Floating LNG – Monetization of Stranded Gas

AIChE, LDM

Zoetermeer, 25 September 2012

Agenda

Introduction to CB&I

Stranded Gas Occurrences

Gas prices

FLNG units

FLNG advantages

Present FLNG projects and prospects

Commercial analysis

Summary

CB&I known for Storage Tanks and Terminals

CB&I Today – The Company

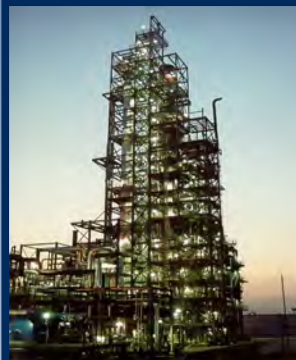
3000 Contracts in 65 Countries

- Offshore
- Pipelines
- Refining
- Petrochemicals
- Natural Gas Processing
- LNG
- Steel Plate Structures

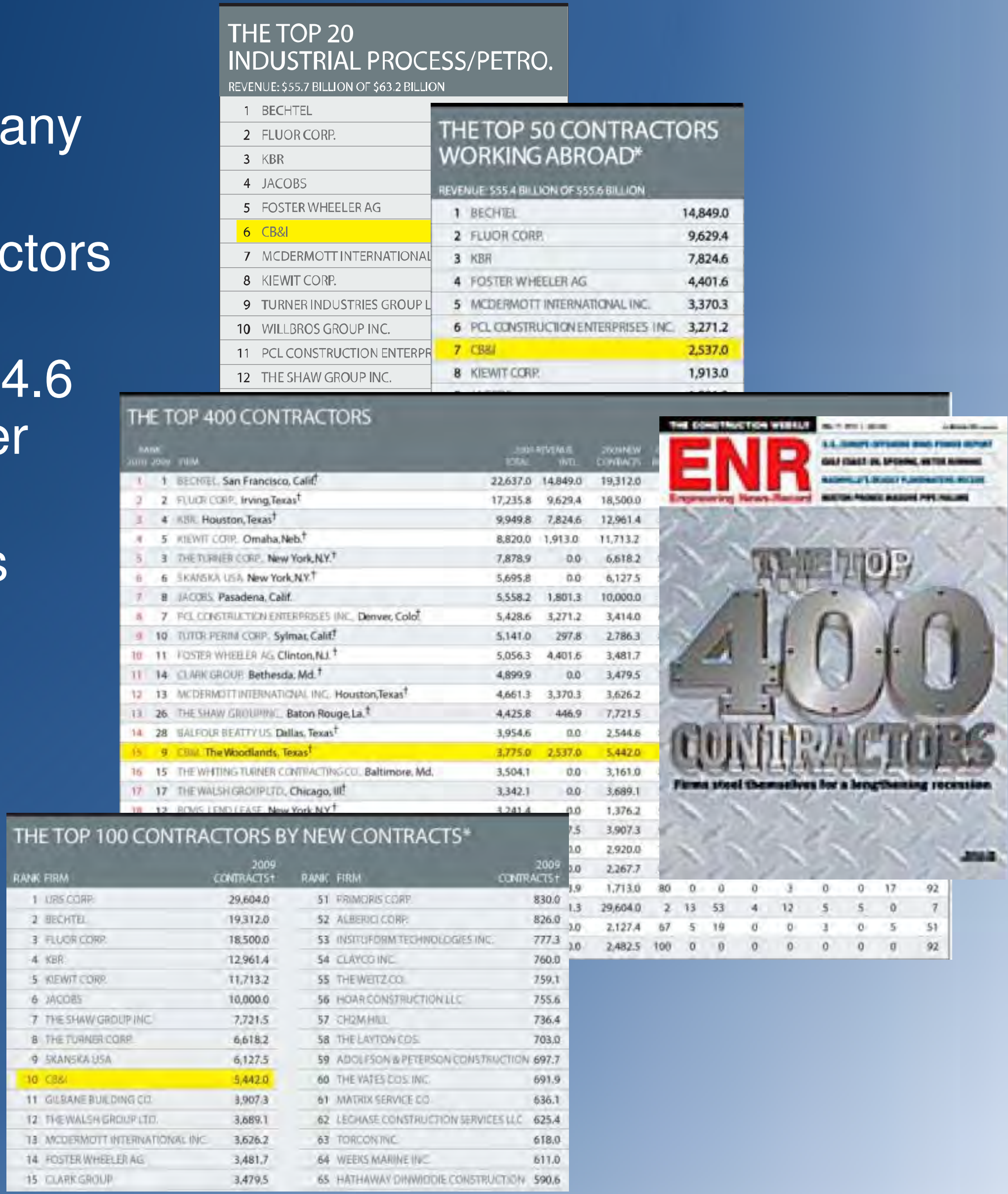
CB&I believes in Strategic Relationships

Repeat Customers

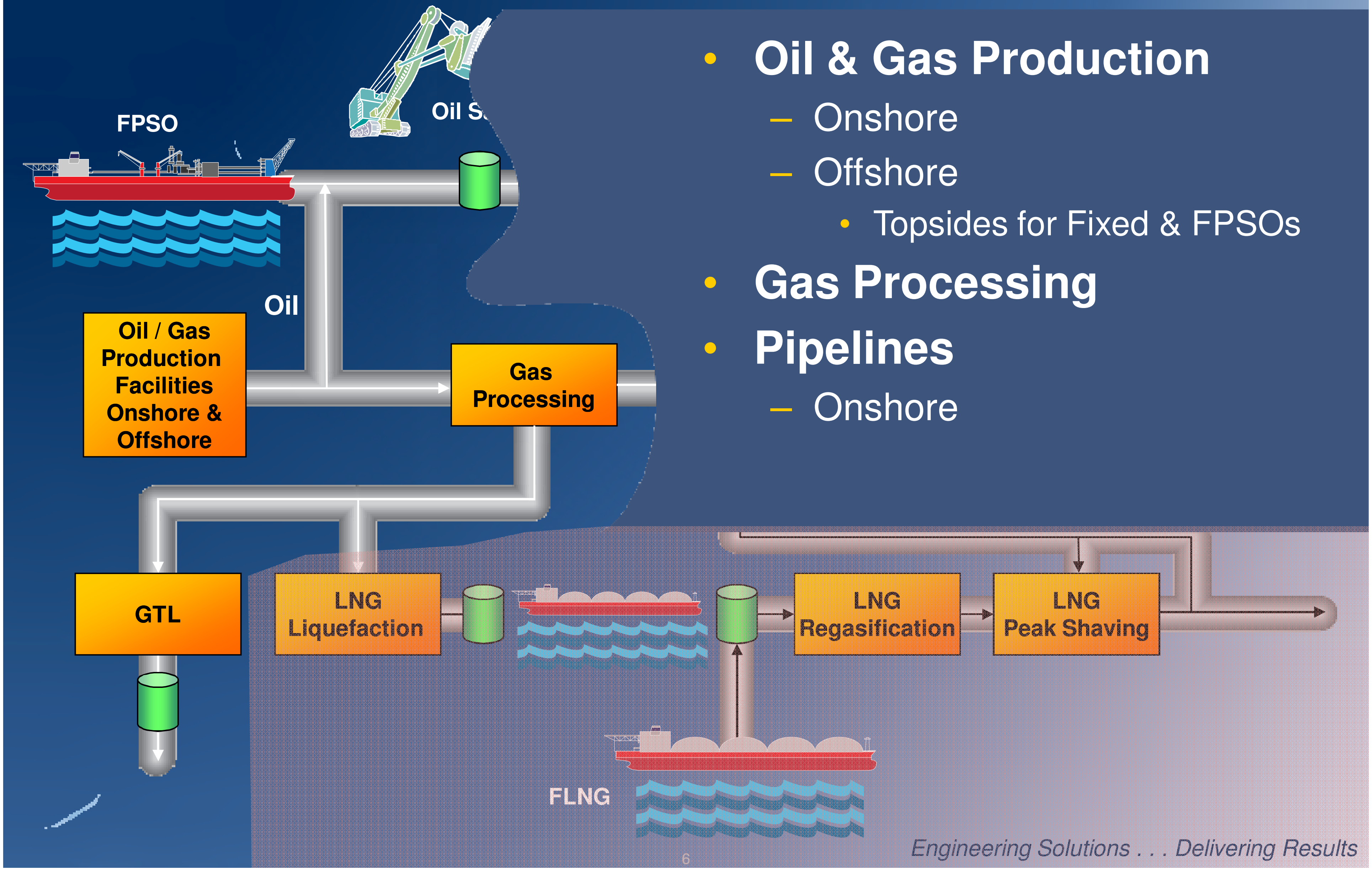
- 82 Customers with > 5 Projects
- 32 Customers with > 10 Projects



- Technology and EPFC company
- Currently ranked number 6 among ENR's Top 20 Contractors in Petroleum
- 2011 revenue of more than $4.6 billion with backlog today over $10 billion
- More than 18,000 employees worldwide
- Full scope services
- Total company commitment to safety



- **Oil & Gas Production**
  - Onshore
  - Offshore
    - Topsides for Fixed & FPSOs
- **Gas Processing**
- **Pipelines**
  - Onshore



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Offshore Capability

- Over 50 Topsides since 1990
- Fixed Platform, FPSO, TLP, Spar
- Weight range: 250t – 30,000t
- Global Experience
  - North Sea, Brazil, Australia, GoM, West Africa, SE Asia, Middle East
- Range of Platform Types
  - Accommodation, NUIs, Wellhead, Compression, HP/HT, Integrated Decks, Float over, Heavy Lift
- Services Offered:
  - Concept, FEED, Engineering, Procurement, Construction Support, EPF, Technical Training

Topsides Facilities Experience

Small Topsides (<2000t)

ExxonMobil - Sable 2
BG - Minerva
Elf - Elgin/Franklin

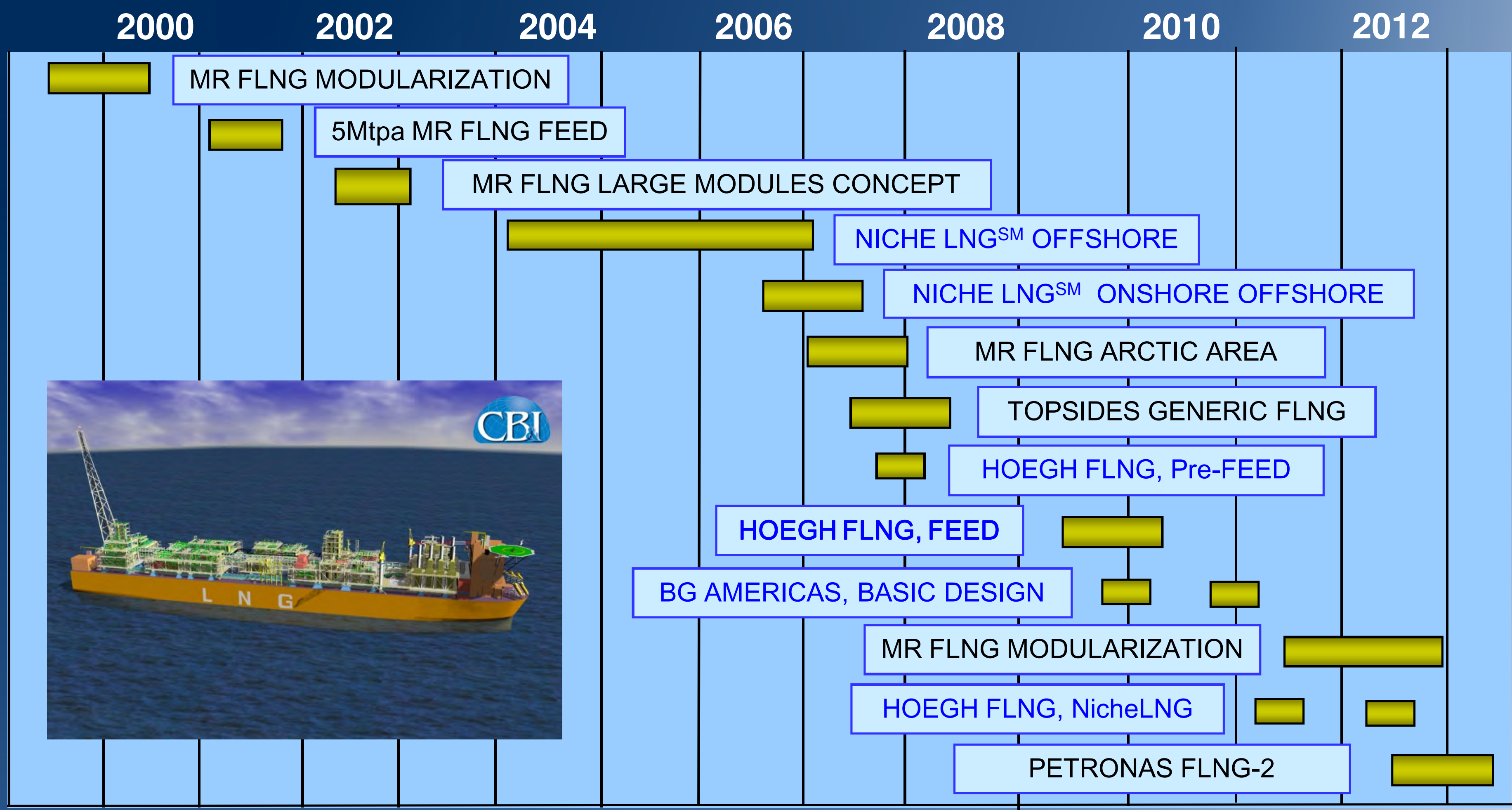
Medium Topsides (>2000t <10,000t)

Talisman – Montrose BLP
BP / HHI – Clair Ridge LQ
BP / Aker – Skarv FPSO
BP – Bruce Phase 2
Texaco - Captain B
Statoil - Huldra

Large Topsides (>10,000t)

Nexen – Golden Eagle
Eni Norge / HHI - Goliat
Nexen - Buzzard
Petrobras / Modec – Tupi
Petrobras / Modec – Guara

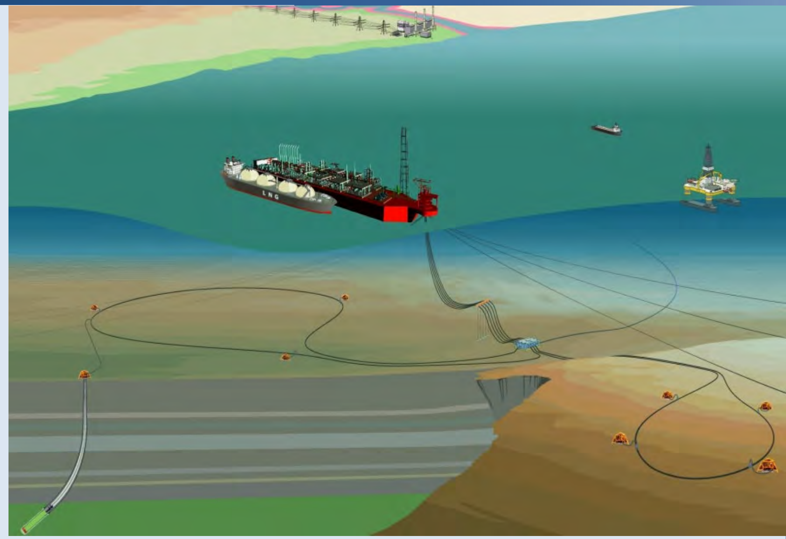
CB&I FLNG experience



- Four FLNG FEEDs executed: Shell Kudu, Hoegh LNG, In-house FLNG, Petronas FLNG-2
- More than 400,000 FLNG manhours spent…
- Ongoing work with Hoegh LNG and Petronas FEED

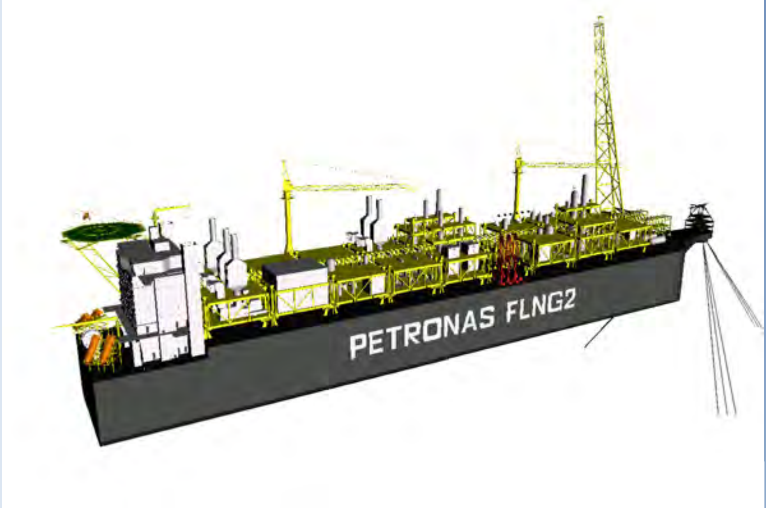
Shell Kudu FLNG Unit

Client:	Shell Global Solutions
Project:	Kudu FLNG Unit
Location:	Offshore Namibia
Project Services:	BE, CE, FEED Project
TIC:	$1 Billion +
Contract Value:	Confidential
Start/ Complete:	FEED completed 2002
Summary:	• LNG 5 MTPA • LPG + Condensates
Highlight:	• Shell MR Technology • Integrated team for project execution in CB&I offices • Babcock (Armstrong) responsible for hull engineering • Similar dimensions as Shell Prelude FLNG



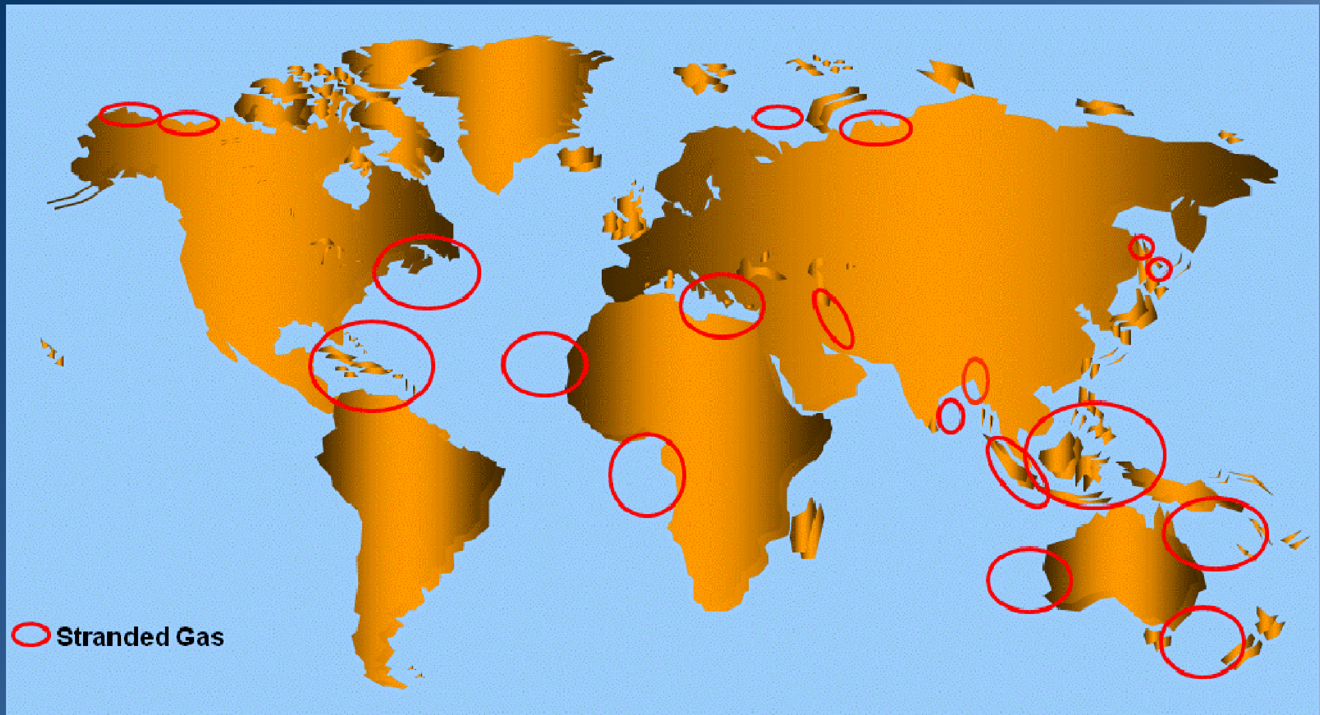
Petronas FLNG-2

Client:	Petronas-MISC
Project:	FLNG-2, Rotan Field
Location:	Offshore Sabah
Project Services:	FEED Process Topsides
TIC:	$1 Billion +
Contract Value:	Confidential
Start/ Complete:	June 2012- June 2013
Summary:	• 25,00 tons topsides • 275 mmscf/day gas • 1500 m water depth
Highlight:	• Consortium with MODEC, IHI and Toyo Engineering • Dual FEED competition • Binding EPCIC offer



World's Stranded Gas Reserves

- Proven reserves: more gas than oil in the world
- Proven conventional gas reserves: 5,500 TCF or 75 years of today's consumption
- Offshore locations with 2 to 5 TCF recoverable gas reserves: 150 – 300
- Half of proven gas reserves is stranded, of which half is offshore
- Most recent locations: East Africa, Offshore Mediterranean



LNG Markets - Firm and Flexible

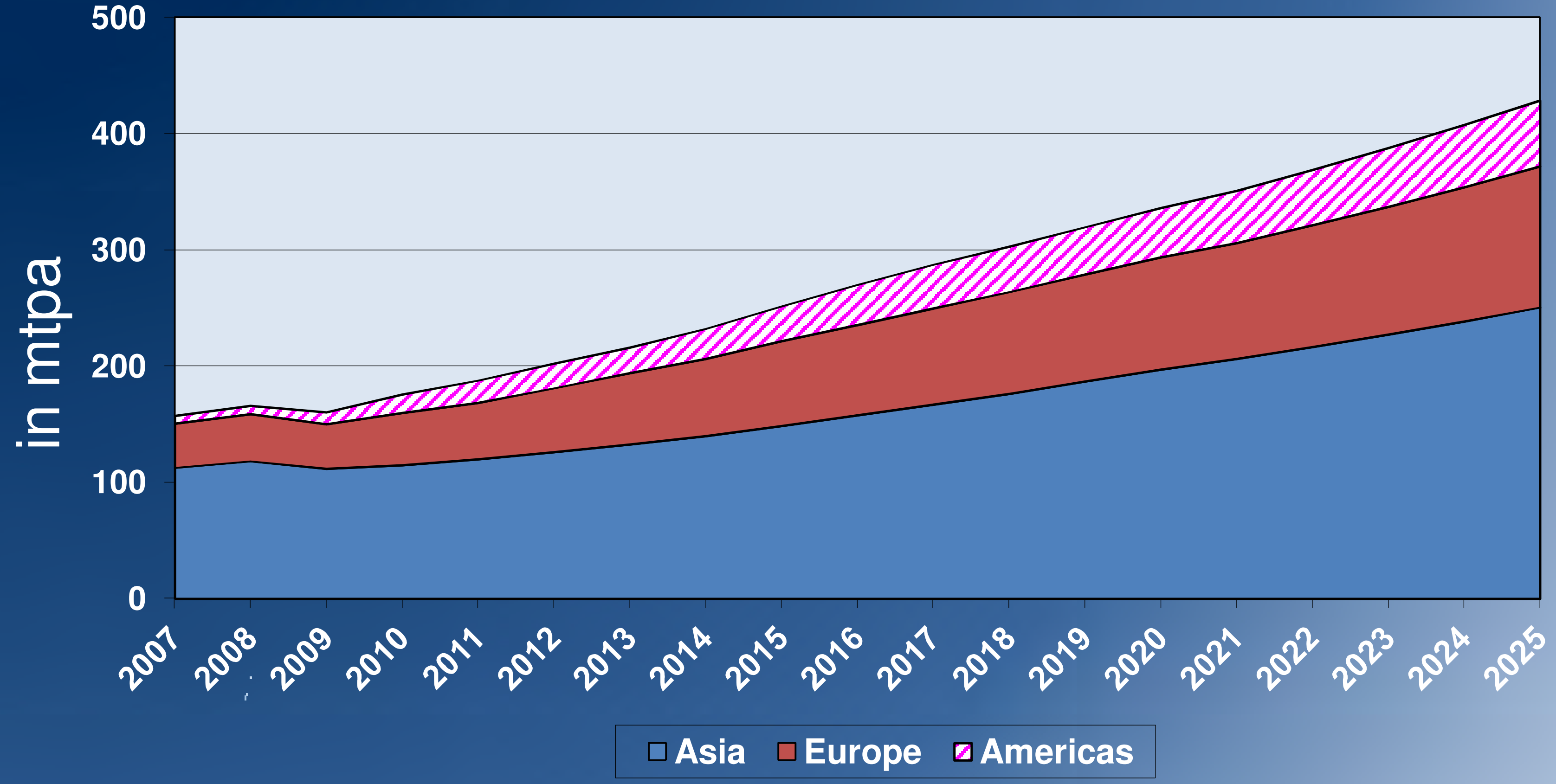
Firm

- Markets which have to have the LNG supply and will pay the price needed to secure cargoes
- Asia, southern Europe (Turkey, Spain, southern France, Portugal), Latin America, Caribbean

Flexible

- Markets with alternative pipeline gas supplies where price will determine whether LNG is imported
- USA (Gulf of Mexico, West Coast), UK, Belgium, Netherlands

Total LNG Demand in firm Markets



Source: Andy Flower

LNG Imports by Country (MTPA)

1	Japan	70.6	Firm
2	S Korea	34.1	Firm
3	Spain	20.5	Firm
4	UK	14.2	
5	Taiwan	11.6	Firm
6	France	10.5	Firm
7	China	9.5	Firm
8	India	9.3	Firm
9	US	8.5	
10	Italy	6.7	
11	Turkey	5.9	Firm
12	Belgium	4.5	
13	Mexico	4.4	
14	Chile	2.3	
15	Portugal	2.2	
16	Kuwait	2.1	
17	Brazil	2.0	
18	Canada	1.5	
19	Argentina	1.3	
20	Greece	0.9	
21	Dominican Rep.	0.6	
22	Puerto Rico	0.6	
23	UAE	0.1	
Total Imports		**223.8**	

Sources: Waterborne LNG Reports, US DOE, PFC Energy

LNG imports in East Asia:

- 123 million tons
- 55% of total LNG demand
- 7.5% more than 2010
- Japan abolishing nuclear power in near future
- China increasing demand – approximately 30 MTPA in 5 years time

LNG Spot Market Prices

- Many longer term contracts in Japan/Korea - price examples of 12 to 14 US$
- Highly attractive market in East Asia
- With a value chain cost of 6 - 7 US$/MMBTU, the East Asia market is very attractive
- USA spot market prices are low – large supply from shale gas

LNG Offshore Concepts

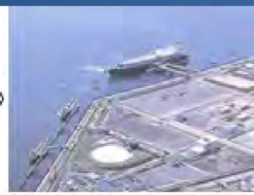
FLNG

Production

Liquefaction

LNG Regas Vessel

Shipping



Storage & Regasification

FSRU

Storage & Regasification

- FLNG is the gas monetization solution for stranded gas

Lessons from fast developing FSRU market

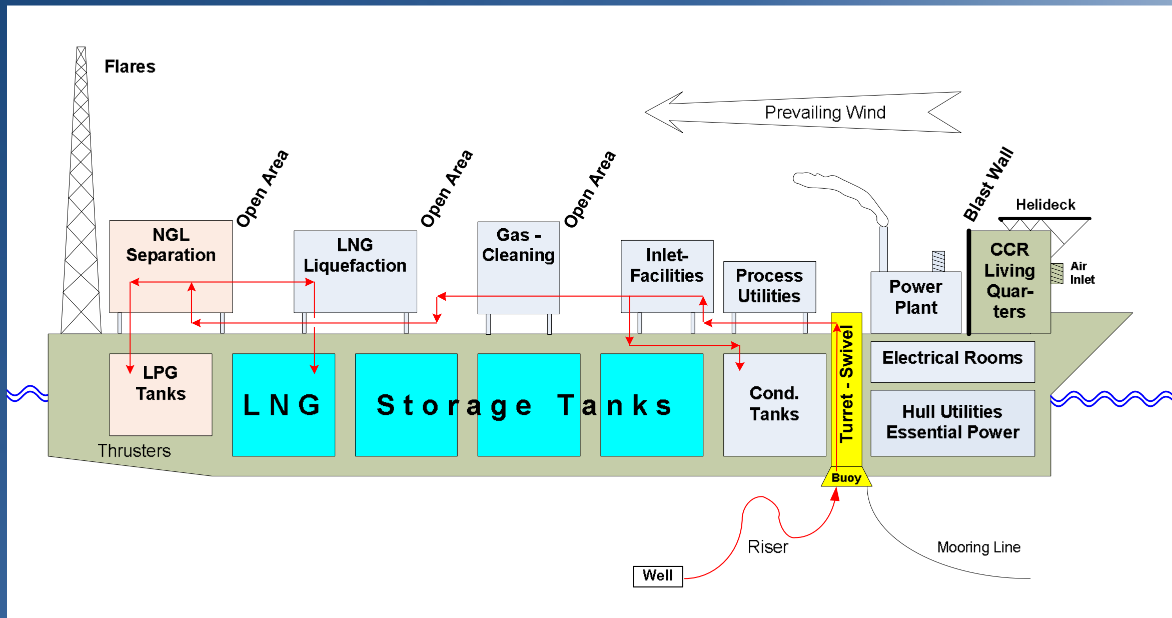
Golar Petrobras
Pecem FSRU

- FSRU market has boomed in the past 2 years
- Presently 11 FSRU units operating, 3 under development and 14 units proposed
- Key players are Excellerate, Golar and Hoegh
- Features include short lead time (record 12 months), low CAPEX, simple civil works.
- Typical Floating unit investment: US$ 300 million

What is a Floating LNG facility

One integrated facility with

- Hull with accommodation and storage tanks
- Turret & mooring
- Topsides with process systems
- Power plant & utilities
- Transport and escape facilities



Onshore LNG Example - Peru LNG

- Pampa Melchorita 170km South of Lima
- 4.45 MMT/yr LNG Export
- APCI Liquefaction Technology

- 2 x 130,000m³ Single Containment Tanks
- 1300m Jetty + Breakwater
- Plant Utilities & Offsites

Floating LNG benefits

- Solution for associated gas for remote and ultra deepwater fields
- Possibilities to monetize smaller reservoirs
- Solution for labor availability constraints
- Sovereign stability
- Smaller environmental footprint
- Remote from population
- No temporary infrastructure required
- Asset security and insurability
- More controlled construction
- Eliminate pipeline routing constraints
- Integrated facilities, no need for loading quays and separate tanks
- No harbour trafic
- Competitive in price

Floating LNG challenges

Technical Design Challenges

- Safety - limited footprint – survivability
- Survival condition/Environmental loads
- Dynamic behavior
- Maintenance / lifting & sea transport
- Combining FPSO marine & LNG practices
- Weight and dimensions

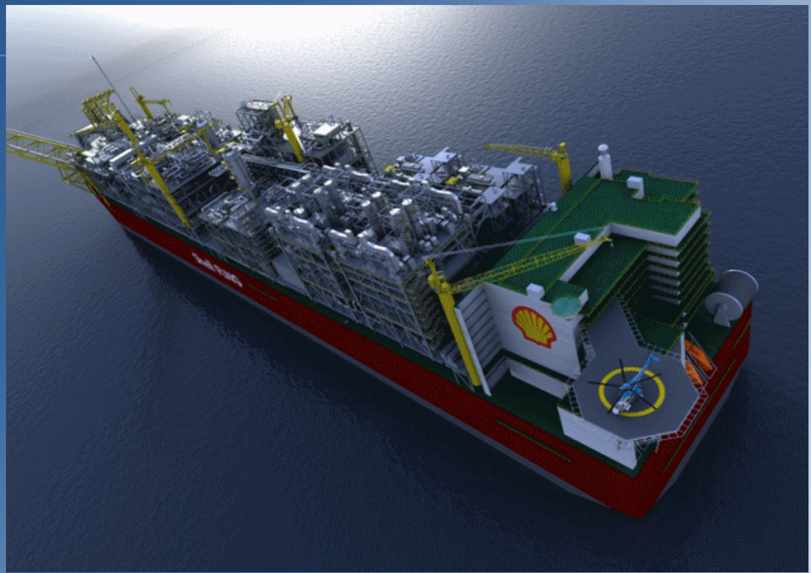
Project challenges

- Business model
- Supply chain & Partnerships
- Risk mitigation
- Offshore logistics
- Product logistics

First FLNG under construction for Shell

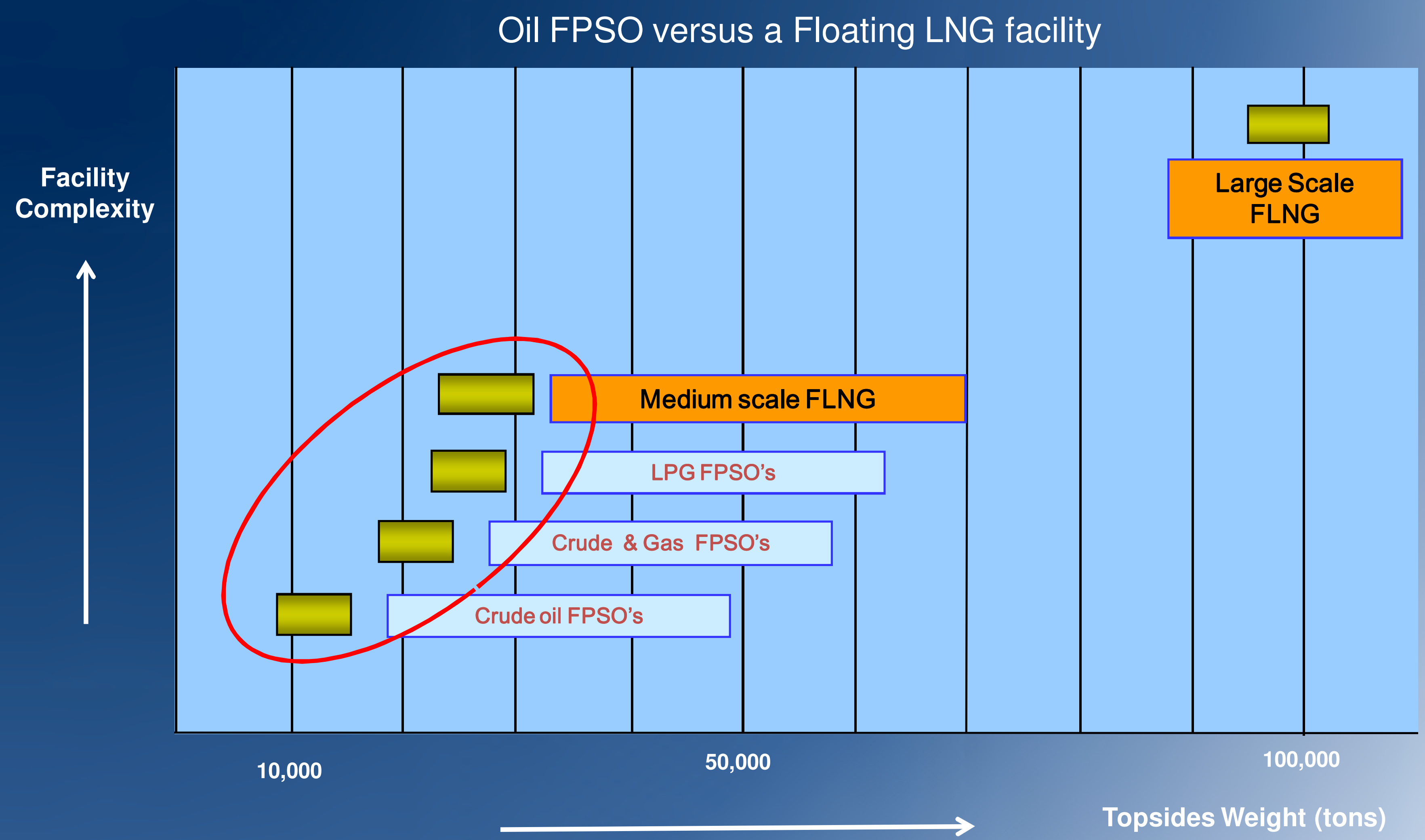
Length	474 meter
Width	74 meter
Draft	17 meter
Displacement	600,000 ton
Production	5 MTPA LNG & LPG & Cond
Turret	30 m Dia, 105 m high
Storage	

- 220,000 m3 LNG
- 125,000 m3 Condensate
- 90,000 m3 LPG



FLNG project challenges

FLNG facility – scaling up….



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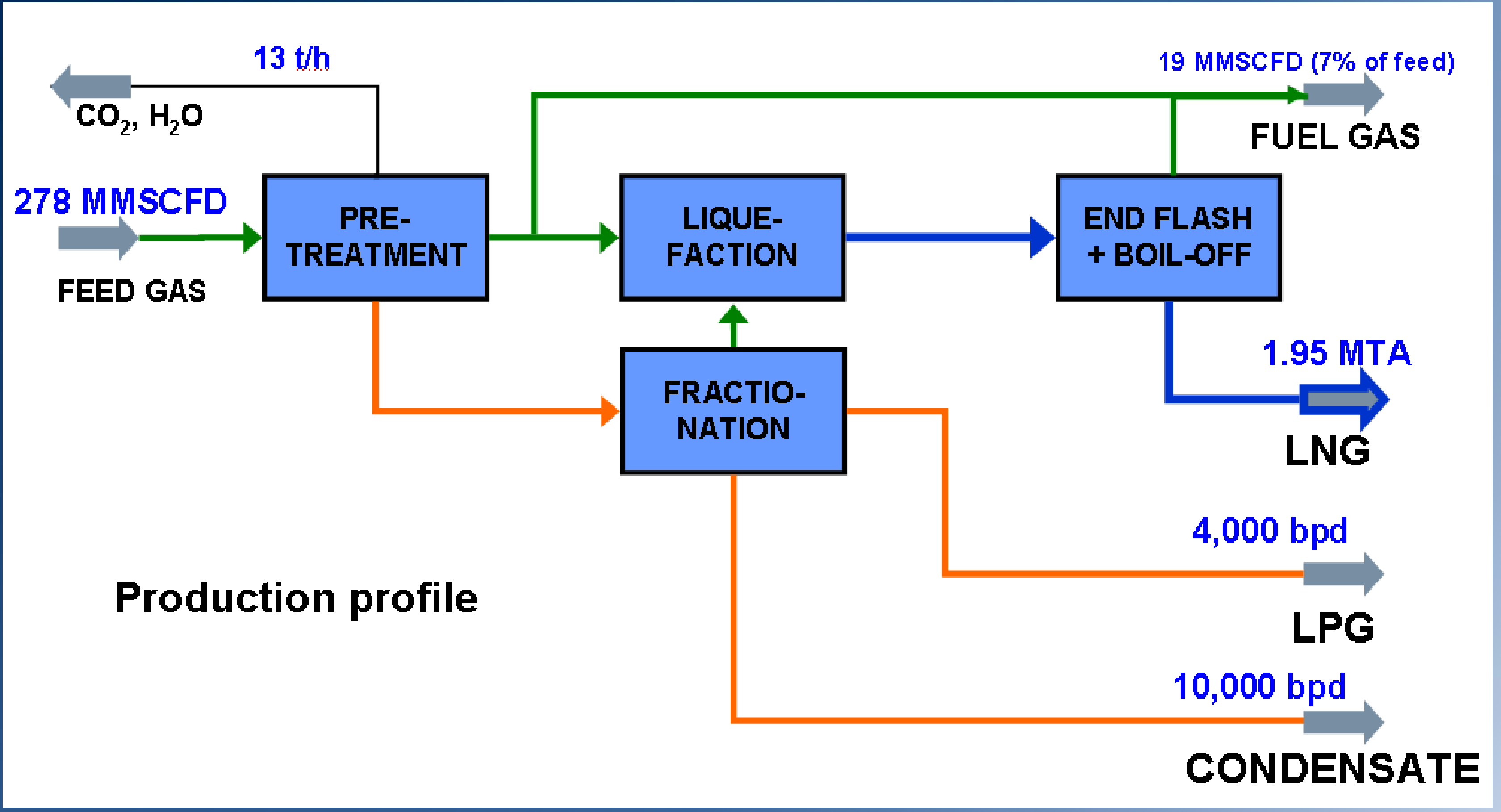
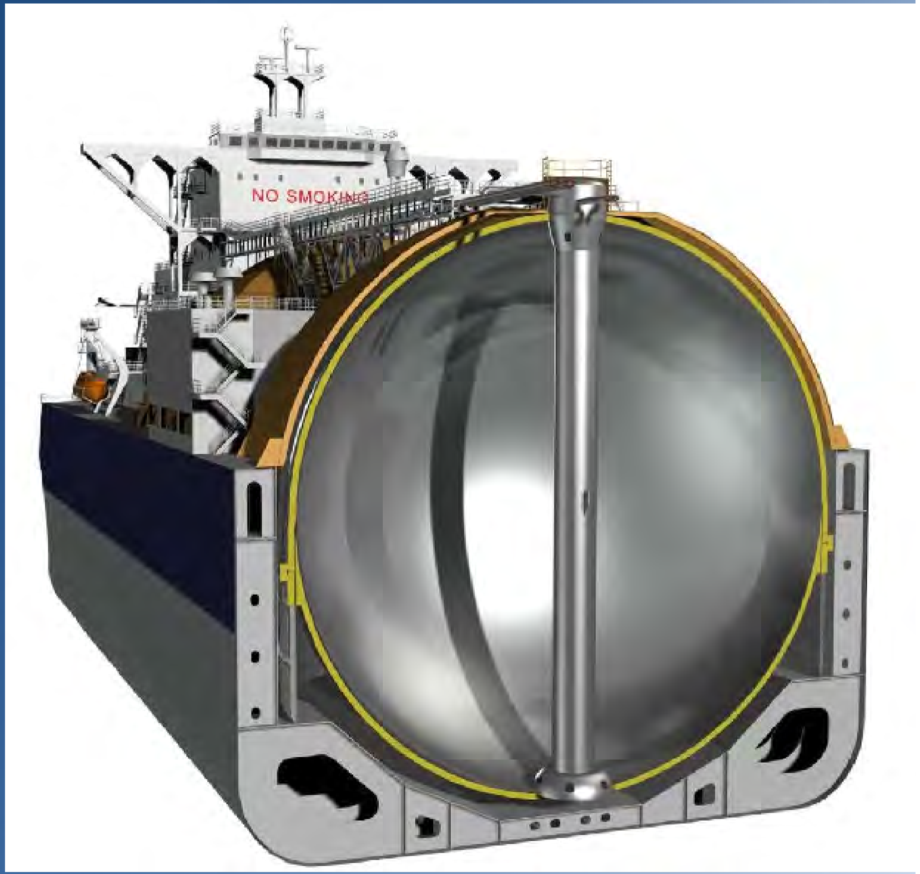
Product logistics



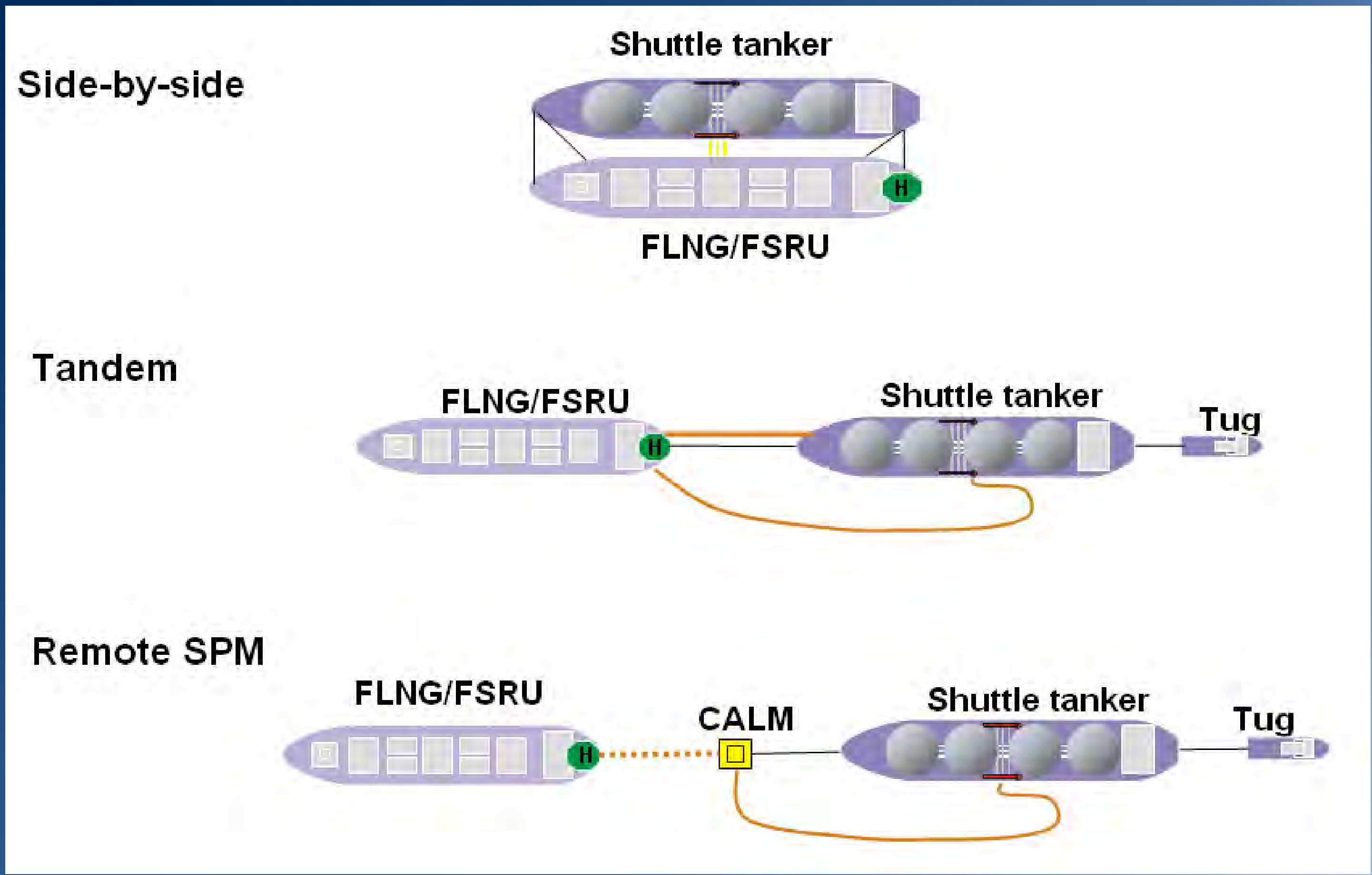
Product logistics

Considerations for offshore environment

- FEED gas via riser system
- Concurrent off loading (LNG, LPG, NGL)
- Vessel suitability & availability
- Safety
- Point of Delivery
- Metering of Product
- New technology / Novel applications



Product Logistics - Offloading Options



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Product Logistics - LNG Offloading Options

Side-by-side

Tandem

Loading Arms

Hoses

Product Logistics

Condensate and Oil transfer

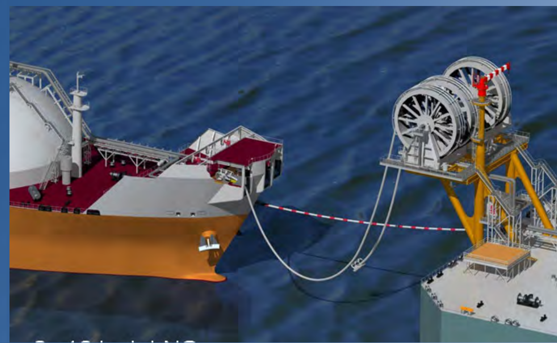
- Proven technology
- Side by side & Tandem systems
- CALM buoy systems
- Fully tested and Certified components

LPG transfer

- Side by side = Proven technology
- Tandem systems possible
- CALM buoy systems possible
- Fully tested and Certified components

LNG transfer

- Working systems
- Concrete proposals
- Fully tested and Certified components

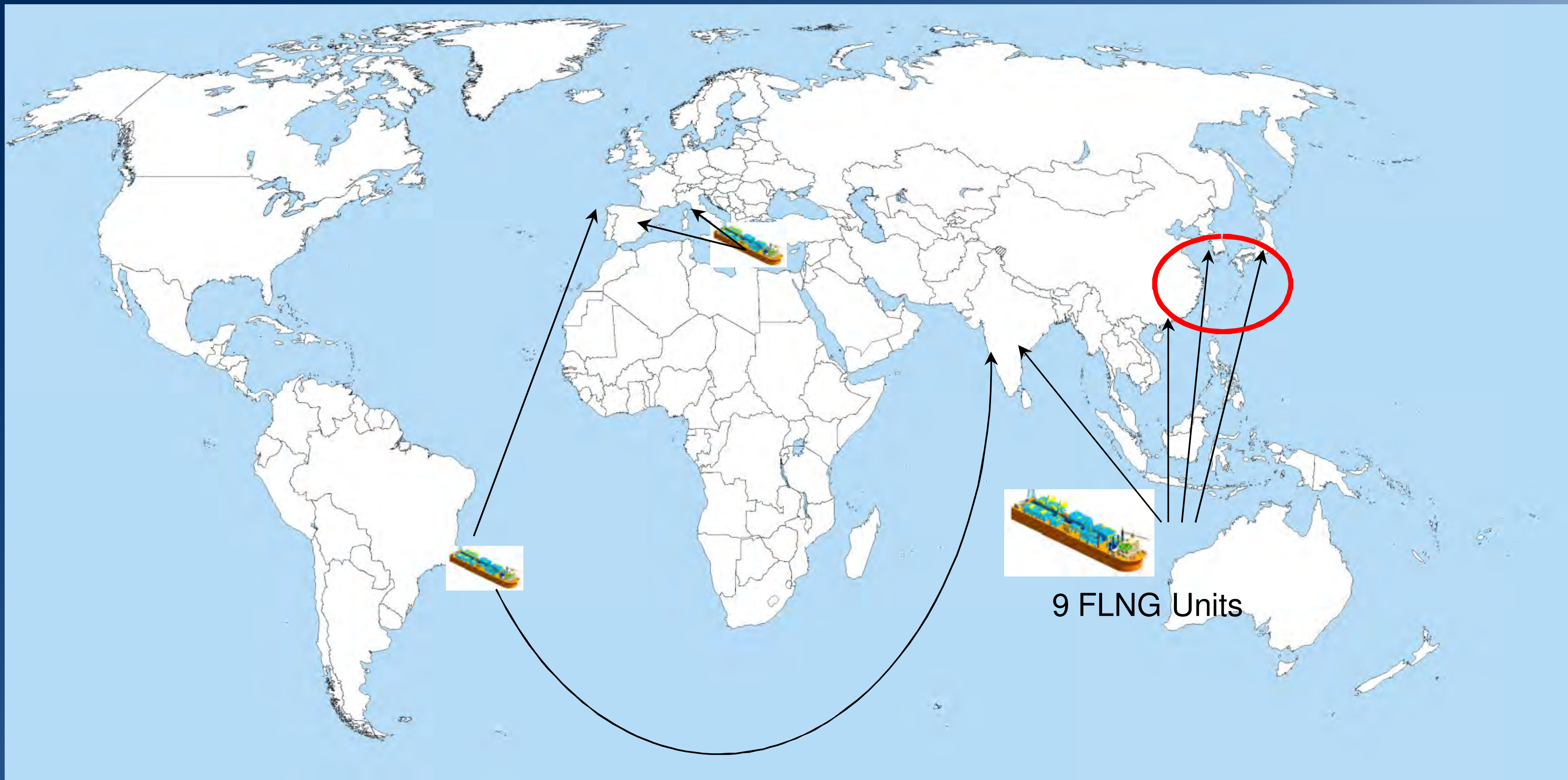


Current FLNG Initiatives – Public Domain

Operator	Name	Location	LNG Prod (MTPA)	Status
Shell	Prelude, Browse	Offshore Australia	3.5	EPC
Petronas	FLNG-1	Offshore Malaysia	1.2	EPC
Exmar	FLSRU	Offshore Colombia	0.5	EPC
Petronas	FLNG-2	Offshore Malaysia	1.5	FEED
Woodside / Shell	Sunrise	Timor Sea, WA	Min. 3	Concept
Petrobras	Santos	Offshore Brasil	2.5	EPC proposals
INPEX	Abadi	Offshore Indonesia	2.5	Concept
PTT	Cash Maple / Oz	Timor Sea, WA	2	Pre-FEED
GdFSUEZ	Bonaparte	Offshore Australia	2	Concept
Hoegh-DSME	Noble Energy, Tamar	Offshore Israel	3	Pre-FEED
DSME	Israel Land Development Energy	Offshore Israel, Myra	3	Pre-FEED Study
Flex/ Interoil	Elk/ Antelope	Onshore PNG	2	FEED
SK Gas	TBA	Offshore Australia	2.5	Technology Selection
Murphy Oil	Semai II field	Offshore Indonesia	TBA	Drilling 2012

All initiatives with gas owner involvement …

FLNG Initiatives versus markets



- FLNG units located relatively close to the market
- East Asia market at 3,000 – 3,500 miles distance

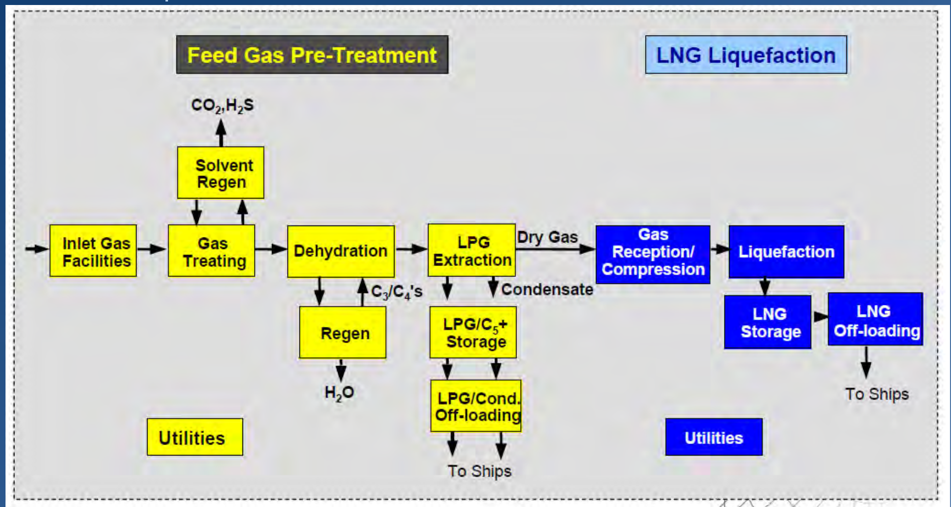
FLNG Capex Prices….??

- Vary a lot and are pending on field of employment, feed gas composition and product specifications
- Mostly new built units on the drawing boards; initiatives emerging for conversion FLNGs
- Shell Prelude is producing 5.2 MTPA of product; Costs in the press: EPC contract 6 BUSD, 10 BUSD for overall project ….
- Petrobras Santos FLNG processes 12 – 14 MM3 gas and produces 2.5 MTPA LNG, “x” MTPA NGL’s. Costs in the press vary from respectively 3.3 to 3.8 and 4.8 BUSD

Source: Upstream

Cost Example

- 1.6 MTPA (1.6 TCF)
- Deepwater (floating)
- Open Ocean
- LNG Tanker Based
- LNG Stored in Hull
- < 1.5 mol% CO2



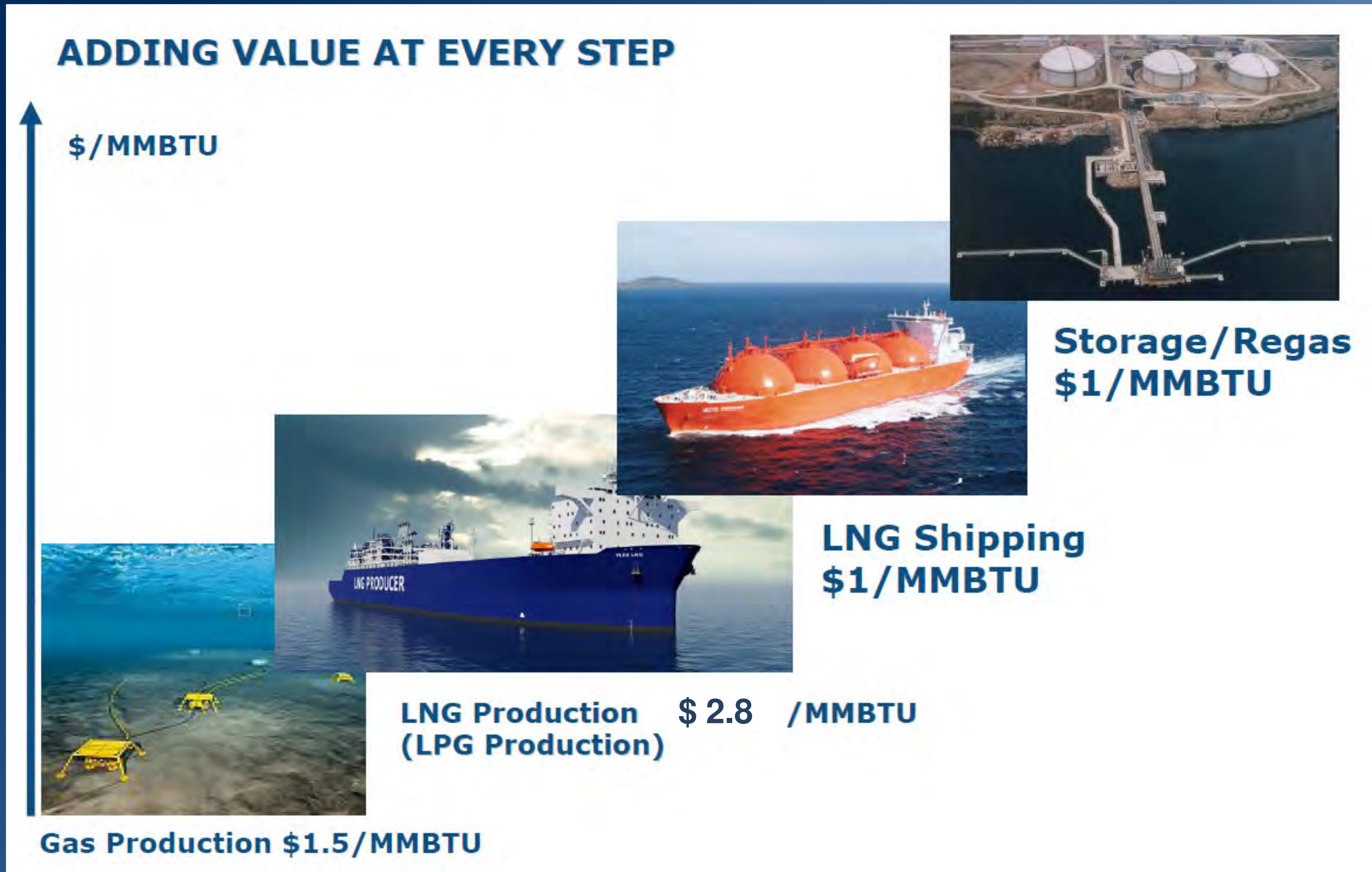
Subsea Costs

- Water depth
- Gas flowrate
- Number of wells
- Number of risers
- Intervention

OPTION	PRODUCTION COST $/MMBTU
Currently Re-injected	-1.0 ?
Currently Flared (Associated Gas)	Zero ?
Shallow Water Production	1.0 – 2.0
Deep Water Production	5.0 – 7.0

Source: Brian Songhurst

Overall Costs



Commercial Risk

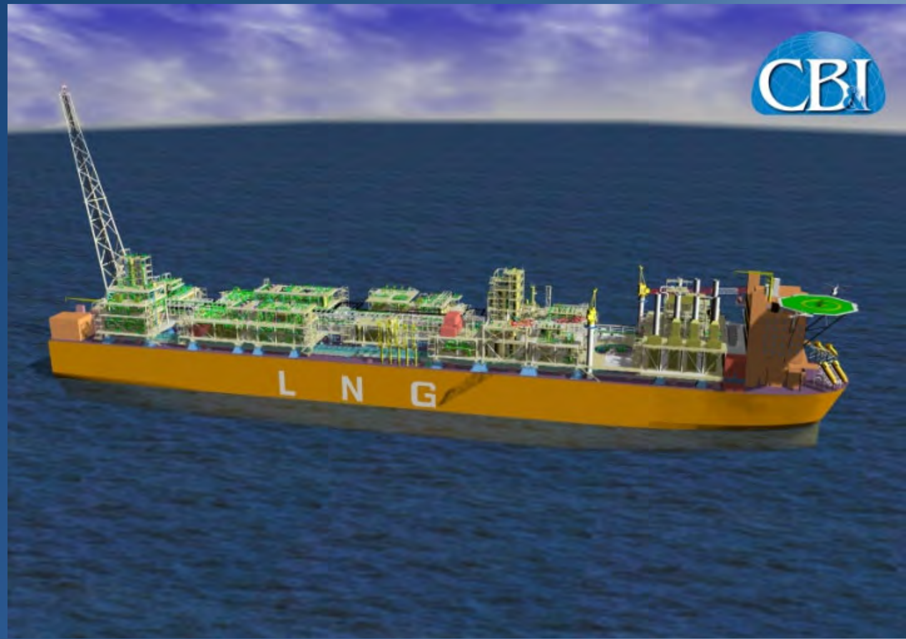
- Known risk
- Unknown risk

Expect the unexpected !

Commercial Risk

Key success factors FLNG unit

- Predictability
- Reliability
- Acceptance of technologies
- Interface management
- Risk sharing



Summary FLNG Future

- FLNGs have become real recently – Shell Prelude and Petronas FLNG-1 are trailblaizer projects
- There are solid reasons to select FLNGs as an alternative for onshore LNG plants
- Most FLNG initiatives are located relatively close to the largest demand market in East Asia
- FLNG CAPEX costs seems to be competitive to onshore LNG plants
- There are limits to the production capacity of FLNG units – Prelude is currently the largest unit with a production of 5.2 MTPA
- FLNG is having a Future….!

Thank You For Your Attention

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