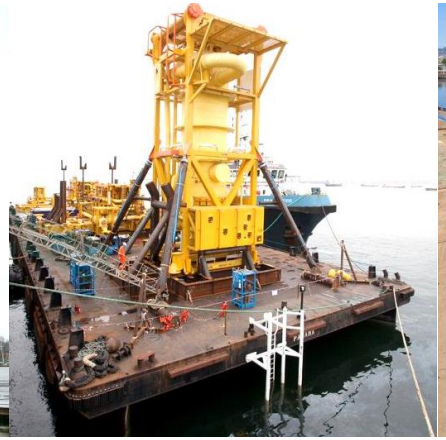
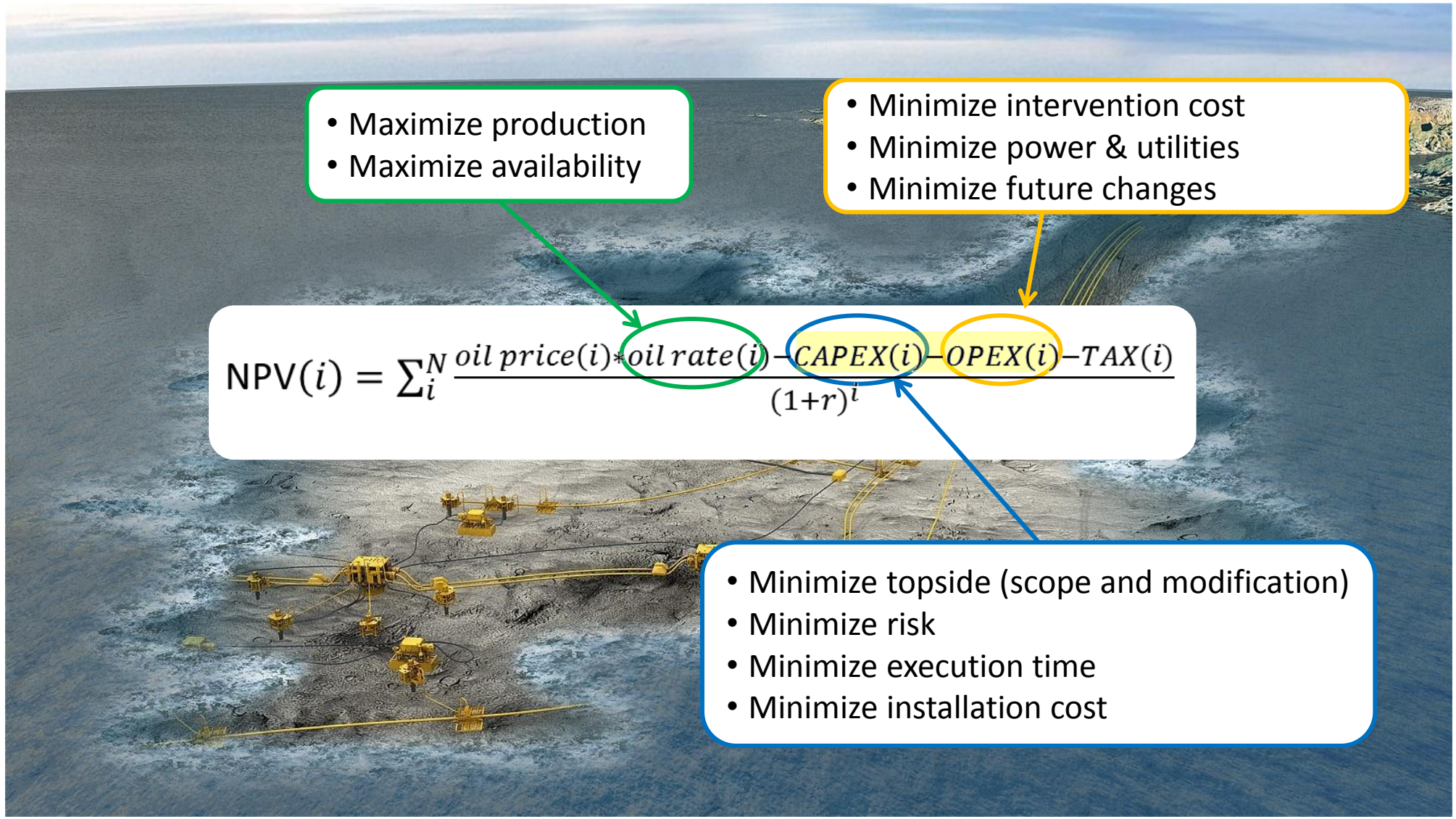
How to select the separation solution to maximize the economics of a subsea development

Amandine Idrac

FMC Technologies

Maximize the value proposition



Selection Principles

$$\mathrm{NPV}(i) = \sum_i^N \frac{oil\ price(i) * oil\ rate(i) - CAPEX(i) - OPEX(i) - TAX(i)}{(1+r)^i}$$

Low Cost

- Simple system
- Optimized Installation

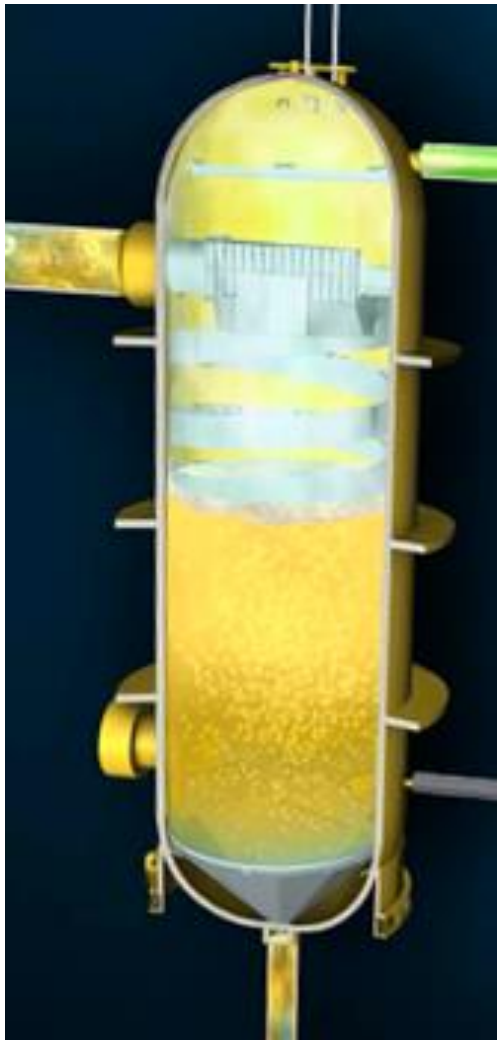
High Maturity

- Low technical risk
- Low development cost

High Availability

- Robustness
- Flexibility
- Simplicity

Deep waters – down to 1000-1500m



Cost optimization

- No reject stream
- Simple control system (large volume)
- Large, heavy

High Maturity

- Field Proven

High Availability

- Robust
- Flexible
  - Good slug handling
  - Infinite turndown
  - Large operational envelope

~99.8% uptime

Maximized Asset Value

Ultra Deep Water Challenges

High external pressure
High shut in pressure

→

Higher vessel design pressure
= Increase vessel wall thickness

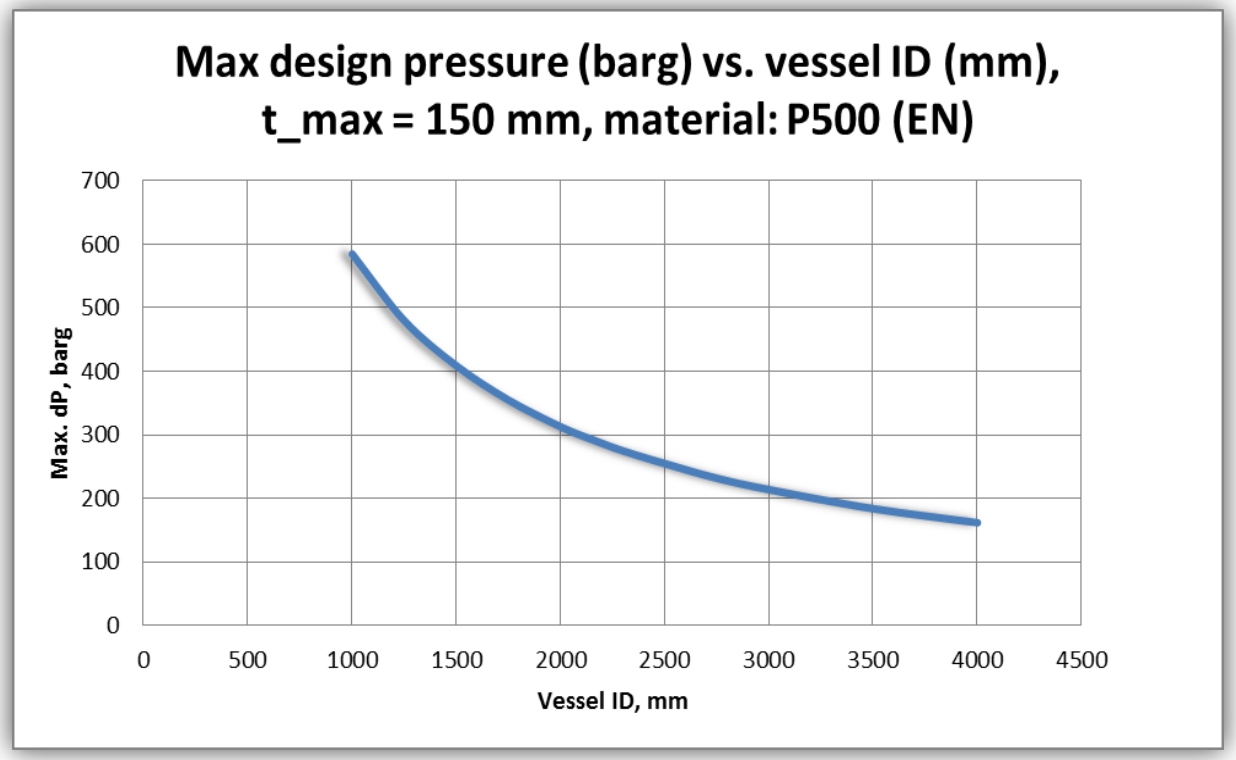
→

Mechanical constraints
Fabrication challenges
Installation limitations

What is the limit?

→ Depends on

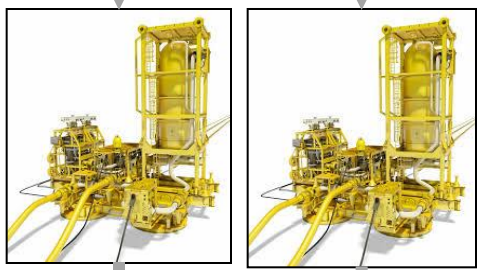
- Design Pressure
  - Shut-in pressure
  - External pressure
  - Subtracting external pressure
- Vessel diameter



Solutions for Ultra Deep Water

Option 1: Parallelisation:

From wells



Cost optimization

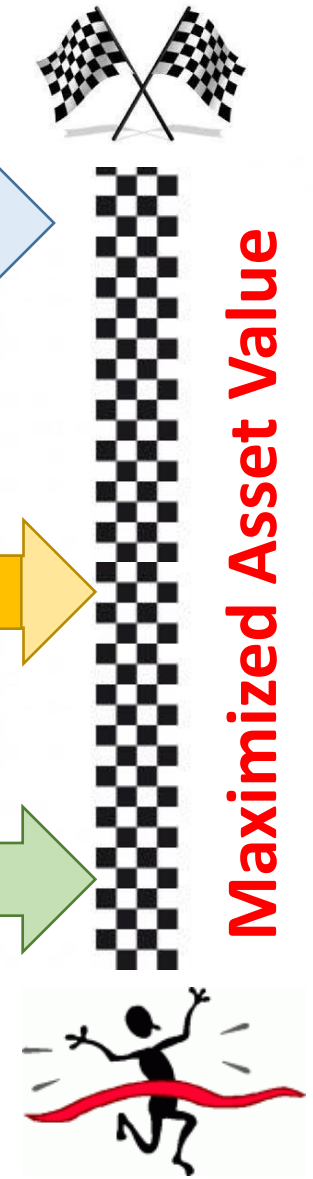
- Increased complexity
- Extra equipment, structure..
- Extra installation requirements

High Maturity

- Field Proven
- Reduced technical risk

High Availability

- Robust & flexible
- Parallel trains

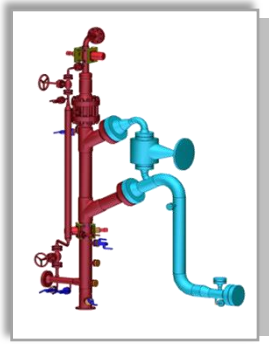


Solutions for Ultra Deep Water

Option 2: Introduce G forces => Compact equipment

Gas Unie

- Based on field proven solution, similar system solution
- High allowable gas load up
- Less slug capacity

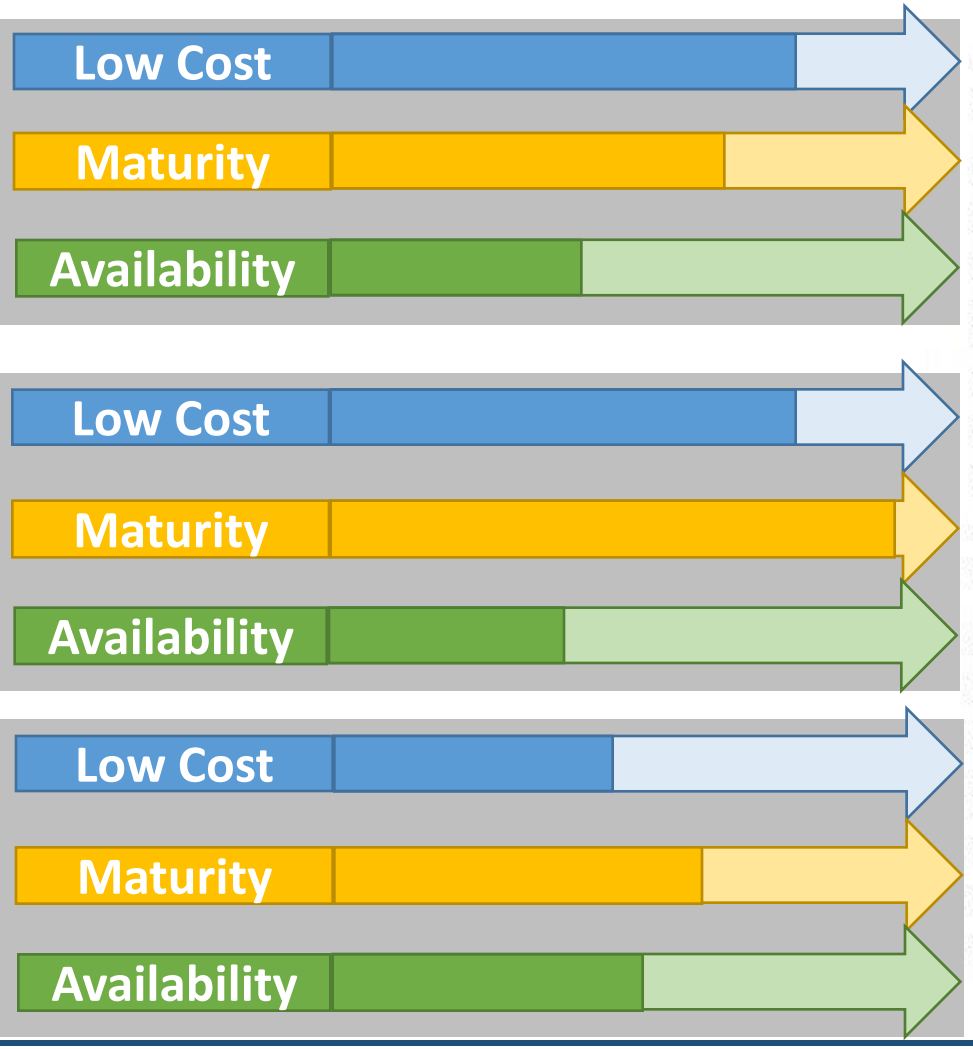


GLCC

- Installed subsea
- Less slug capacity
- Requires fast acting control system

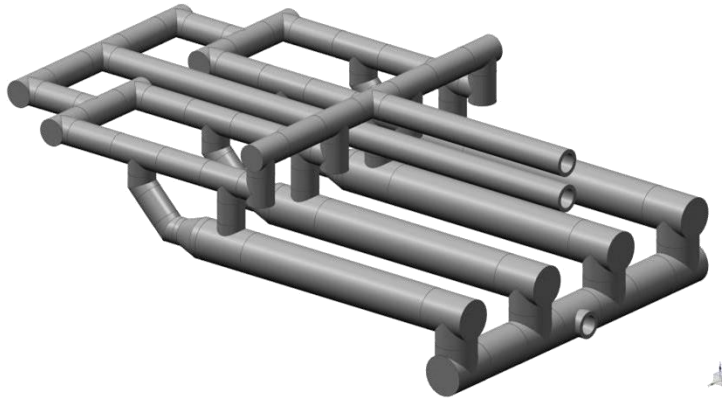
System combining Inline Equipment

- System tested
- Increase system complexity
- Less slug capacity
- Requires fast acting control system



Solutions for Ultra Deep Water

Option 3: MultiPipe



- Developed through engineering and CFD
- Proof of concept in lab at low and high pressure
- Ongoing qualification

Cost optimization

- Low complexity
- Large footprint
- Extra installation requirements

Lower Maturity

- Under development (prototype tested, TRL3)
- Gravity separation well known

High Availability

- Slug tolerant
- High turndown

Maximized Asset Value

Summary

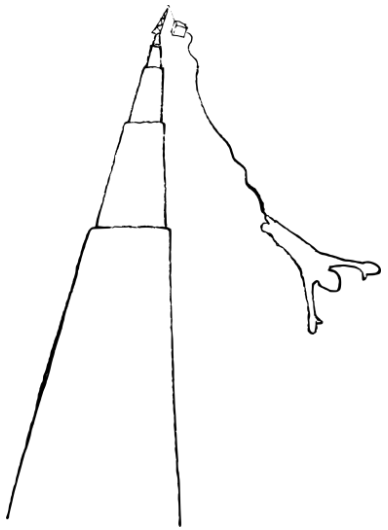
- A generic methodology has been presented – does not remove need for case specific study

- Economic attractivess does not only depend on low hardware cost

$$\mathrm{NPV}(i) = \sum_i^N \frac{oil\ price(i) * oil\ rate(i) - CAPEX(i) - OPEX(i) - TAX(i)}{(1+r)^i}$$

- Use of field proven equipment when feasible helps to bring costs down

- Getting to more challenging areas as deep water, new technologies have to be cost effective
    - Technologies are available
    - Economic attractiveness often suffer from high financial penalty accounting for technical risk



Perceived risk
vs.
Real risk