Commercial and Technical Considerations in the Developments of Offshore Liquefaction Plant

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23rd World Gas Conference, Amsterdam
5-9 June, 2006
Amsterdam, The Netherlands

Summary

Why Offshore LNG Plants?

Commercial Challenges

- Host Government Considerations
- Buyer’s Worries
- Lender’s Risk Assessments

Technical Challenges

- Process and Equipment
- Liquefaction and LNG Storage
- Offshore LNG Transfer
- Improvement and Safety

Conclusion

Why Offshore LNG Plants?

Economical access to offshore stranded gas

- Suitable for both associated and non-associated gas
- CAPEX savings and shorter development to market

Conceptual engineering 1970's

- FEED for Kangan natural gas field in Persian Gulf
- Salzgitter Group and LGA Gastechnik barge concept for West Africa

Mobility and greater recovery of natural gas

Commercial Challenges
Offshore Liquefaction Plant

More commercial issues but will be resolved on the same basis as a land-based plant

No commercial distinction in the risks associated with a FPSO, GBS or land-based plant

Offshore LNG projects are site specific as land-based projects

Major challenges will entail addressing commercial and technical concerns of the host government, the buyers and the lenders

Host Government's Concerns

Ownership and "commercial declaration" of natural gas under the PSC (Production Sharing Contract) or Concession Agreement

Ownership of the FPSO and other supporting moveable equipment

Local employment and content during construction and operation of an offshore facility

Domestic gas use and spin-off industrial development

Safety of unproven concept

Host Government's Concerns

Need for fiscal concessions without reciprocal benefits

- Tax holidays
- Accelerated depreciation
- Waiver of import duties and taxes
- Oil and gas tax regime

Required government guarantees and assurances

Public visibility and acceptability

Buyer's Worries

Reliability of the system to produce and deliver LNG as contracted

Assurance of sufficient gas reserves to meet contract obligations

Special purpose vessels required for bow or stern tandem loading

Buyer's Worries

Special purpose vessels limits FOB attractiveness and buyer's shipping flexibility

Availability of "spot cargoes" tied to vessels availability

Expanded contractual and force majure terms to compensate for increased operational risk

Availability of expansion quantities

Lender's Risk Assessment

Reliability - will it generate revenues sufficient to repay the loan?

Safety - resistance to collision and consequence of gas leakage

CAPEX, OPEX and unforeseen cost

Approval of classification society

Country of registration or flagging

Lender’s Risk Assessments

Longevity of reserves versus loan term

Sponsor experience and reputation in offshore operations

Recourse to sponsors

Each project will be evaluated on the basis of its own merits

Technical Challenges
Process Considerations

Compactness

Minimize hydrocarbon refrigerant

Reduce effects of motion

Less equipment counts

Flexibility

Availability

Safety

Equipment Consideration

Liquefaction Heat Exchangers

- Higher design pressure to reduce flare
- Avoid fluid maldistribution
- Equipment integrity verification
- Reduce height with separate units

Reduce numbers and sizes

Modularization

Flexibility and reliability

Liquefaction Processes

Nitrogen expansion cycle

Single mixed refrigerant cycle

Double mixed refrigerant cycle

Mixed fluid cascade cycle

Multiple expander cycle

Condensate and LPG could also be produced along with LNG on the same floating facilities

LNG Storage

Floating barge design

- Rectangular shape favors spacing
- Concrete hull versus steel hull

LNG storage

- Spherical, robust, has less deck space
- Membrane, sloshing effects can be reduced, has more deck space
- Prismatic, another alternative

Floating LNG Plant

Courtesy of Moss Maritime

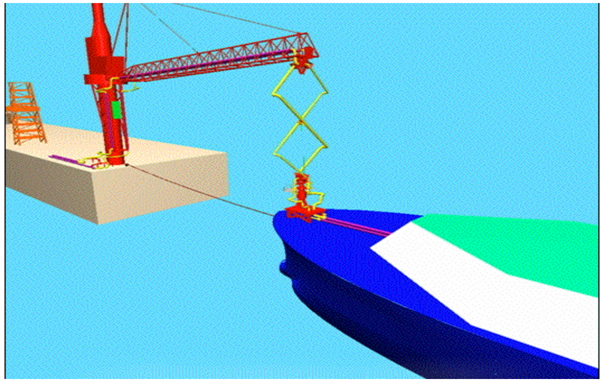
Offshore LNG Transfer

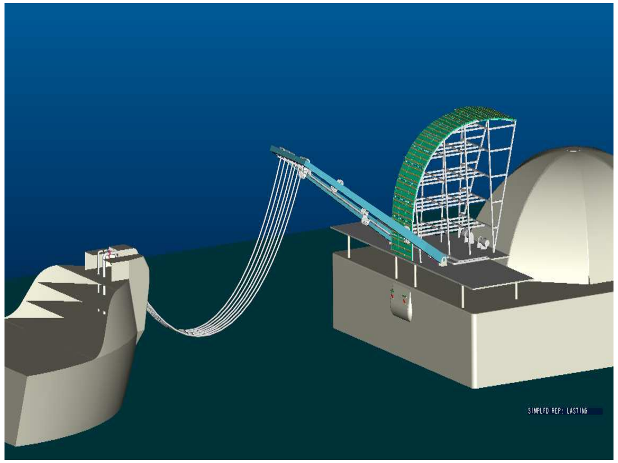
Loading patterns

- Side by side
- Boom to tanker or tandem

New development

- Coflexip flexible piping
- SPM articulate arms
- Offshore cryogenic loading (OCL)
- ITP undersea LNG pipeline





Improvement Concepts for Offshore LNG Plants

	Technology	Equipment	Safety
Liquefaction	Better compressor fit with aero-derivative turbines	Improve heat exchanger performance under effects of motion	Reduce relief loads with better control and design
Utilities	Use gas turbine to generate electricity for all electric driven refrigerant compressors	Synergy and sharing of utility with other units such as LPG and condensate recovery and oil production	Reduce flare loads and sizes; Consider using vents
Storage	Improve other storage concepts for effects of motion	Improve membrane and other type tanks for offshore large storage	Reduce risks of spills, collisions and proximity to cryogenic processing equipment
LNG Transfer	Transfer of LNG of side by side or in tandem between FPSO and ship or ship and FRSU	Loading arms: testing of tandem loading and the cryogenic flexible hose loading	Reduce risks of LNG spill and fire during transfer of LNG

Safety Consideration

Arrange overall plant layout according to risk level

Apply concept safety review and quantitative risk assessment

Turret mooring to allow the floating barge to weathervane

Vapor dispersion and blast overpressure modeling

Escape, evacuation, and rescue systems

Conclusions

Offshore gas liquefaction make sense to

- Facilitate deep water exploration and production
- Monetize “stranded” gas resources
- Eliminate costly production platforms and pipelines
- Reduce time and expense of land reclamation, dredging and harbor development
- Overcome environmental, NIMBY and BANANA (Build Absolutely Nothing Anywhere Near Anyone) concerns