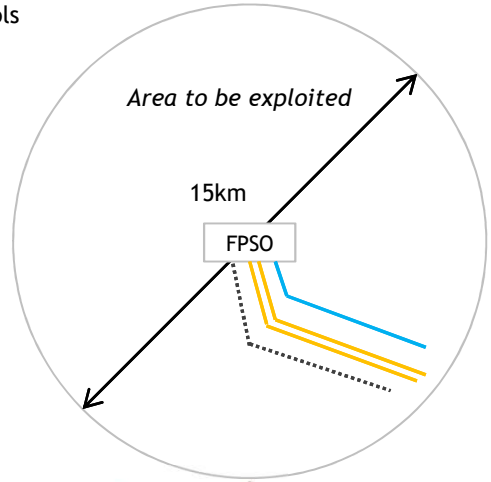


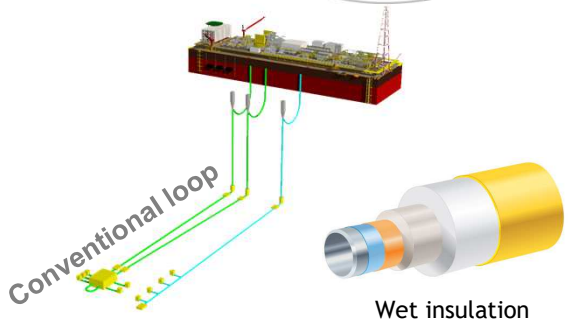
Riser development:
- Mechanical design to resist to fatigue
- Hydrodynamic
- Buoyancy and mooring

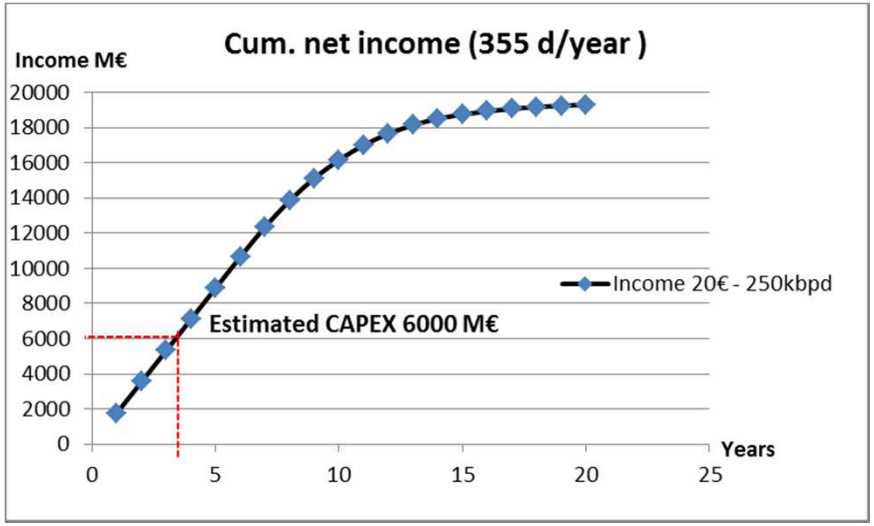
Deep offshore - a story of innovation

1995 - 2005: Birth - Project type

Big Reservoir - 650 Mbbls
Concentrated <230km2
Water depth < 1500m







Even with a barrel price at 20€ the project is profitable

Subsea architecture - 5 conventionnal loop (50kbpd production each)
- Subsea trees
- Two production lines: robustness / flexibility / preservation
- 10km max length : wet insulation to avoid hydrate
- small diameter to ease installation
- Gas lift for late life production

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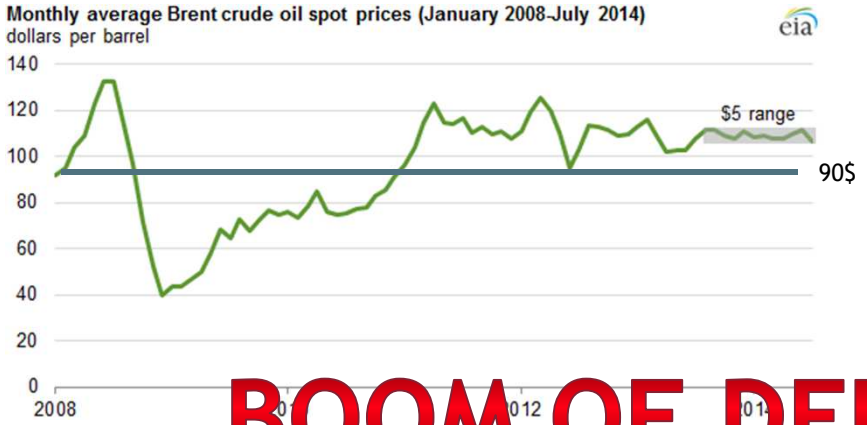
Deep offshore – a story of innovation

2005 – 2015: Growth - Context

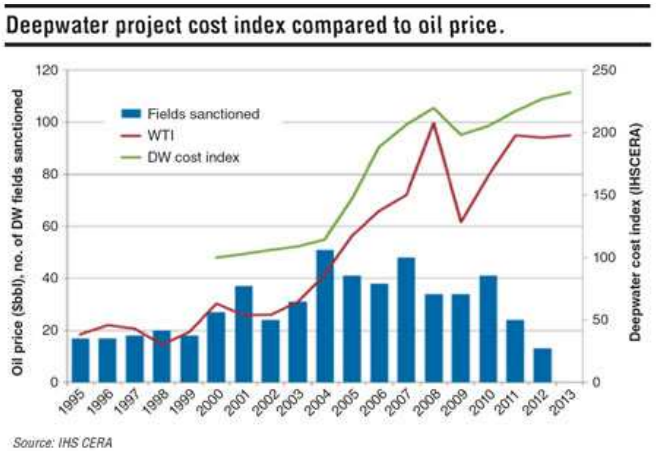


BOOM OF DEEP OFFSHORE

High Barrel price

Boom of offshore development

High risk – Deepwater horizon 2010



Prices are increasing due to a high demand of companies for deepwater services
High risk of operations implies higher rate standard and regulations which as a cost
Countries wants to benefit from the deepwater ressources exploitation : higher taxes and local content requirements

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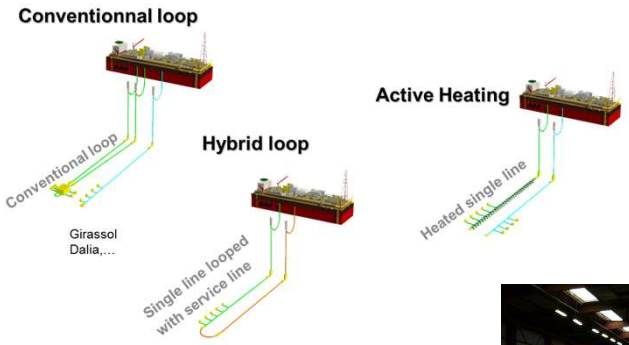
Offshore field development

2005 – 2015: Growth – Challenges and innovation

Invest for the future:

Increase tie back length up to 50km at the same cost



Enhance recovery

Subsea separation

Susbea boosting

Figure 3: Åsgard Subsea Compression Train – Process System with Structure
Courtesy: Aker Solutions

Subsea compression

Increase Installation vessel capabilities

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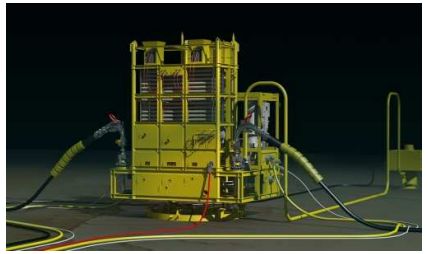
High performance insulation

Facilitate brownfield development



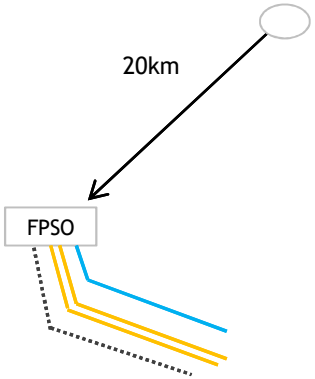
Subsea water treatment

Subsea electrical equipment

Deep offshore - a story of innovation

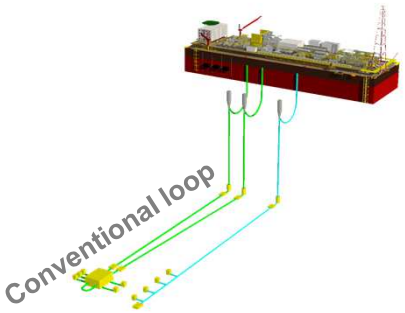
2005 - 2015: Growth - Project type - Brownfield

Small Reservoir - 350 Mbbls
Dispersed but near a mature facility
Water depth < 1500m



With decrease of production of asset developped during birth age, development of tie back to existing facilities enables to keep production at a good level with a low CAPEX investment.

Such type of project are exceeding the 10km achievable with wet insulation and required the development of new insulation technology
Such as Pipe in Pipe



Dry insulation (PiP)

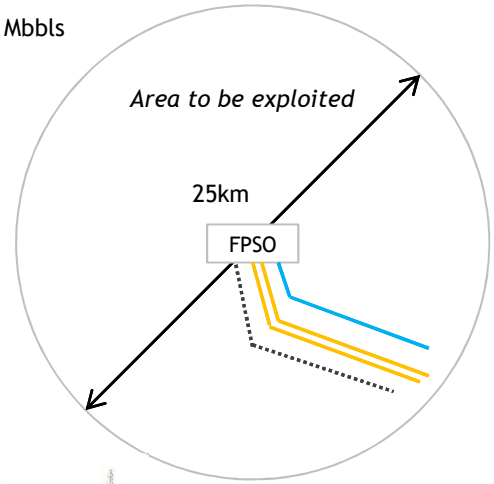
Subsea architecture - 1 conventionnal loop
- Subsea trees
- Two production lines: robustness / flexibility / preservation
- **20km max length : Dry insulation (PiP) to avoid hydrate**

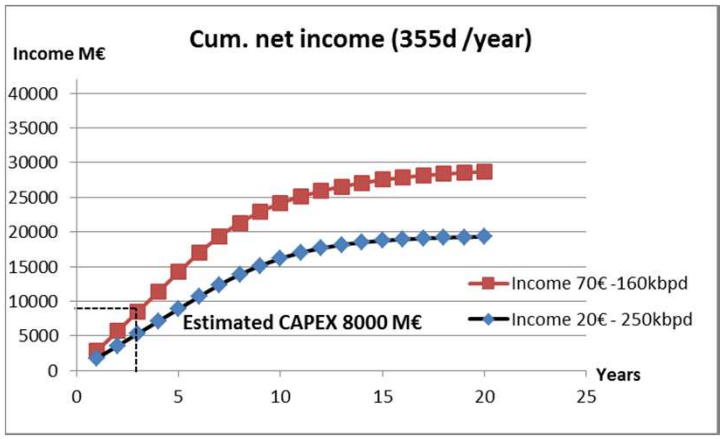
Offshore field development

2005 – 2015: Growth – Project type - Greenfield

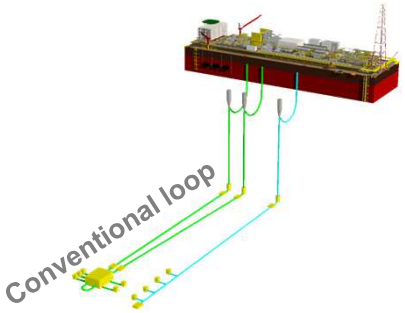
Higher Complexity
Higher Technological requirement

Medium Reservoir - 500 Mbbls
Dispersed <400km2
Water depth < 1500m

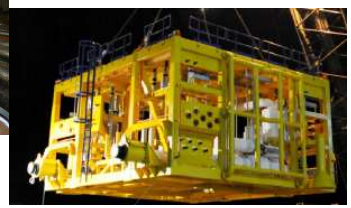




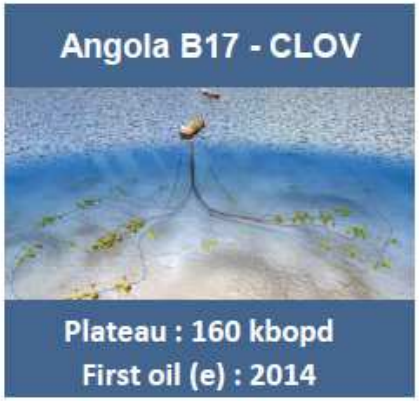
Profit are higher than during birth age enabling high investment
In knowledge and technologies.



Dry insulation (PiP)



Subsea Multiphase pump

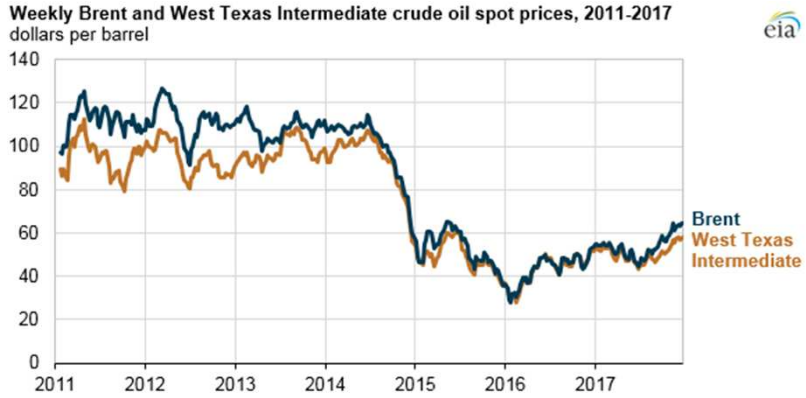


Subsea architecture – 3 conventionnal loop (50kbpd each)

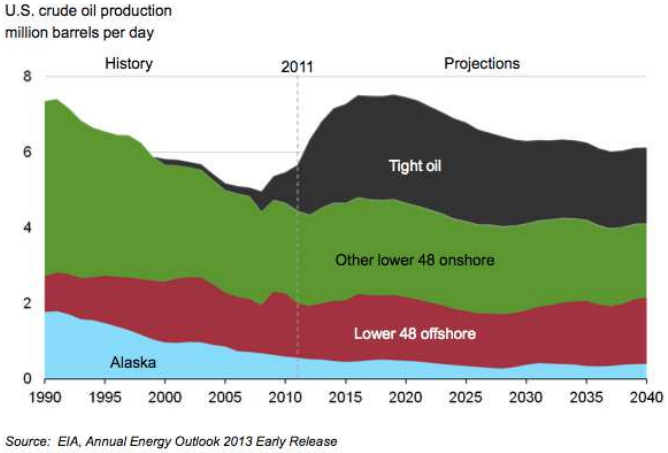
- Subsea trees
- Two production lines: robustness / flexibility / preservation
- **20km max length : Dry insulation (PiP) to avoid hydrate**
- **Subsea multiphase pump to enhance production**

Deep offshore – a story of innovation

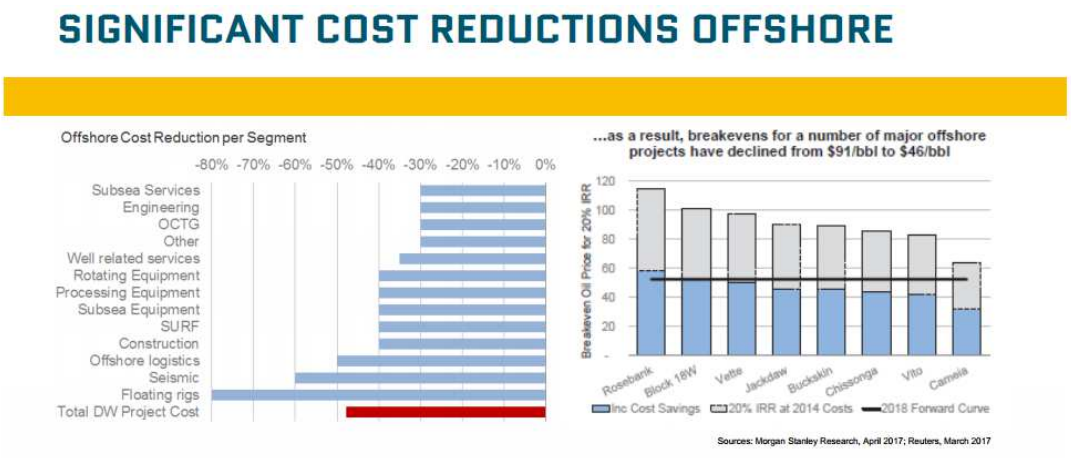
2015-2025? – Maturity - Context



Fall of the oil barrel price – End of the growth period for deepwater



A new competitor : the tight oil revolution in the U.S

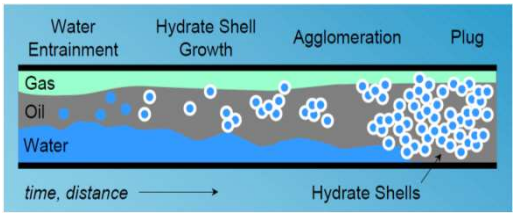


The deepwater industry shall change and reduce its cost – the end of golden age ?

Deep offshore – a story of innovation

2015-2025? – Maturity – Challenges and innovations

Be smarter, accurate and cheaper:



Hydrate formation mechanism

Reduce margin by increasing knowledge

Enhance Synergies and Collaboration

Standardization

Participate to Energy Transition

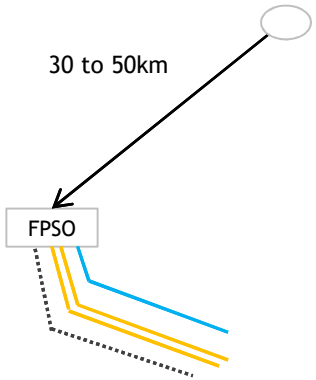
Digitalization and Robotisation

Enhance local development

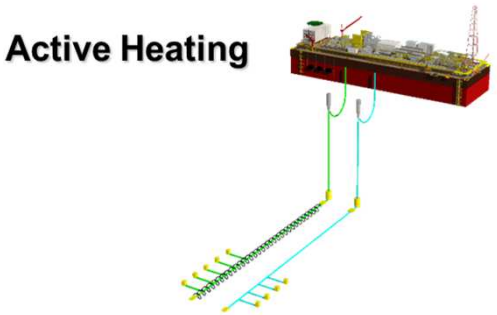
Deep offshore – a story of innovation

2015-2025? – Maturity – project type – Brownfield

Small Reservoir - 350 Mbbls
Dispersed – higher distance than in the past
Water depth < 1500m



In a low oil price context, tie back to existing facilities appear to be the most profitable solution. The new discovery are located at long distance from existing facilities and then new development scheme and technologies are required.



Heat traced PiP

Direct electrical heating

Facilitate connection to existing facilities thanks to subsea processing technologies

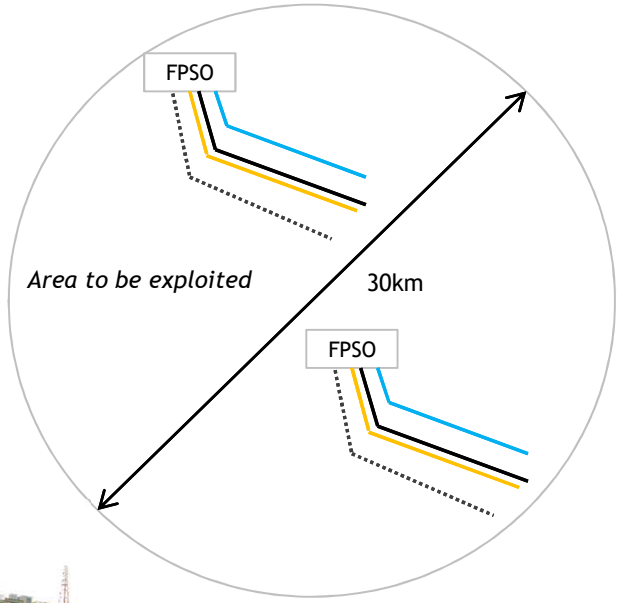
Subsea liquid/liquid separation

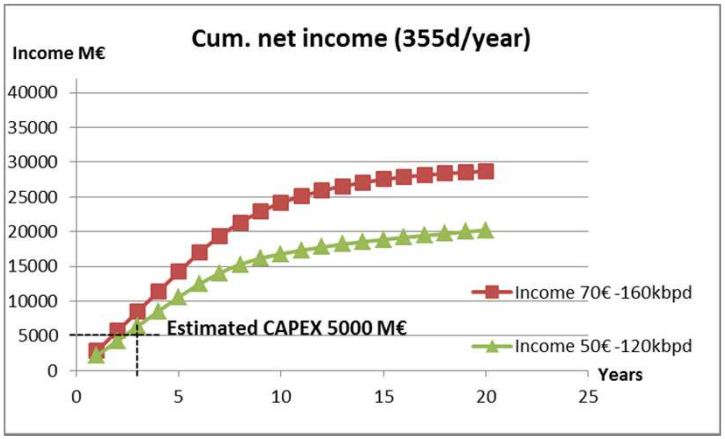
Deep offshore – a story of innovation

2015-2025? – Maturity – project type – Greenfield

Small Reservoir – 2 x 330 Mbbls
Very Dispersed <800km2
Water depth >1500m

Higher Complexity
Higher Technological requirement

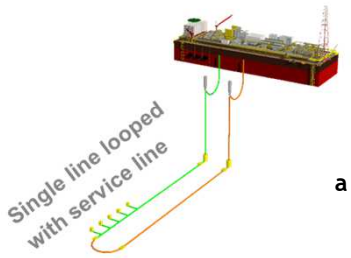




The target CAPEX shall be lower than during the birth area with higher complexity.

CAPEX is a real challenge and the solution shall be optimized as much as possible.

Hybrid loop



Simplify subsea network thanks to a better understanding of multiphase flow

Standardized floating unit / revamping of an existing hull

Modify Subsea architecture – 3 hybrid loop (50kbpd each)

- Subsea trees
- One production lines and one service line
- 30km max length : Dry insulation (PiP) to avoid hydrate and wax

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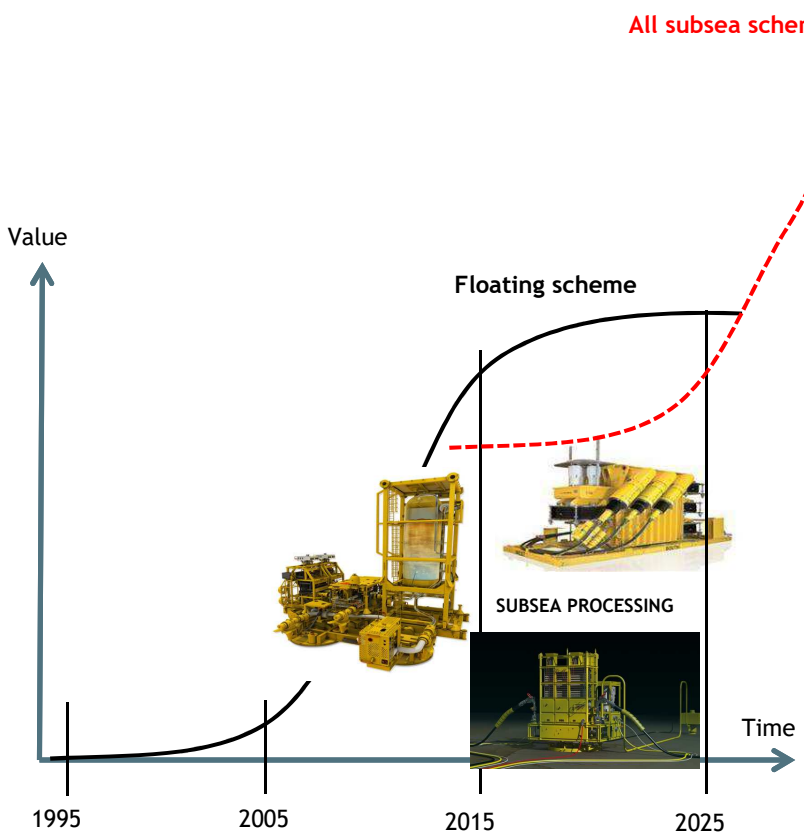
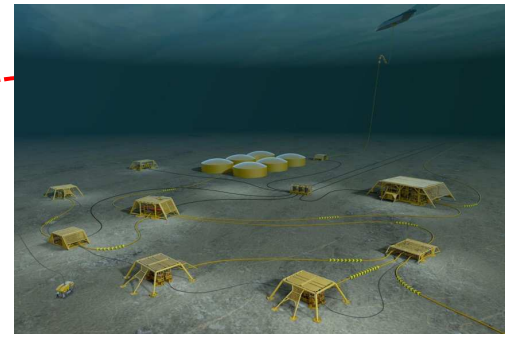
Deep offshore - a story of innovation

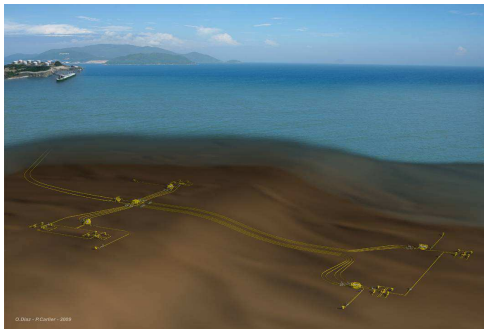
Conclusion

A long story since the beginning of the offshore industry with a lot of innovation but …
Maybe also the starting point for a new journey…





Subsea Factory



Tie back to coast 150km without floating unit

Tie back to coast (>100km)