HOW TO DEVELOP AN ECONOMICAL SMALL CAPACITY FLOATING LNG TAKING ADVANTAGE OF A DESIGN FOR A LARGER CAPACITY UNIT

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LNG17- HOUSTON 2013- TOTAL- How to develop an economical small capacity FLNG
Agenda

• 16 years of Operating experience offshore
• 13 years of FLNG development
• Basis of Design of the Generic Total FLNG 2.5Mtpa
• How to develop an economical small FLNG
• Basis of Design for the 1Mtpa FLNG
• Process simplification
• Architecture simplification
• Layout which preserve the key criteria: safety, simplicity, operability
• Leverage on Technical Cost break down
• Conclusions
• film
16 years of experience of floating and producing facilities

- Akpo: First oil 2009
- Pazflor: First oil 2011
- Usan: First oil 2012
- CLOV: First oil 2014, Contract execution
- Egina: Contract CFT
- Moho Bilondo: First oil 2008
- Dalia: First oil 2006
- Girassol-Jasmim: First oil 2001
- NKOSSA: First oil 1996
- NKOSSA II - LPG

PROJECT EXECUTION AND OPERATIONAL FEEDBACK FROM FPSO-FPU TO FLNG

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An innovative response to new challenges

Our FLNG design philosophy is based on TOTAL experience with LNG plants, LNG shipping and FPSO design and operation.

Supported by TOTAL corporate technical referential, certified ISO9001

13 years of R&D program to support FLNG design

– Process, liquefaction optimization
– Transfer system and cryogenic flexible
– Qualification and implementation of new technology
FLNG basis of design

**SAFETY, OPERABILITY, SIMPLICITY**

<table>
<thead>
<tr>
<th>FLNG Basis of Design</th>
<th>TOTAL DESIGN</th>
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<tbody>
<tr>
<td>Liquefaction process</td>
<td>Inert gas N2+CO2</td>
</tr>
<tr>
<td>Compressor drivers</td>
<td>Electrical drive</td>
</tr>
<tr>
<td>LNG storage</td>
<td>Membranes</td>
</tr>
<tr>
<td>LNG transfer</td>
<td>Tandem Offloading</td>
</tr>
<tr>
<td>flare position</td>
<td>at the stern</td>
</tr>
<tr>
<td>Living Quarter</td>
<td>up wind at the bow</td>
</tr>
</tbody>
</table>

The main HSE Design criteria

- Protection of the personnel on board, LQ up wind at bow and flare at stern
- Reduction of Hydrocarbon inventory by using inert gas liquefaction process
  - Reduction of collision risk by using tandem LNG offloading
  - No Hot point in the process by using Electric-only drive configuration

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How to develop an economical small FLNG

• Main challenges to down scale to a small FLNG
  – Process selection
  – Lay-out arrangement
  – Storage capacity plan optimization
  – Define what is the maximum-optimum size achievable for each equipment
  – No compromise on Safety & Operability

The aim of this study was hence to explore the means of simplification in order to reduce the investment as much as possible
Based on a Gulf of Guinea Generic field

Process Basis of Design
- 1.2 MMTPA of LNG FOB
- CO2<1%, No H2S
- No LPG’s production.
- Liquefaction pressure = 80 bars

3+1 Gas turbines generators

Plant availability = 90%
PROCESS SIMPLIFICATION

2.5Mtpa FLNG
- 2 trains of liquefaction
- N2 + CO2 pre-cooling
- 5+1 gas turbines generators
- NGL recovery unit for heavies
- Heating medium: steam
- End flash and BOG compressors
- Cold recovery on EFG

1.2Mtpa FLNG
- 2 smaller trains of liquefaction
- No CO2 pre-cooling
- 3+1 gas turbines generators
- NGL recovery unit for heavies
- Heating medium: hot water
- End flash in tanks: EFG & BOG compressors merged
- No cold recovery on EFG
2.5Mtpa FLNG
- Storage based on 155,000 m³ Lot
- Tandem LNG offloading with hoses
- Module weight: max 2500 t
- Turret mooring
- Elec. & Inst. room on deck
- The power generation on deck

1.2Mtpa FLNG
- LNG storage 75,000m³
- Tandem LNG offloading with cryogenic hoses
- Module weight: max 2500 t
- Spread moored configuration
- Elec. & Inst. room in hull space
- The power generation on deck with cantilever
Main characteristic of the 1.2Mtpa (FOB) FLNG

- Hull size = 300m x 61m
- Topside Modules gross dry weight = 28,000 tons
- Electrical Power requirement = 100MW
- LNG & Condensate storage
**Leverage on Technical COST break down**

<table>
<thead>
<tr>
<th>Feed Gas transfer cost:</th>
<th>OTHER COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Gas pipe price or</td>
<td>- pre-FID cost</td>
</tr>
<tr>
<td>- Drillex + SPS + UFR</td>
<td>- insurance</td>
</tr>
<tr>
<td></td>
<td>- taxes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLNG Upstream</th>
<th>Economical interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>• CGR, CO2</td>
<td>• Return On Investment</td>
</tr>
<tr>
<td>• Mooring type</td>
<td>• Pay out Time</td>
</tr>
<tr>
<td></td>
<td>• Government Taxes</td>
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</table>

<table>
<thead>
<tr>
<th>FLNG downstream</th>
<th></th>
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<tbody>
<tr>
<td>• Liquefaction</td>
<td></td>
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</tbody>
</table>

**OPEX**

Small FLNG architecture can present economical interests
Conclusions

• Based on its experience in building and operating FPSO’s, TOTAL has decided upon some options in the design of the FLNG whatever the production between 1Mtpa to 4Mtpa.

SAFETY, SIMPLICITY and OPERABILITY

• The main applications for which such small FLNG can be considered economical are as follows:
  – Offshore stranded gas field with low CO2 content + high CGR
  – Associated gas available from offshore oil field
  – Near shore location to liquefy country excess gas or shale gas
Film

Floating LNG

A solution focused on innovation, safety and operability

Total's design is based on an inert-gas liquefaction cycle, tandem offloading and electric-only drive: choices that ensure the safest and most reliable solution on the market. Our FLNG vessel is ready to produce, liquify and offload natural gas on the high seas.

New gas resources
The economically viable solution for difficult-to-access reserves

The expertise of a major player
The solution of a specialist in FPSOs, the deep offshore and LNG processes

Safety, an absolute priority
The foundation of the design process: managing risks and keeping people safe

Operability and performance
Flexible, straightforward technologies to overcome the challenges of the offshore environment

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