Technological innovation and infrastructure in the LNG industry

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History of the LNG industry

1955 – 1965
Pioneer age

1965 – 1975
Industrial and commercial development

1975 – 1995
Industrial and commercial maturity

1995 – 2005
New expansion phase: Mega-trains,...

2005 – Present
FSRU, FLNG, Terminal Conversion

Le Havre, France

Kenai LNG Plant, Alaska

Qatari mega trains
Innovation in Liquefaction
Innovation in Liquefaction

**OBJECTIVES**

- **Construction cost reduction**
  - Use of aeroderivative gas turbines
  - Reduction of feedgas consumption: 20% - 25%

- **Operation cost reduction**
  - Increase in train sizes from 1.3 to 7.8 mtpa
  - 40% liquefaction costs reduction
  - Conversion of LNG terminal in the US
  - CAPEX savings: 10%
  - Modularization construction
  - CAPEX savings: up to 10%
  - Expanders for end flash
  - 1% increase in LNG volumes produced

- **Business Development**
  - FLNG / Liquefaction barges
  - Access to more than 800 stranded fields.
  - Ship-to-ship / Offloading system
## Monetizing stranded gas fields: FLNGs

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Challenges</th>
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### Advantages
- More than 800 stranded fields greater than 1.5 Tcf in the world, suitable to FLNG solutions
- Reduced environmental footprint
- Cost-effective versus onshore options
- Can limit execution risks
- Redeployable
- Adaptation of existing technologies

### Challenges
- Meteocean constraints (berthing, cyclones)
- Hull (to remain compatible with shipyards)
- Turrets (efforts, safety): Designed to resist a hurricane with a return period of 10,000 years
- Weight management
- Congestion
- Motions management
Key technological points to be validated in FLNG design

- Gas liquefaction process and mechanical drivers
- Offloading system
- Gas treatment processes
- LNG storage technology
- Turret
Innovation in Shipping
Innovation in Shipping

**OBJECTIVES**

**Operation cost reduction**
- Increase in shipping capacity: from MedMax to QMax
- From conventional steam turbines to Dual Fuel/Tri-Fuel Diesel Electric engines, MEGI, …
- Development of membrane containment system technology

**Business Development**
- Ice-breaking LNG tankers

**INNOVATION**

- Decrease shipping costs: by up to 0.5 $/MMBtu*
- Better efficiency of propulsion: from 25% to 30%
- BOG rate decrease from 0.15%/day to 0.10%/day

**BENEFIT**

- Access to new Arctic resources: 30-40 mtpa currently assessed and more prospective areas.

* For a 40-50 days round trip
Ice class LNG vessels for Arctic LNG project

- Ice class LNG vessels to be designed to ship through Kara Sea at all times and in North Sea Route during summer.
- Capacity up to 170,000 m3.
- Double acting concept, forward and backward
- Ships would cost between US $300 million to $350 million each.
- Speculative projects post 2025 in Russia, Greenland, Alaska…
Innovation in Regasification
Innovation in Regasification

**OBJECTIVES**
- Construction cost reduction
- Operation cost reduction
- Business Development

**INNOVATION**
- New FSRUs / Conversion of LNG carrier into FSRUs
- Air heating technology
- Improved fuel efficient in FSRUs with open loop technology, recondensers, ...
- FSRUs enabling a first step before onshore terminal, lower initial imports and fast installation

**BENEFIT**
- Lower CAPEX (equivalent to 10-20% of onshore terminal)
- Construction time: 10-18 months vs. 36-60 months
- Terminal CAPEX reduction: 1%
- Savings of up to $100k/day for a 3.5 mtpa FSRU
- Access to new markets: FSRUs could amount to 60 mtpa in 2020 (10% of regasification capacities)

Fos Tonkin, 1972
GDF SUEZ Neptune, 2010
Floating Regasification

A new regasification scheme: FSRUs

- Options: “permanently” moored, offshore or in a port (quay, berth)
- Being regularly used in regasification mode, their efficiency improvements will be:
  - Open-loop (limit fuel consumption)
  - Recondenser (limit BOG flaring); a higher operating pressure of LNG tanks would simplify BOG management
  - LNG transfer: ship-to-ship (aerial flexible hoses, articulated arms) or ship-to-jetty-to-ship
Development of Retail LNG markets
Retail LNG for maritime uses

**OBJECTIVES**

- Development of an LNG Bunkering vessel to feed sea-going ships
- Ship-to-ship transfer

**INNOVATION**

- Market potential of 25-30 mtpa by 2030

**Environmental concerns**

- A 5000m³ LNG Bunkering Vessel is currently developed by GDF SUEZ, together with NYK.

- The Basic concept approval was awarded by Bureau Veritas in May 2012.

- The Ship-to-Ship system is developed to enable successful and safe bunkering of various kind of customer ships (container, ro-ro, etc.)

**Studies ongoing to:**

- Optimize the BOG management while using pressurized LNG tanks.
- Validate the LNG quality with regards to ageing LNG.
- Evaluate various conditions of the LNG transfer for a safe design of the bunkering system (STS).

**BENEFIT**
THANK YOU!

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