

KBR



We Deliver

A large, stylized globe composed of a grid of small white dots on a gray background, centered behind the text.

**Engineering
&
Construction**

**FLNG Global
2018**

**FLNG Economics
What drives CAPEX?**

Andy Loose

KBR Overview



A leading global provider of full life-cycle professional services, project delivery and technologies supporting the Government Services and Hydrocarbons markets, creating exceptional value for customers, employees and shareholders.



**Life-cycle
Professional
Services**



**Disciplined
Project Delivery**



**Technical
Differentiation**



**34,000+
People**



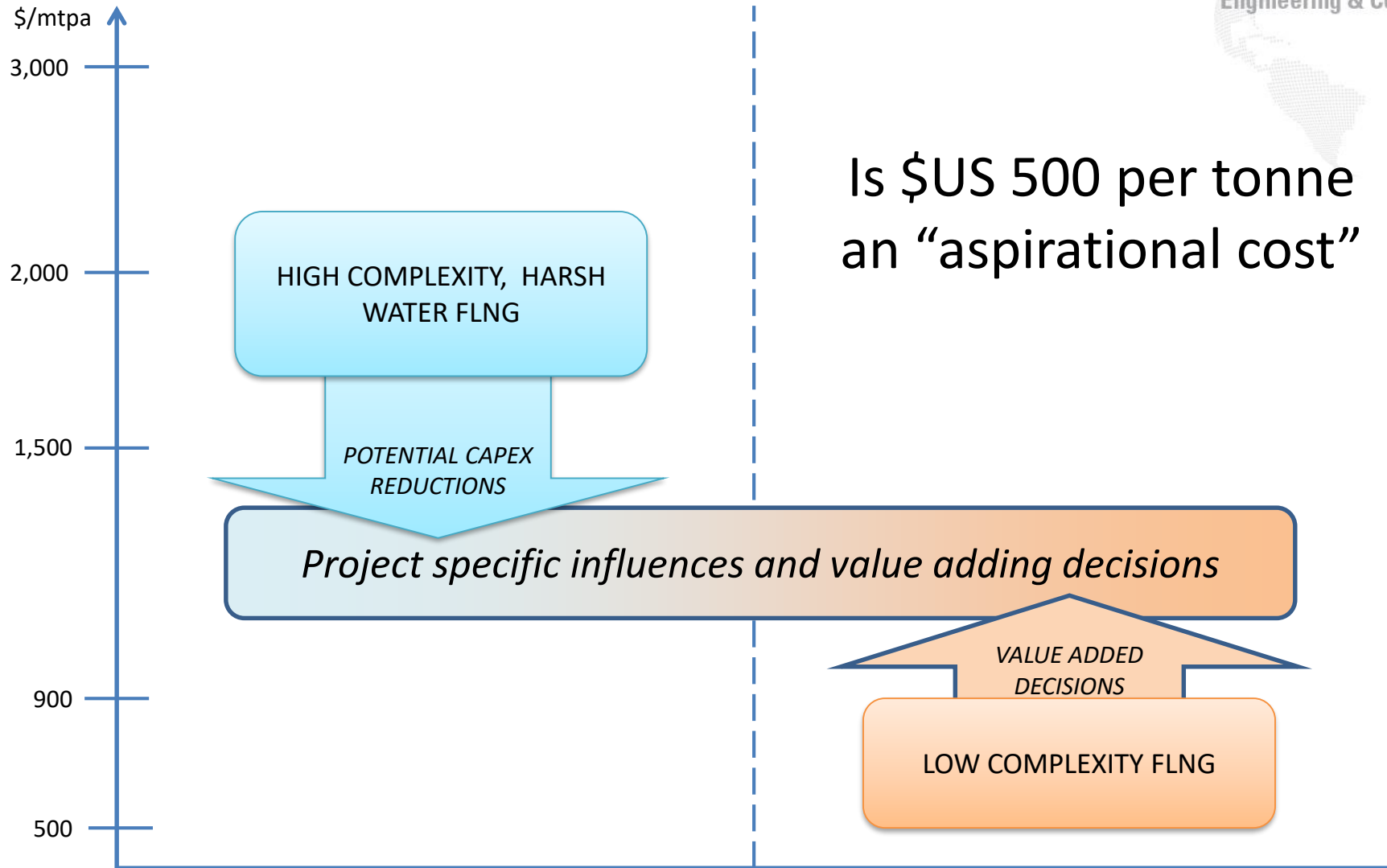
**40+
Countries**



**Industry-leading
Safety Record**

2016 revenue was \$4.3 BB

CAPEX – The \$/mtpa Question



Not all FLNG Projects are Created Equal

Engineering & Construction

The “Complex” solution



The “Novel” solution



The “Simple” solution



The “Arctic” solution



FLNG/FSRU Cost Make-Up



- Topsides
- Hull and LQ
- Turret and Moorings
- Other Infrastructure
- SURF
- Transport and Installation
- Commissioning/Start-Up
- Project Risk and Contingency
- Ongoing Operations and Maintenance



FLNG CAPEX Influencer

Engineering & Construction

TOPSIDES

- Gas composition
- Specs & standards
- Process selection
- Environment
- Equipment reliability
- Inherently safe design
- Fabrication yard location

HULL

- New build vs. conversion
- Metocean environment
- Specs & standards
- Field life – 10, 20 or 30 years
- Storage volumes
- Containment type
- Offloading system
- Fabrication yard location
- Winterization

MAINTENANCE & OPERATIONS

- Location – nearshore or offshore
- Support base
- Sparing philosophy
- Availability
- OPEX vs CAPEX
- POB & mechanical handling

TURRET AND MOORINGS

- Metocean environment
- Nearshore or Offshore
- Internal or External
- Spread mooring
- Breakwater / Ice Protection

CONTRACTING STRATEGY & FINANCE

- Lease or Owner Operate
- Financing basis
- EPC execution strategy
- Local Content requirement
- Lowest CAPEX or \$/mtpa

RISK

- Risk and Contingency allocation
- Completion Guarantees
- Performance Guarantees
- Facility Damage and Defects

SURF

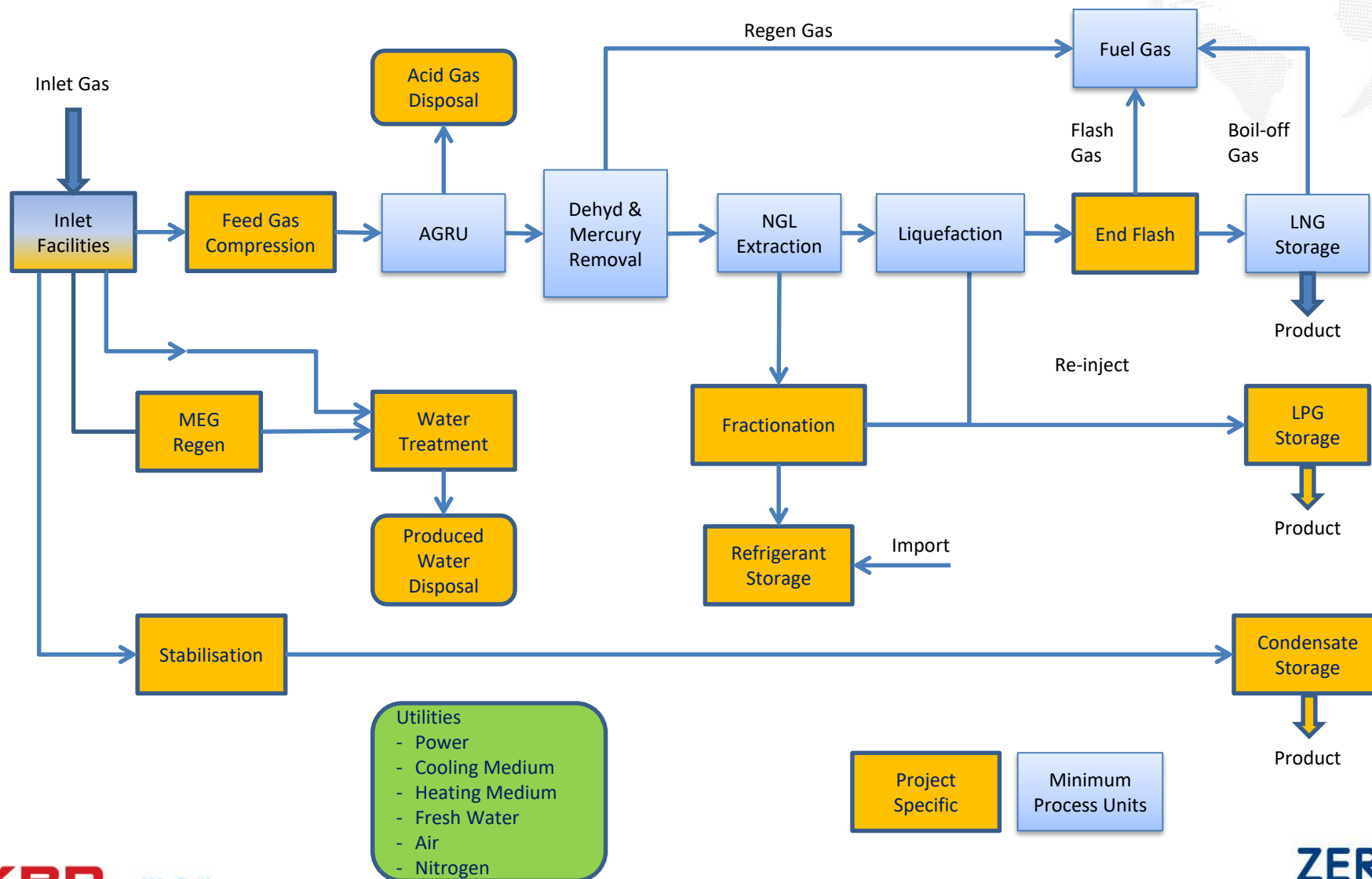
- Field architecture (or onshore pipeline)
- Flow assurance
- Depth / Liquids / Hydrates

BATTERY LIMITS

- What's included?

CAPEX Drivers: Process and Gas Composition

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FLNG CAPEX Drivers

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| Trends toward higher CAPEX | Trends towards lower CAPEX |
|--|--|
| Net Present Value (NPV) driven | Lowest CAPEX driven |
| High availability | Lower availability |
| Higher process efficiency | Lower process efficiency |
| Difficult metocean / geotechnical | Simple metocean / geotechnical |
| Complex mooring / site | Simple mooring / site |
| Deep water / offshore | Shallow water / nearshore |
| Richer / complex gas composition | Leaner / simple gas composition |
| Highly specified O&M philosophy | Basic O&M philosophy |
| Company specifications compliance | Recognizing industry standard |
| Experienced lower risk fabrication centers | Low cost higher risk fabrication centers |
| Tightening of environmental discharge limits | Simple compliant disposals |
| Contractor takes all the risk | Company carries all risks |
| Optimized parcel size and logistics | Suboptimal parcel size and logistics |

FSRU – Comparison with Onshore

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FSRU advantages versus

- Fast track implementation
- Usually Chartered
- Lower capital cost
- Reduced project execution risk
- Easier permitting
- Re-deployable

Onshore terminals advantages

- No limit on storage or regas capacity
- Good economics over longer term
- Owner managed
- No restriction on LNGC size



Hoegh Independence FSRU



Onshore Terminal

3 x 150,000m³

FSRU CAPEX Influencer

Engineering & Construction

TOPSIDES

- Gas send out rate
- Regas system – seawater / air / steam
- Gas specification
- Retrofit or newbuild

JETTY/ MOORINGS

- Metocean environment
- Atshore by jetty or nearshore mooring
- Existing harbor / port
- Breakwater protection requirements
- Dredging

HULL

- New build or conversion
- Level of refurbishment
- Metocean environment
- Storage volumes
- Ship systems or dumb barge
- Loading/Offloading system – rigid arms / hoses / other

CONTRACTING STRATEGY & FINANCE

- Own, Lease or Tolling
- Duration of supply contract
- Financing basis
- Link to Power Project
- Local Content requirements

MAINTENANCE & OPERATIONS

- LNGC fleet size
- Frequency of LNG supply
- Need for dry docking
- Number of personnel

RISK

- Risk and Contingency allocation
- Performance Guarantees
- Facility Damage and Defects

PIPELINES

- Pipeline to shore?

BATTERY LIMITS

- What's included?

Conversion or New Build

Engineering & Construction

| Factors | LNG Carrier Conversion | New-build FSRU |
|--------------------------|---|--|
| Vessel Storage | ~130,000-150,000 m ³ | Up to 300,000 m ³ |
| Send Out Rate | 1.7-3.4 mtpa / 200-400 mmscfd | 5-6 mtpa / 600–700 mmscfd |
| Vessel Design Life | <ul style="list-style-type: none"> - Life extension works - Additional maintenance for ageing facility | Designed and built for intended service and design life |
| Vessel Design and Layout | <ul style="list-style-type: none"> - Challenges incorporating new equipment into existing vessel - Compromised layout | <ul style="list-style-type: none"> - Purpose designed - Uncompromised layout |

Mitsui OSK FSRU “Challenger”

Delivered Oct 2017 to Turkey

Capacity 263,000m³ – world’s largest.

≈4 MTPA LNG, 540 mmscfd gas.

Can take full cargo from Q-Flex class

LNGC 210,000m³



Conversion or New Build

Engineering & Construction

| Factors | LNG Carrier Conversion | New-build FSRU |
|----------|------------------------|----------------|
| Schedule | ~18 months | 27 – 36 months |

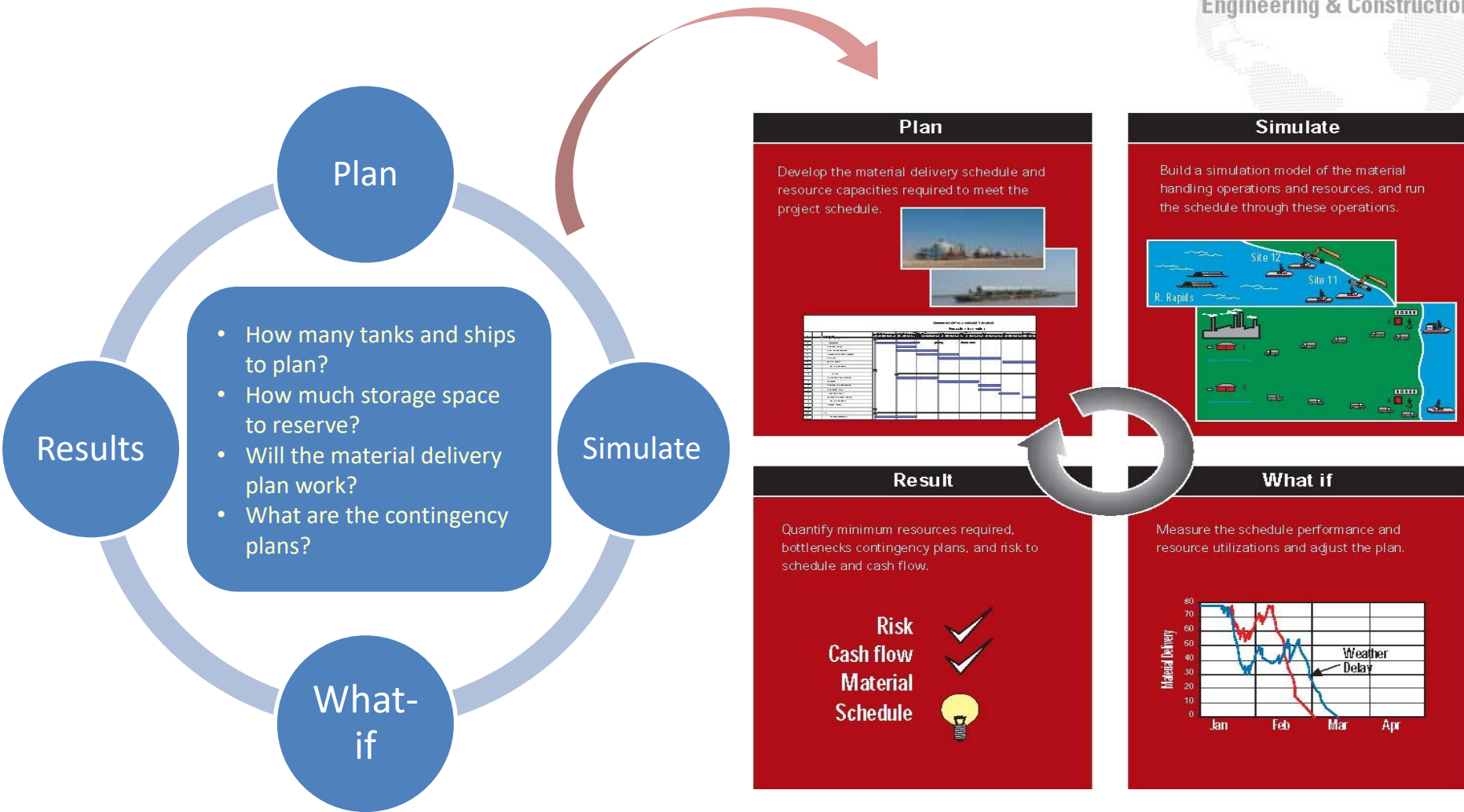
- Is the vessel readily available for conversion?
- Are shipyard slots available?
- Can the infrastructure be completed in time?
- Are local authorities aligned with project objectives?

| Factors | LNG Carrier Conversion | New-build FSRU |
|---------------|---|-----------------|
| Costs - CAPEX | ~\$230M (~\$150M vessel + ~\$80M conversion) | \$240M - \$300M |

- An older tanker will be cheaper
- Competition between shipyards may reduce conversion costs but also reduces new-build cost

FSRU Logistics Modelling

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LNG and The Great Reformation – The Players

(Paper by Chris Caswell, KBR at Gastech 2017)

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- **Reformers** see project CAPEX trending very high
 - New projects must have drastic cost reductions from current levels to support sanction
 - Cost targets (\$US/tonne) are set well below projects currently in EPC as recent project costs cannot be tolerated
 - Change must be visionary and occur now
- **Traditionalists** are also keen to reduce costs, but see history differently than the Reformers
 - Projects are site specific and recent results do not indicate a permanent shift in unit cost
 - CAPEX is a function of reliable project data, sequential engineering, and project execution strategy
 - Unrealistic targets derail development planning

- Not all Projects are created equal
- Many factors influence CAPEX and it is site specific
- Understand the key CAPEX drivers for your Project
- Learn from the lessons of the past, proper planning is critical

Questions?

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LNG EXPERIENCE + **FPSO** EXPERTISE = INOVATIVE **FLNG** DESIGNS