Delivering Floating LNG in the Timor Sea

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Project Overview

- A joint venture with Santos (GDF SUEZ operator with 60%)
- To extract gas from three fields 250 km west of Darwin, in the Timor Sea
- Using a Floating LNG production facility
- Producing around 2.4 million tonnes of LNG per annum
- Sold to fast-growing Asia-pacific markets

- The joint venture brings together Santos’ regional upstream knowledge and GDF Suez’ globally renowned expertise in LNG and E&P.
GDF SUEZ experience in developing new LNG technologies

- 50 years in the LNG business and LNG technology development
- First LNG chain to supply Le Havre, France (Gaz de France) and Canvey Island, UK (British Gas) from Arzew (Algeria) in 1964
- 1980: Montoir – First to build membrane full containment tanks
- 2001: Partner in Snohvit's innovative liquefaction project in the Arctic
- 2002: First to order Diesel electric LNG carriers
- Delivery of 2 Shuttle and Regasification Vessels in 2009-2010
- Leverage in-house Research and Development Centre as well as its international partnerships
Bonaparte LNG will target gas demand in Asia, expanding GDF SUEZ’s LNG supply portfolio of 16 Mtpa which already includes Latin America, Europe, Africa and the Middle East.

Bonaparte LNG’s geographical location presents an excellent platform for anchoring the company’s strategy to make inroads into a region forecasting significant growth in LNG demand. From its current portfolio, GDF SUEZ has already contracted short- and mid-term sales to CNOOC, Kogas, Petronas, Petronet LNG, GAIL, PTT...
BLNG – The way forward

- Aug 2009: GDF SUEZ enters Bonaparte LNG JV
- Feb 2010: GDF SUEZ opens Australian office
- Aug-Oct 2011: Pre-FEED contracts awarded
- Mar 2012: End of Concept Select
- Jul 2013: Start FLNG Concept Definition
- Nov 2012: Federal Environmental Approval
- Oct 2012: End of Concept Select
- Q1 2014: Start FEED
- Jul 2015: FID
- 2019: First Gas
BLNG – An integrated project
FLNG advantages

- Reduced environmental footprint: no need to compress the gas for transmission purposes, to lay down long pipelines to shore, to dredge, to build a jetty and an onshore LNG plant.
- Can be cost-effective versus onshore options (for remote gas fields, high local labor costs, lack of appropriate onshore sites,...)
- Can limit execution risks (construction controlled in a shipyard, limited soil quality issues)

Remote medium-sized gas fields can be monetized.
Overview of FLNG projects in the world

The most advanced projects are located in Western Australia, Colombia, Malaysia and Indonesia.
FLNG size compared to other ships

- Queen Elizabeth II
- QFLEX LNG CARRIER
- QMAX LNG CARRIER
- BONAPARTE LNG (2.4 Mtpa)
- SHELL PRELUDE (3.6 Mtpa + 1.7 Mtpa liquids)
Baseline Environmental Studies: Conclusions

- Typical of other open water environments in the Timor Sea.
- Low biological activity, no recognised high sensitivity areas (i.e. reef ecosystems).
- No significant commercial fisheries.
- EPBC* listed species transit the Project area – not recognised as a feeding, breeding or resting area.
- Noise data identified Humpback, Sperm and Bryde’s whales. No Blue whales were identified. No whales sighted during marine baseline surveys.
- Flatback and Olive Ridley turtles known to forage in areas within the vicinity of the Project area – no turtles or foraging areas identified during marine baseline surveys.

On October 25, 2012, after public consultation, the Australian Environment Minister approved the development of the Project subject to 15 conditions such as the implementation of various Management plans and Monitoring Programs.

* EPBC Act : Environment Protection and Biodiversity Conservation Act, central piece of Australian Government’s environmental legislation
FLNG approved features

- Steel, double-hull floating facility
- Up to 400m long and 70m wide
- Anticipated project life 25 - 30 years
- Turret mooring, staying on station during severe weather event
- Storage capacity of 210,000m³ for LNG/40,000m³ for condensate
- Vessel movements - 1 LNG carrier/11 days and 1 condensate tanker/month
The technology is proven but not for FLNG service (motions, congestion, weight management)
Key points validated during Concept Selection

**Gas treatment processes**
(AGRU, Dehydration, Hg removal)

Selection of processes and technologies, qualification of motion sensitive equipment

**Gas liquefaction process and mechanical drivers:**
(N2 expansion, SMR, DMR)

Comparison and prequalification of liquefaction processes and technologies to drive the compressors (Gas Turbines, Electric Motors, Steam Turbines)

**LNG storage technology**
Membrane (GTT) or SPB (IHI)

Qualification of containment system to afford sloshing meeting high reliability and safety criteria and high availability level

**Offloading system:**
- Validation of side by side transfer using marinized loading arms according to metocean conditions (wind, waves, currents) and safety constraints
- Qualification of equipments
- Definition of operational limitations
- Survey of Tandem systems development as alternate solution if required

**Turret**
disconnectable or not disconnectable

FLNG sails away when cyclones alert or permanently moored and designed to face 10,000 years return period Metocean event

AGRU : Acid Gas Removal Unit
Hg : Mercury
N2 : Nitrogen
SMR : Single Mixed Refrigerant
DMR : Dual Mixed Refrigerant
SPB : Semi-Prismatic type B
Validated key points

Stay on station or Sail away?

- The location is a cyclone origin area, resulting in frequent warnings with little time to determine likely severity.
- Improving the design from 100 years (winter storms) to 10,000 years (cyclonic storm) not significantly more onerous; owing to short distance for wave height development even in high severity cyclones.
- Sailing away leads to significant loss in production as every event results in a disconnect.

Permanently moored station is selected.

Gas treatment processes:

- **Acid Gas Removal Unit**: this is the most challenging equipment as the removal of CO2 down to 50 ppm is usually done onshore through high columns (amine absorber and regenerator) whose efficiency could be affected by motions. Nevertheless, thanks to physical models, some vendors are able to guarantee separation efficiency with MDEA for motions (roll, pitch) which will be very rarely obtained on this site. **MDEA process is selected.**

- **Dehydration, Mercury removal**: Standard technologies used onshore, not sensitive to motions as solid adsorbers, will be selected here (molecular sieves for dehydration, sulphur impregnated carbon for mercury removal).
Liquefaction process

An extensive comparison of suitable processes has been conducted during Concept Selection

- Selection among 13 processes, based on gas (flammable or not) expansion or liquid hydrocarbon refrigerant
- Deeper comparison, involving process licensors and equipment vendors, made for 7 processes against Open art nitrogen expansion,
- At this stage, **APCI DMR is selected** as the base case for the next phase of this project

**Selection criteria applied to DMR:**

- **Safety**: preliminary QRA shows a risk level similar to N₂ expansion (higher risk from explosion but lower risk of fatalities due to unignited leaks; limited contribution to the global IRPA anyway)
- **Environment**: lower CO₂ emissions due to higher efficiency
- **Technical robustness / Operability**: limited number of equipment (one train for 2 to 3 mtpa), heat exchangers proven onshore and not much affected by motions, support from an experienced licensor
- **CAPEX/NPV**: overall CAPEX/NPV should be similar (similar CAPEX, lower availability but better efficiency)
Mechanical drivers

Comparison of drivers for liquefaction compressors has been conducted as well

- Availability of such drivers with the appropriate power is key for the design of liquefaction trains
- Steam turbines discarded first due to higher CAPEX, number of equipment, space requirements, and operation issues
- Study of Gas Turbine-drive versus Electric motor-drive carried out with an external consultant, including inputs from vendors
- At this stage, **GT-drive is selected** as the base case for the next phase of this project

**Selection criteria :**

- **Safety** : some advantage to E-drive but with a very limited contribution to the global IRPA anyway; in case of E-drive, power is also produced by Gas Turbines
- **Environment** : some advantage to GT-drive in terms of CO2 emissions (avoid power losses in the distribution system) but not very significant
- **Technical robustness / Operability** : similar level with pro and cons for each technology (lack of offshore references for the largest drivers)
- **CAPEX/NPV** : better NPV for GT-drive due to lower CAPEX and OPEX (lower number of equipment, weight and footprint) and better efficiency, despite lower availability
LNG cargo containment system

Issues:
- sloshing (partial filling capability),
- offshore maintenance and repair,
- operational feedback,
- tank size, construction timeline,

Options:
- Semi Prismatic type B (IHI)
- Double row membrane concepts (GTT)

Both technologies are qualified for the next step but reinforced membranes look more cost-effective.
Offloading system

**Availability issue**: Need for a system able to carry out the whole LNG loading process in a safe manner within an expected 24 h window from approach to departure of LNG carrier.

**Options**:

**Base case studied**

- **Side by Side through rigid arms or flexible hoses**
  - **Pros**: existing technologies, existing LNG carriers fleet
  - **Cons**: metocean limitations for operation

**Alternative case**

- **Tandem through flexible hoses**
  - **Pros**: Increased operational windows (metocean)
  - **Cons**: lack of experience, need for specific LNG carriers

Taking into account Full bridge simulations, basin tests and numerical simulations carried out for the Triton FSRU project, and preliminary QRA, downtime studies and FLNG/LNGC side by side moored dynamic simulations specific to Bonaparte, **Side-by-side is selected for this site** (mooring limitations not reached 98.8% of the time).
BLNG – FLNG main characteristics

- Production capacity: 2.4 MTPA
- LNG storage: 210,000 m³
- Condensates: 40,000 m³
- APCI-DMR gas liquefaction process
- Gas turbines for liquefaction cycle compressors and power gen
- LNG Offloading side by side
- LNG storage technology Reinforced Membrane
- Gas treatment processes Amine-based process
- Condensates offloading tandem
- Turret and risers
- FLNG will stay on-station and designed to survive 10,000 years return period Metocean event
- LQ location at the AFT

Production capacity: 2.4 MTPA
LNG storage: 210,000 m³
Condensates: 40,000 m³
## Technology: choices made by others

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Concept definition objectives (2013)

- Optimise major design parameters and equipment to create a BOD for FEED
- Competitive bidding process; world-class contractors involved with shipyards (Technip with DSME, KBR with Hyundai)
- Reduce uncertainty around cost and schedule
- Optimisation of subsea infrastructure, wells (pre-FEED with Woodgroup Kenny)

Enter into FEED with a robust and cost-effective design and with highly skilled and committed industrial partners