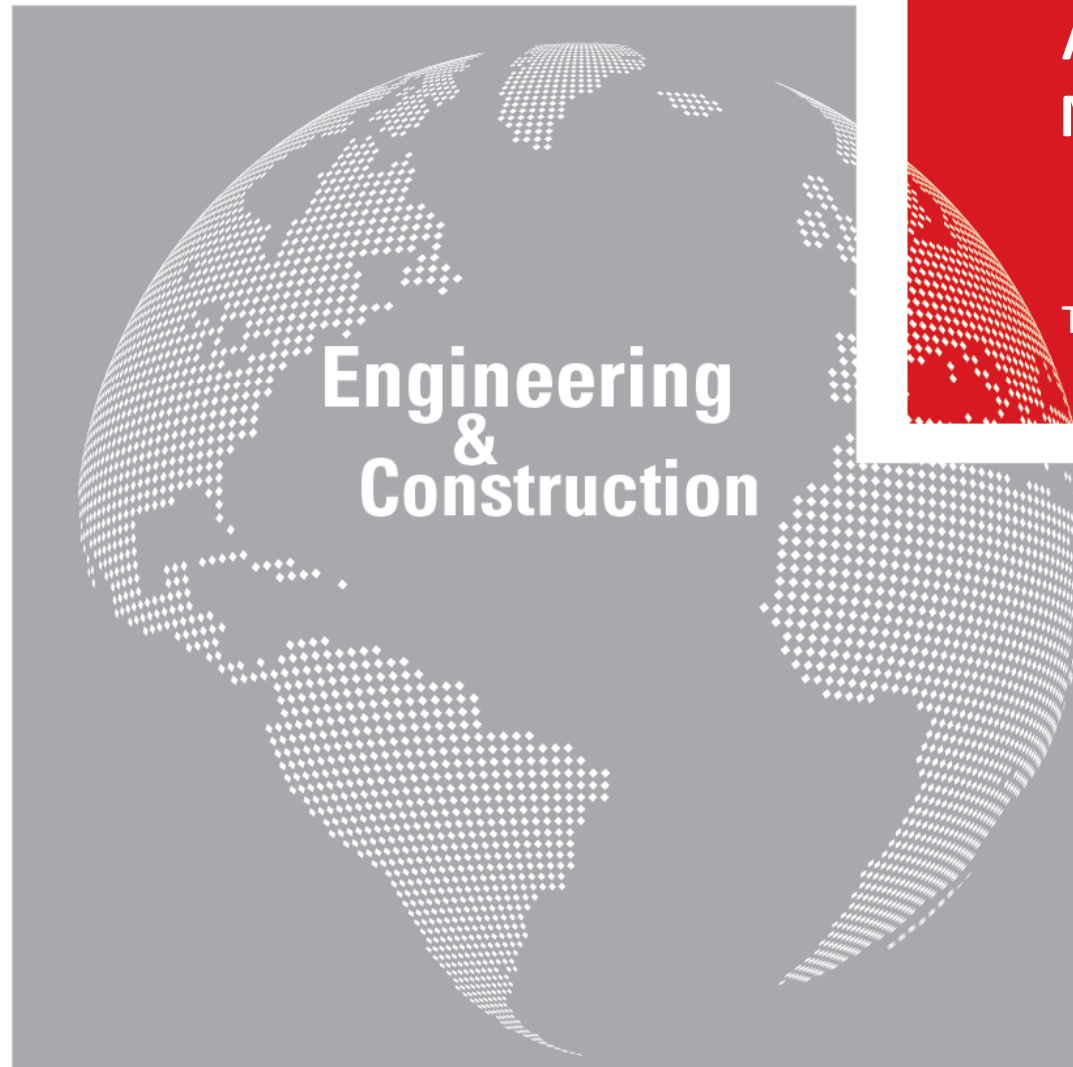


KBR



We Deliver



FLNG Economics What drives CAPEX?

**Amsterdam
March 2017**

Andy Loose
Technical Director
FLNG and LNG

FLNG So Far....Not all Projects are created equal

Engineering & Construction



Shell Prelude FLNG



Exmar Caribbean FLNG



Petronas FLNG 1



Golar Conversion FLNG

LNG and The Great Reformation

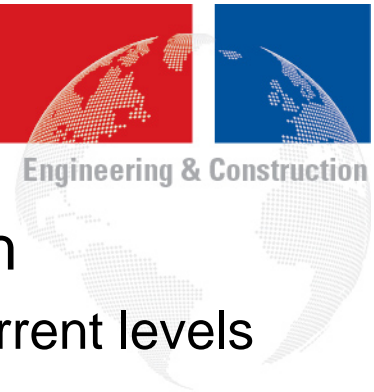
(Paper by Chris Caswell, KBR at Gastech 2017)



- In recent years, the capital cost (CAPEX) of LNG projects is viewed to be radically expensive
 - Proposed LNG projects are viewed to be economically unsustainable at current costs and LNG sales prices
- There is growing restlessness to reverse the trend of high CAPEX projects
 - Can new projects be delivered as forecasted?
 - What happens now (future project sanctions)?
- Two polarised views on LNG project development and \$US/tonne based on people's core beliefs
 - There is logic to both viewpoints, no one side is right

LNG and The Great Reformation – The Players

(Paper by Chris Caswell, KBR at Gastech 2017)

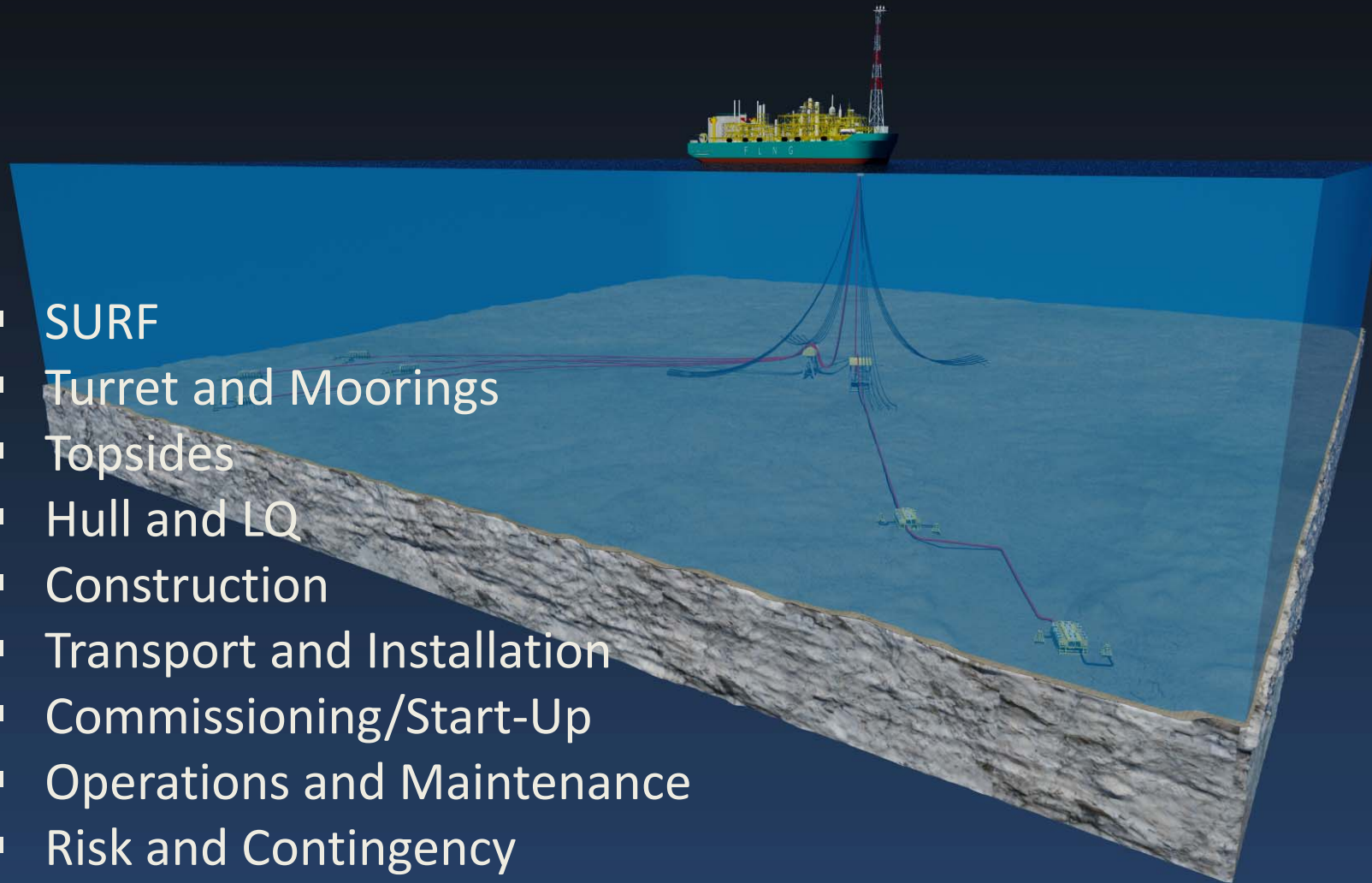


- **Reformers** see project CAPEX trending very high
 - New projects must have drastic cost reductions from current levels to support sanction
 - Cost targets (\$US/tonne) are set well below projects currently in EPC as recent history cannot be tolerated
 - Change must be visionary and occur now
- **Traditionalists** 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 highly reliable project data, sequential engineering, and project execution strategy
 - Unrealistic targets derail FEED development planning
 - Refer to lessons on execution found by IPA

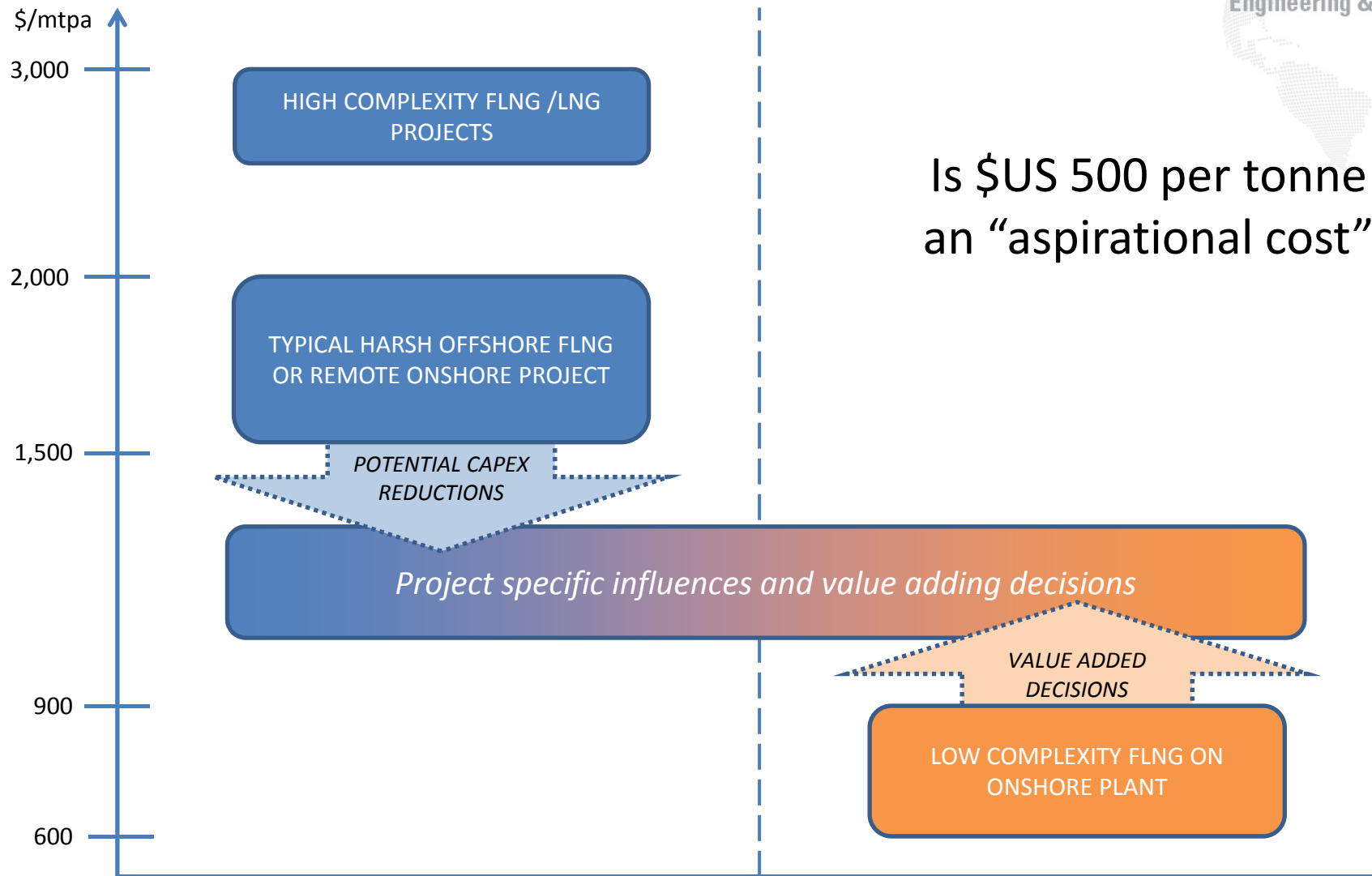
FLNG Cost Make-Up



- SURF
- Turret and Moorings
- Topsides
- Hull and LQ
- Construction
- Transport and Installation
- Commissioning/Start-Up
- Operations and Maintenance
- Risk and Contingency



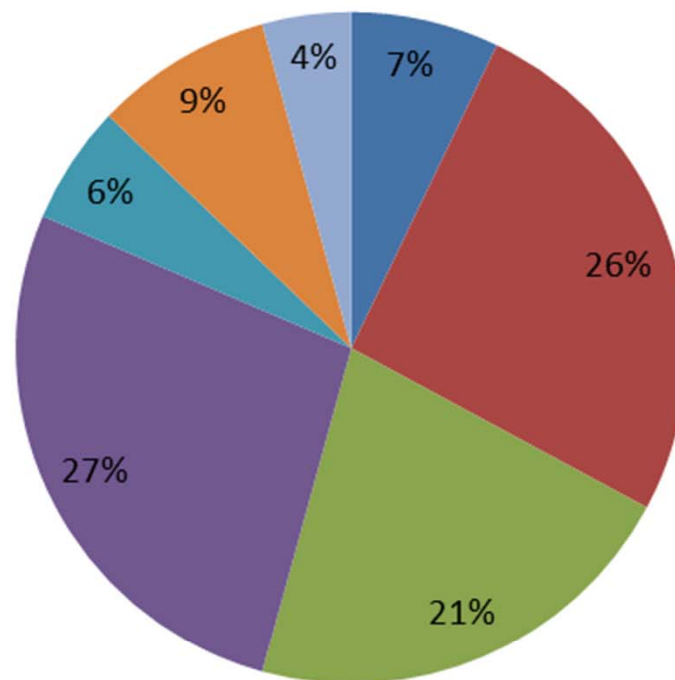
CAPEX – The \$/mtpa Question



Typical FLNG CAPEX Breakdown

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Offshore FLNG



Other

Topsides Equipment

Topsides Fabrication

Hull and LQ

TMS

SURF

Commissioning/Start-Up

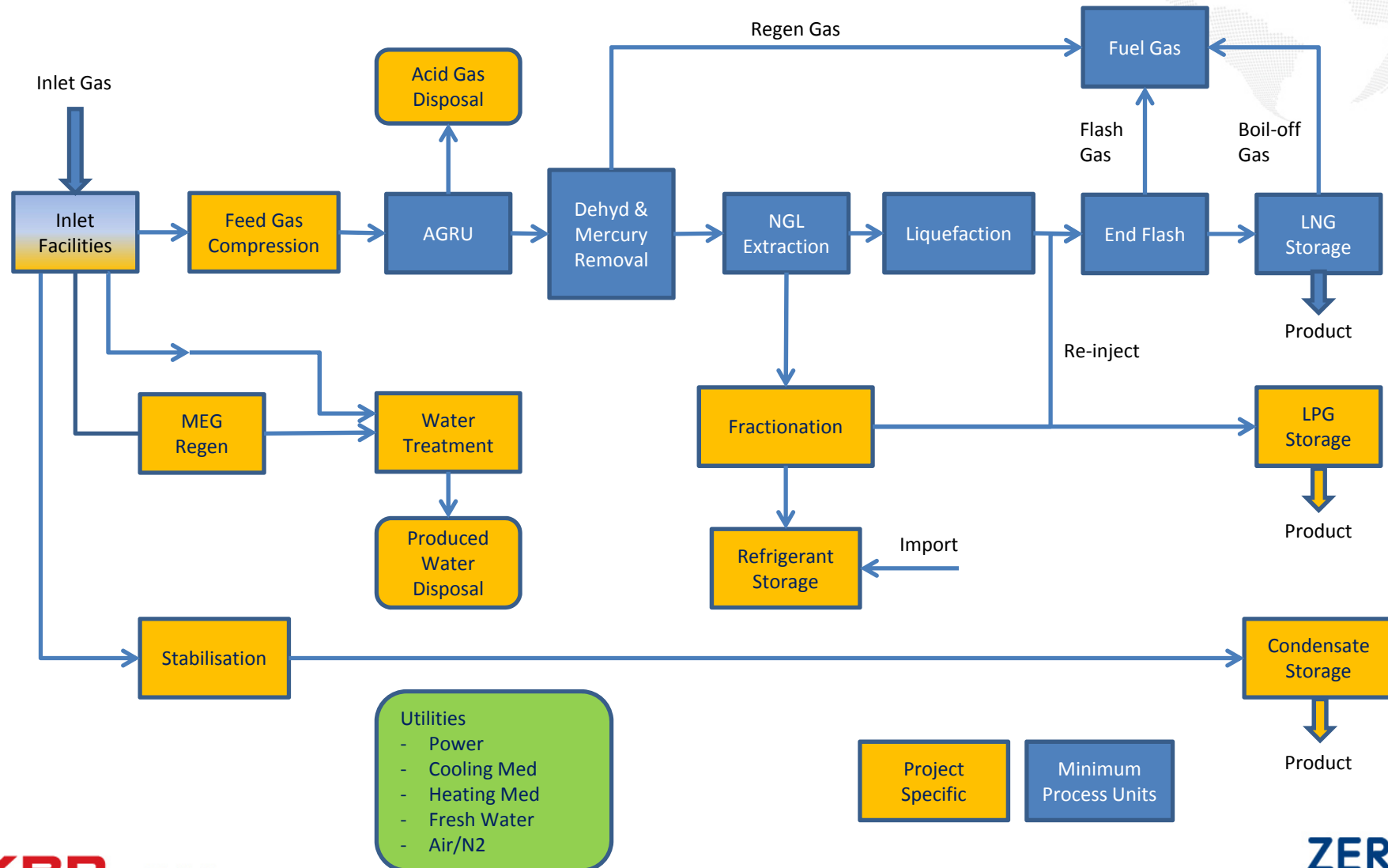
CAPEX Influencers – FLNG Solutions



TOPSIDES	<ul style="list-style-type: none"> • Gas composition • Specs & standards • Process selection • Environment • Equipment reliability • Inherently safe design • Fabrication yard location 	TURRET AND MOORINGS	<ul style="list-style-type: none"> • Metocean environment • Nearshore or Offshore • Internal or External • Spread mooring • Breakwater/Ice Protection
HULL	<ul style="list-style-type: none"> • New build vs. conversion • Metocean environment • Specs & standards • Field life – 10,20,30yrs • Storage volumes • Containment type • Offloading system • Fabrication yard location • Winterisation 	CONTRACTING STRATEGY & FINANCE	<ul style="list-style-type: none"> • Lease or Owner Operate • Financing basis • EPC execution strategy • Local Content requirement • Lowest CAPEX or \$/mtpa
MAINTENANCE & OPERATIONS	<ul style="list-style-type: none"> • Location – nearshore or offshore • Support base • Sparing philosophy • Availability • OPEX vs CAPEX • POB & mechanical handling 	RISK	<ul style="list-style-type: none"> • Risk and Contingency allocation • Completion Guarantees • Performance Guarantees • Facility Damage and Defects
		SURF	<ul style="list-style-type: none"> • Field architecture (or onshore pipeline) • Flow assurance • Depth / Liquids / Hydrates
		BATTERY LIMITS	<ul style="list-style-type: none"> • What's included?

CAPEX Drivers: Process and Gas Composition

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CAPEX Drivers – Simple vs Complex



The “simple” solution

The “complex” solution



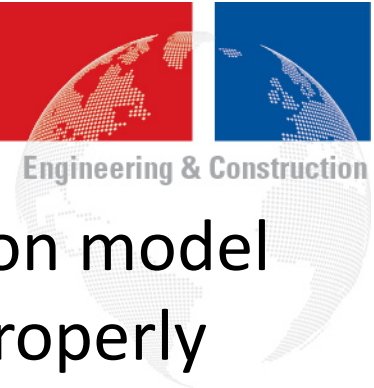
There is a place for both

CAPEX Drivers – Simple vs Complex



Trends toward high CAPEX production	Trends towards low CAPEX production
Net Present Value (NPV) driven	Lowest CAPEX driven
High availability	Lower availability
Higher process efficiency	Lower process efficiency
Complex metocean/geotech	Simple metocean/geotech
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	Recognising industry standard
Experienced lower risk fabrication centres	Low cost higher risk fabrication centres
Tightening of environmental discharge limits	Simple compliant disposals
Contractor takes all the risk	Company carries all risks
Optimised parcel size and logistics	Suboptimal parcel size and logistics

Can we meet the “Aspirational Cost”



- The current project development and execution model (e.g. supported by IPA) is not broken if used properly
 - Advantageous sites can result in much lower costs
 - Most reductions in CAPEX (or \$US/te) occur “outside liquefaction”
 - Executing to a workable plan will result in reliable CAPEX
 - Projects that have not completed a robust FEED cannot estimate CAPEX with significant accuracy
 - Do not set unrealistic CAPEX or schedule estimates
 - Creative thinking and non-traditional execution models can support lower cost solutions

In Summary



- Not all Projects are created equal
- Many factors influence CAPEX but it is very site specific
- Understand the key CAPEX drivers for your Project
- Importance of NPV vs CAPEX
- Learn from the lessons of the past

Questions?

Contact: Andrew.Loose@kbr.com

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