CURRENT STATUS & STRATEGIES FOR NATURAL GAS DEVELOPMENT USING FLNG

Seminar on Offshore Activities for Natural Resources
Japan International Transport Institute (JITI)

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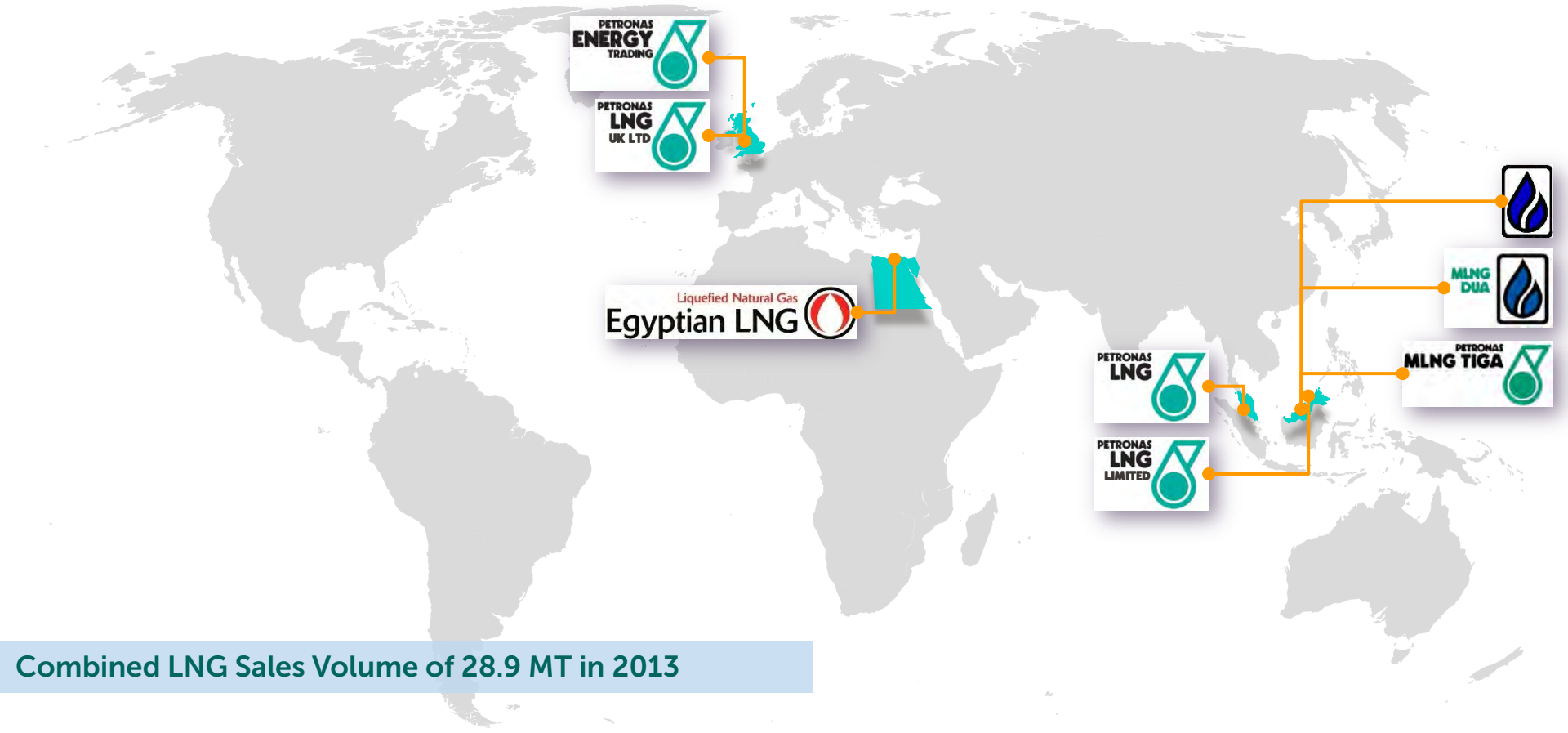
PETRONAS LNG Presence Today

PETRONAS LNG is one of the leaders in LNG production worldwide



Combined LNG Sales Volume of 28.9 MT in 2013

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Global FLNG Projects Overview

FIELD	LOCATION	OPERATOR	CAPACITY (MTPA)
Kanowit	Malaysia	PETRONAS	1.2
Rotan	Malaysia	PETRONAS	1.5
Prelude	Australia	SHELL	3.6
Browse	Australia	WOODSITE	10 - 12
Abadi	Indonesia	INPEX	2.5
Bonaparte	Australia	GDF SUEZ	2.3
Cash/ Maple	Australia	PTT	2
Greater Sunrise	Australia	WOODSITE	4
Scarborough	Australia	EXXON MOBIL	6 - 7

Source : Energy Business Intelligence

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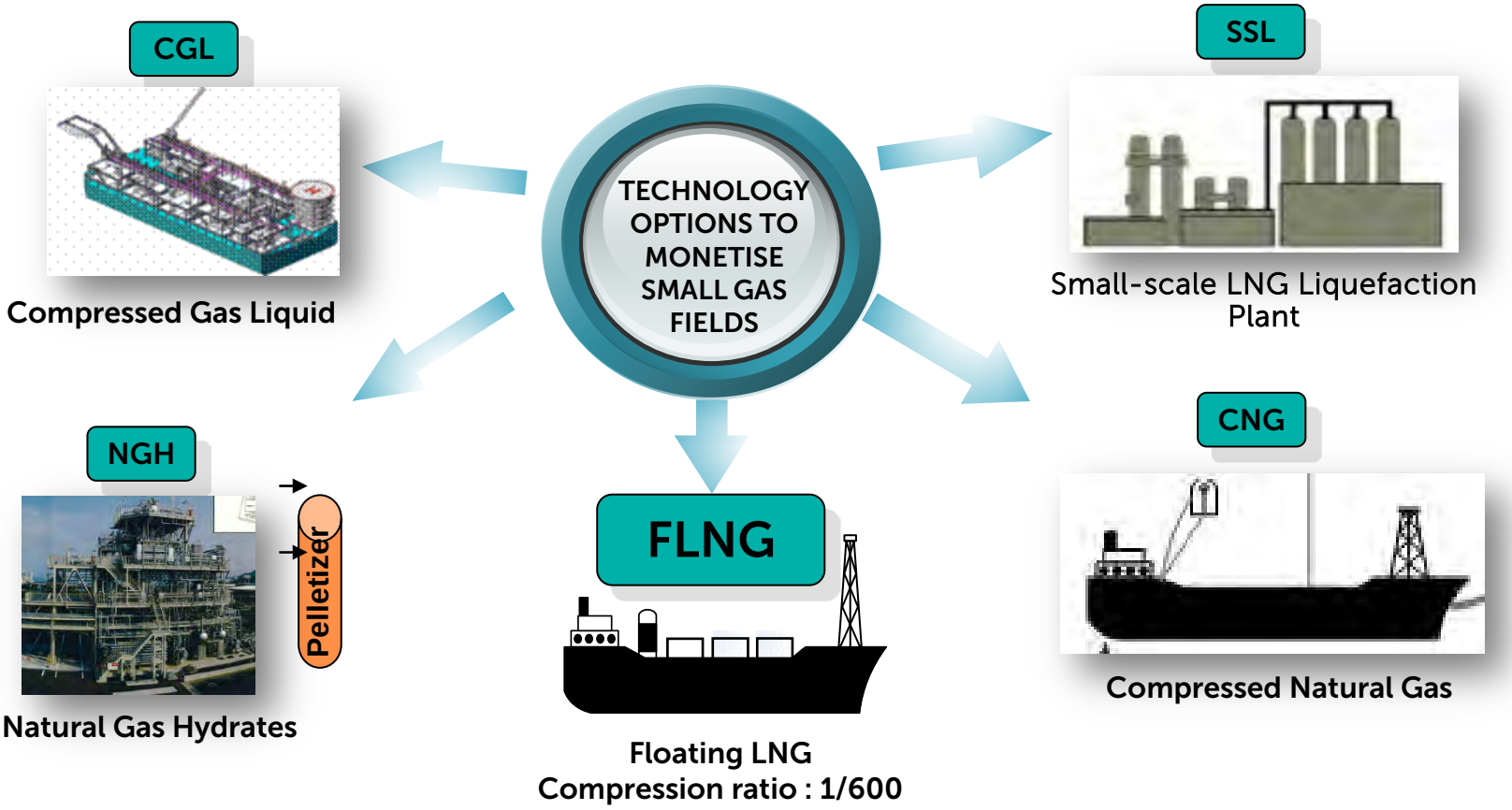
The FLNG Journey...

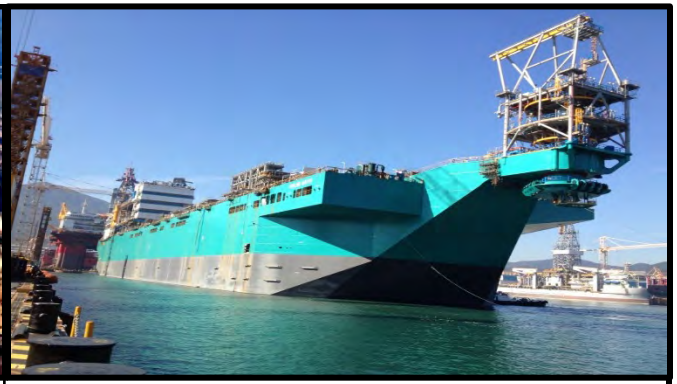


- **Since 2006, PETRONAS considered many options to monetise the small and stranded gas fields.**

	Final Investment Decision (FID)	Current Progress	Planned Completion
PFLNG 1	March 2012	89%	1st Quarter 2016
PFLNG 2	January 2014	30%	1st Quarter 2018

Source : Technology Agenda 2006

Why FLNG?

	ONSHORE	OFFSHORE
		
CAPEX (excluding production systems)	Extra cost for land, pipeline, jetties, infrastructure	One facility at gas location and direct shipping to LNG buyers
EIA and Permitting	Longer process and potentially area limitations	Simpler and easier process expected for offshore locations
Installation & Abandonment	Permanent Installation	Relocatable offshore floating units
Screening of Locations	Limitations by suitability of seafronts, water depth etc.	Can be located at source even if remote area, few restrictions
Homeland Security	Close to the population	Lower risk, less public exposure

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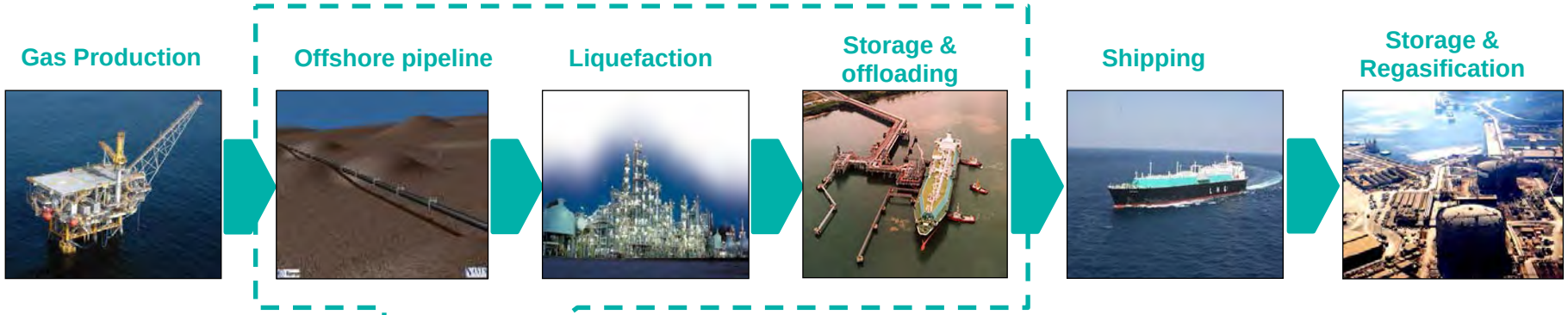
FLNG - Changing the traditional LNG landscape



Floating LNG (FLNG) is:

- An integrated LNG floating production, storage and offloading (FPSO) unit
- Stationed offshore at a gas field to extract natural gas from the wellhead and processed into liquefied natural gas (LNG)
- The produced LNG is stored in the FLNG containment system and is offloaded directly into LNG carriers offshore
- Solution to monetize stranded gas field or as an early production option
- To be proven operationally & may be a widely used solution for future LNG production

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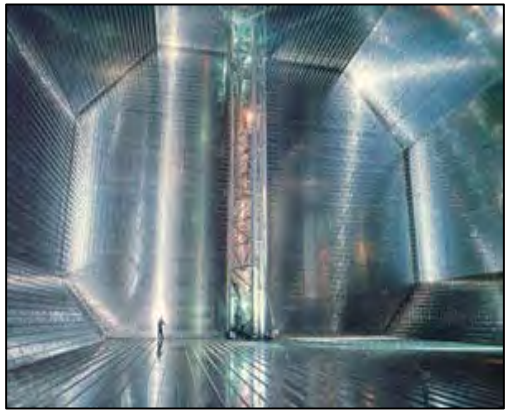
PETRONAS FLNG – A Combination of Proven Technologies

PROCESS PLANT

TURRET

LOADING ARMS



LNG TANKS

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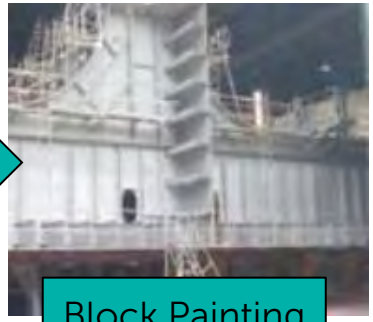
Complete Hull Erection from Steel Cutting to Dock Erection

Steel Cutting

Component Fabrication

Pre-outfitting



Block Painting

Pre-erection &
Super Block Outfitting

Keel Laying

Hull Launching &
Quay Side Outfitting

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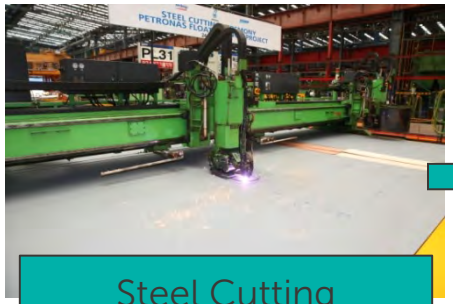
Complete Topside Erection from Steel Cutting to Erection



Steel Cutting

Assembly & Pre-PE
*Block Stage Outfitting

Pre-outfitting
*Before Turnover Outfitting

Block Painting

Turnover & PE
*Turnover, Outfitting and Pre-erection

Module Outfitting
*Deck Stage Equipment Installation & Outfitting

Module Outfitting
*On Module stage

Ready for Lifting

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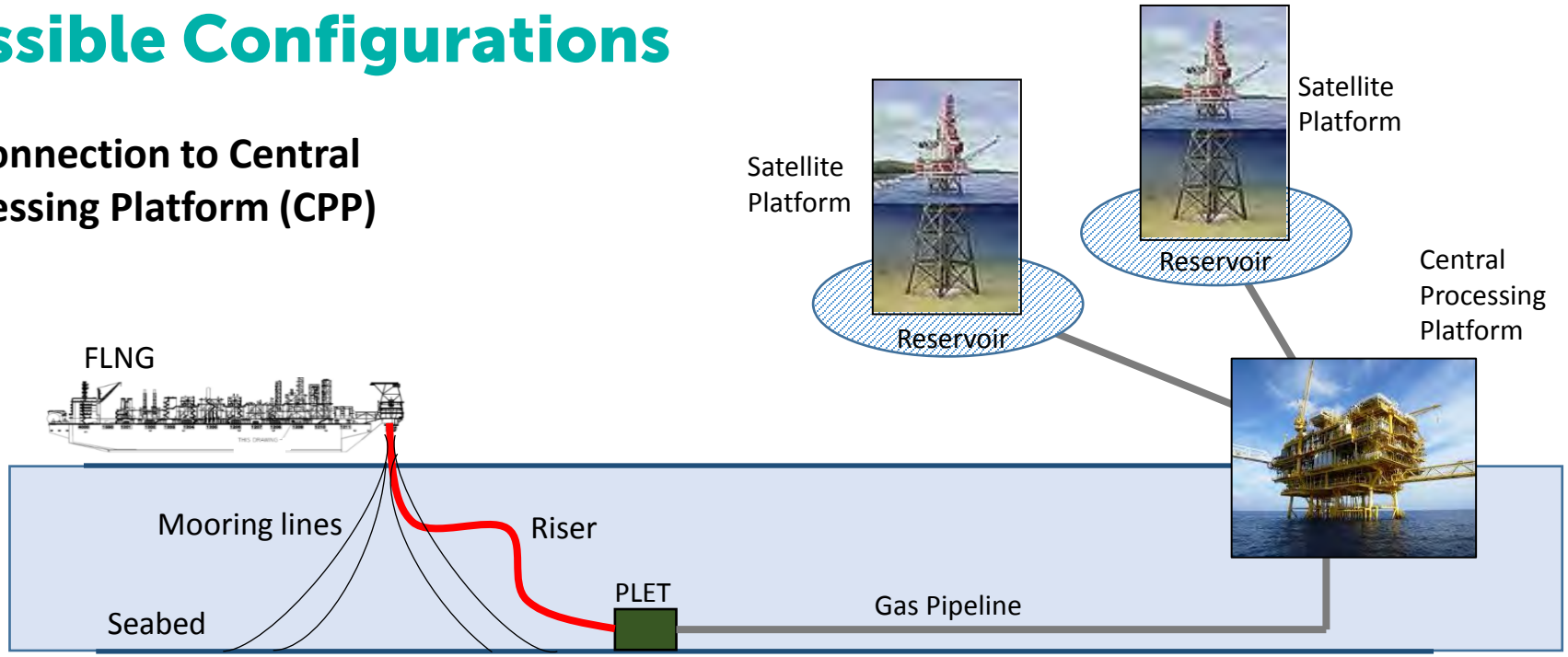
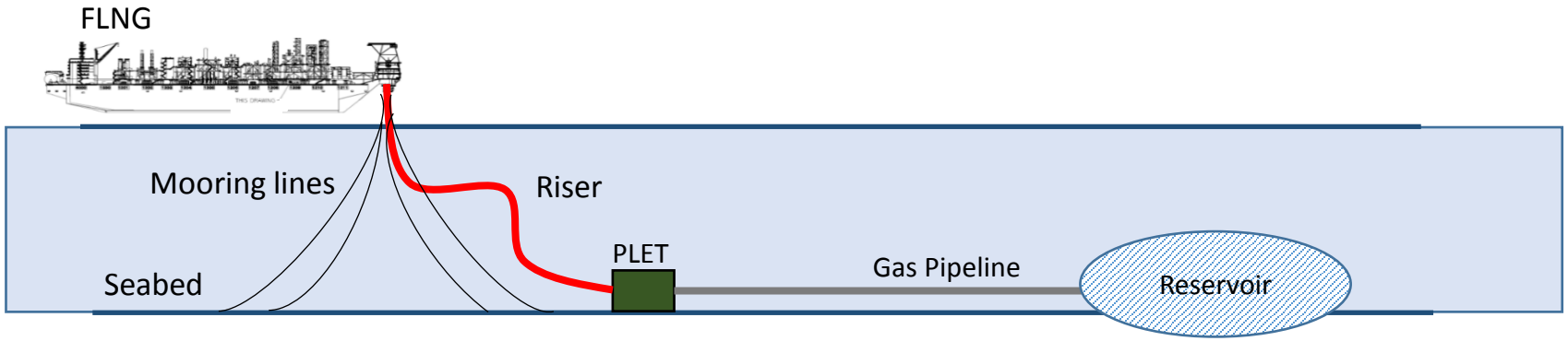
Possible Configurations

1 - Connection to Central Processing Platform (CPP)



2 – Full Well Stream



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Advantages and where FLNG is applicable

- Small and Stranded Gas Fields
- Faster Overall Project Schedule as compared to conventional grass root facility
- Early Production System (EPS) for Gas
- Mobile and re-locatable
- Difficulties in Building Plants Onshore

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Key Design Considerations

Selection Criterias

- Inherent safety design
- Production Capacity and Field Development Strategy
- Process robustness, efficiency and reliability
- Proven operational experience on onshore LNG Plant
- Research and development on marinisation
- Sea state conditions (stability and structural integrity)
- Relative size of FLNG and LNGC

Key Technologies

- Turret & Mooring System
- Acid Gas Removal (AGR) Process
- Liquefaction Process
- Cargo Containment System
- Marine Loading Arm

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Key Technologies

Turret & Mooring System

- Function: to station-keep the FLNG
- External turret is employed
- Considerations:
  - Provision for additional risers and umbilical at future location
  - Robustness against various metocean data
  - Internal vs external turret or other type of mooring systems
  - Permanent or detachable
  - Cost competitiveness

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Key Technologies

Acid Gas Removal (AGR) Process

Function: to remove contaminants

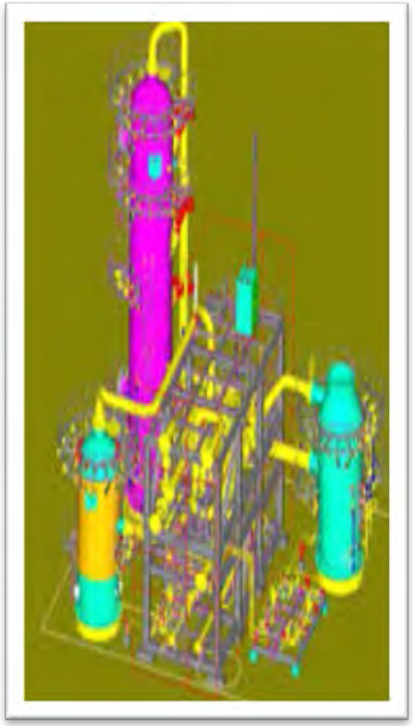
Key parameters considered:

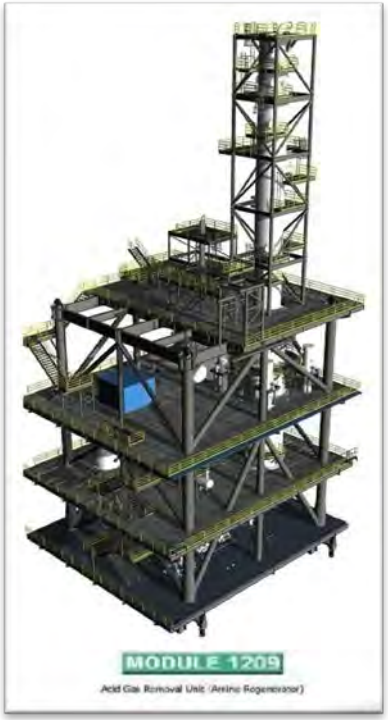
- Reservoir gas compositions

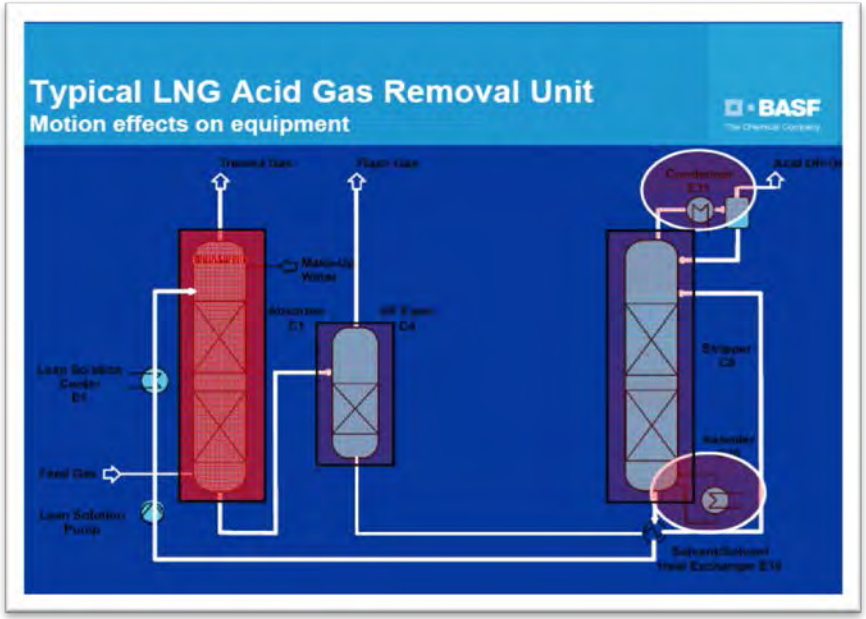
  E.g: Could be divided in phases depending on field specific:

  - Phase 1 = 10% CO_2
  - Phase 2 = 20% CO_2

- High availability (marinisation) and other considerations due to motion
- Smaller foot print
- Available technologies such as amine, membrane & hybrid







Source: BASF, 8th FLNG Conference, Korea

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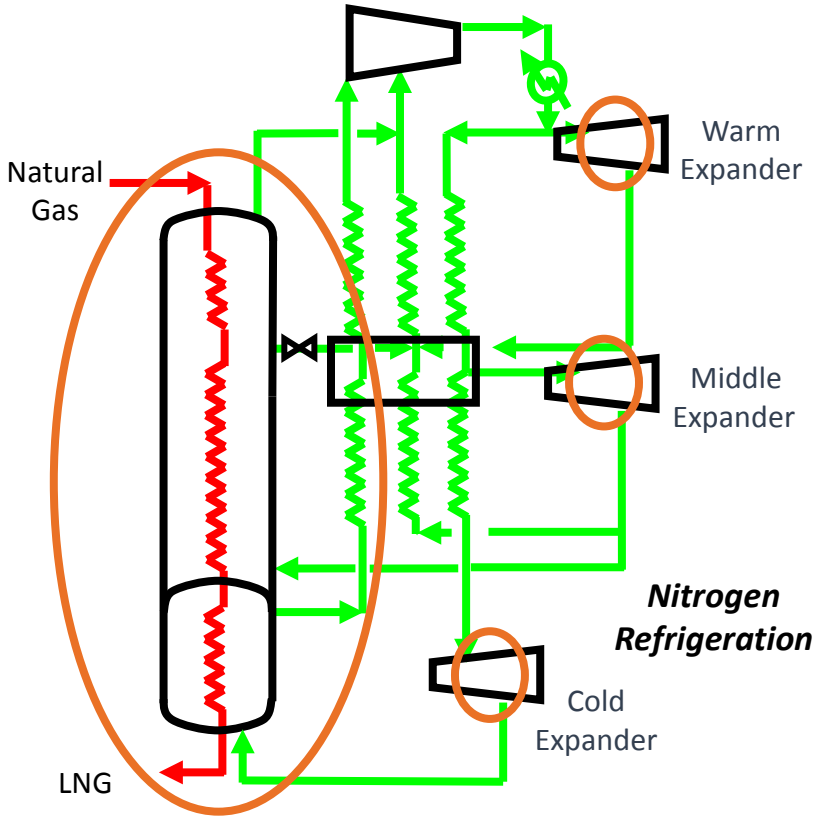
Key Technologies

Liquefaction Process

- Function: to liquefy the natural gas
- Several technologies considered from various technology providers;
  - Dual N2, C3/MR, Cascade etc.
- Redundancy for increased availability and robustness
- Rapid ramp-up
- Safety consideration
- N2 is selected due to lean gas field



Source: APCI

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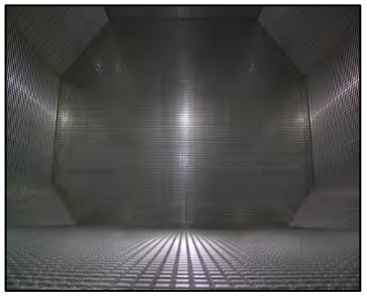
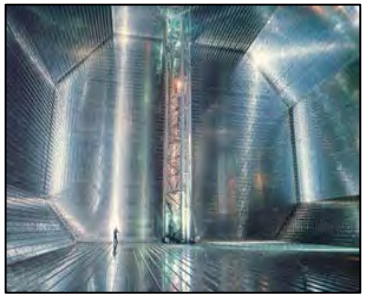
Key Technologies

Cargo Containment System

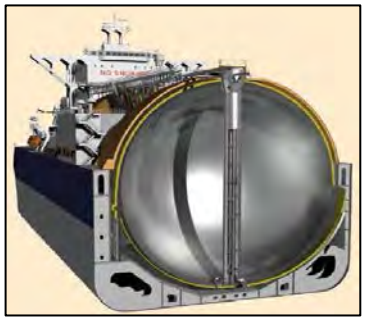
- Function: to store the LNG
- Available technologies: semi-prismatic, moss, membrane etc.
- Considerations:
  - Least susceptible to sloshing and Structural Integrity
  - Footprint, weight & vessel displacement
  - Cost competitiveness
  - Operating cost and BOG efficiency
  - Shipyard capability and constructability



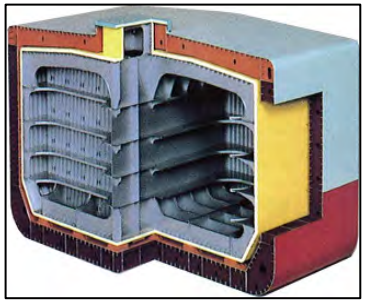
Membrane
GTT Mark III



Membrane
GTT No 96



Independent
Moss Type



Independent
IHI-SPB

Source : *GTT, IHI and Moss*

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Key Technologies

Marine Loading Arms

- Function: to transfer the LNG into the LNGC
- One of the most critical design consideration
- Capability to load time to avoid plant shutdown
- Ship to Ship or Side by side offloading with targeting system
- Safety Consideration
- Require compatibility study between FLNG and LNGC
- Highly dependent on:
  - Relative size of FLNG and LNGC
  - Sea state conditions
  - Draft variations during off-loading
  - Working envelope

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Challenges in the development of FLNG

- No track record / reference
- Marinisation of topside equipment
- Towing window due to typhoon
- Feed gas composition vs. process design envelop
- Multi-product handling (LNG, condensate, LPG if any)

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Conclusion

- FLNG is a breakthrough technology and it is a game changer and require bold decision in becoming the pioneer.
- FLNG signifies technology advancement solution which adds value to marginal and stranded offshore gas resources which otherwise would be uneconomical to develop via onshore LNG
- PETRONAS FLNG will become a reference / benchmark for future projects
- Design phase has considered all aspects of risk but the real operational challenges & difficulties are yet to be experienced

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END OF SLIDE
THANK YOU