An industrial perspective of the role of R&D and innovation in frontier gas monetization projects

Philip Hagyard, Senior Vice President, Gas Monetization, 3rd Trondheim Gas Technology Conference (TGTC-3). 4th-5th, June 2014
Outline

- Technip’s credentials
- LNG innovation history
- Innovation within frontier mega projects - FLNG
- Tomorrow’s projects and their needs
Technip Today

- With engineering, technologies and project management, on land and at sea, we safely and successfully deliver the best solutions for our clients in the energy business
- Worldwide presence with 40,000 people in 48 countries
- Industrial assets on all continents, a fleet of 35 vessels (9 of which under construction)
- 2013 revenue: €9.3 billion

Energy is at the core of Technip
Technip in Norway

- Technip Norge is a leading EPCI contractor for subsea projects on the NCS
- Main office in Sandvika and Stavanger.
- Spoolbase in Orkanger (Trondheim)
- Norwegian workforce exceeds 600
Technip is Present Across the Gas Value Chain

Oil Field Facilities inc. Shale oil

Associated Gas

Non-Assocciated Gas

Gas Field Facilities inc. Shale gas

Khursaniyah, Saudi Arabia

Gas Processing

Methane (C₁)

CO₂, Sulphur, Water

Onshore Liquefaction

Offshore Liquefaction

GTL

Petrochemicals
- Ammonia/Urea
- Hydrogen
- Polyethylene
- Polyvinyl chloride...

LPG

Gasoline

Condensate

C₃/C₄

C₅₋₁₂

C₅₋₂₀

Yansab, Saudi Arabia

Steam cracker (Ethylene)

Ethane (C₂)

Phu My Fertilizer, Vietnam
Two projects taking LNG offshore

Prelude FLNG

Petronas FLNG1
One project in the Russian Arctic

“Using only proven technologies with established effectiveness and reliability”

Yamal LNG

Courtesy of JSC Yamal LNG
LNG related innovation at Technip

- **Flowsheet development**
  - Cryomax for Gas treatment or Liquefaction
  - Nitrogen rejection from LNG and natural gas
  - High efficiency LNG plants

- **Products developed with manufacturers**
  - Wieland – dual enhanced surface tubes for propane pre-cooling exchangers.
    50% market share in the last 10 years

- **Advanced numerical simulation**

- **FLNG related:**
  - Developments using flexible pipe
  - Cryogenic spill protection
GTL: Sasol alliance

- **May 2013 alliance**
  - FS, BE and FEED services for all future Sasol projects
  - Design & development of the FT section

- **Canada**
  - 96 kbdps

- **Lake Charles**
  - 96 kbdps

- **Uzbekistan**
  - 38 kbdps

- **Oryx**
  - 34 kbdps

- **Natural gas**

- **GTL**
  - Diesel: 70 - 80%
  - Naphtha: 20 - 30%
  - LPG: 2 - 5%

- **In operation**
- **Planned**
- **FEED**
II. LNG innovation history
Scale and efficiency … with reliability

Liquefaction plant efficiency has doubled in 30 years.
The LNG industry borrows and adapts ideas

- Cryogenics
- Mixed refrigerants
- CO2 removal
- Gas processing
- Power generation
- Compressor drivers
- Offshore
- Compact equipment
Small scale LNG projects provide opportunities

Innovation $\propto \text{CAPEX}^{-1}$

Yinchuan City, Ningxia Hanas LNG

- 2 trains x 0.4 Mtpa
- Air Products SMR liquefaction process
- May 2009 – Oct 2011

Recent projects, rich in innovation
- Removal of trace heavy components
- Variable speed EM driven compressors
- Nitrogen rejection
III. Innovation within a frontier mega project - FLNG
FLNG - mega projects with innovation

The LNG Supply Chain

FLNG: Upstream + Offshore Treatment, Liquefaction & Offloading on Transport
FLNG – principle innovations
... From Onshore to Offshore...

- Deck space management and module congestion
- Multiple deck levels including in the hull
- Weight control, centre of gravity and liftability of modules.
... designing for motion

Columns for condensate stabilisation/ NGL removal/ fractionation/ N2 rejection mandatory when required by composition

Columns of CO2 removal process - mandatory

Inlet separator

Acid Gas Removal

Dehydration

Mercury Removal

NGL Extraction

Liquefaction

Refrigeration

LNG Storage

Fuel gas

N2 Rejection

Refrigerant Make up/ LPG reinjection

C5+ Gasoline

Condensate Storage

Condensate offloading

Well fluids from subsea risers

Water & chemicals

LNG specific process units

CO2 disposal

Falling film mixed refrigerant
# N2 and DMR Liquefaction Processes

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<th>N2</th>
<th>DMR</th>
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<td>Efficiency of liquefaction</td>
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<td>Availability of equipment at large scale</td>
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<td>HC refrigerant inventory/ inherent safety</td>
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<td>Motion sensitivity</td>
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[Image: Technip logo]
Refrigerant Compressor Drivers

- Steam turbines
- Electrical motors
- Aeroderivative gas turbines

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<tr>
<th>ISO power (MW)</th>
<th>RB211</th>
<th>PGT25+G4</th>
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**Onshore**
- Power generation: ✓ ✓ ✓ ✓ ✓
- Mechanical drive: ✓ ✓ ✓ ✓ ✓

**Offshore**
- Power generation: ✓ ✓ ✓ ✓ ✓
- Mechanical drive: ✓ ✓ ✓ ✓ ✓

References:

- Onshore
- Mechanical drive
- Offshore
- Power generation
- Mechanical drive
Mechanical design

- Equipment and piping loads generated by motion
- HSE design
- Maintenance
- Salt and humidity from the marine environment
- Early site dates for hull equipment

Many critical challenges can only be discovered during detailed design & fabrication
Construction strategy borrowed from FPSO‘s…

At twice the size
## Shell Floating Liquefied Natural Gas Contracts

**TSC: Technip Samsung Heavy Industries consortium**

1. **Master Agreement 2009**
   - The design, construction and installation of multiple FLNG facilities over 15 years

2. **Generic FLNG FEED 2009**

3. **Agreement to strengthen 2012**
   - FLNG collaboration

4. **Prelude FLNG**
   - **FEED 2010**
   - **EPCI 2010**
     - Contract under which the FLNG would be built when the project received the final investment decision
   - **Notice to Proceed 2011**
   - **Hull steel cut 2012 Oct**
   - **Topside steel cut 2013 Jan**
   - **Hull launch 2013 Nov**

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TSC: Technip Samsung Heavy Industries consortium
Prelude EPCIC Execution Plan

- **Shell Project Directorate**
- **TSC Project Directorate**
  - IT/methods
  - Project controls
  - Procurement of tagged items and equipment
- **Technip Paris Operating Center**
  - Topsides engineering
  - Substructure interface management
  - Construction coordination

- **Samsung Heavy Industries**
  - Hull engineering
  - All construction & module integration up to mechanical completion
  - Procurement of steel and other selected bulk

- **Technip**
  - Onshore commissioning

- **Offshore**
  - Tow, Hook-Up & Commissioning

- **Kuala Lumpur, Malaysia**
  - **Technip Kuala Lumpur Operating Center**
    - Topsides engineering

- **Perth, Australia**
  - **Technip Perth Operating Center**
    - Subsea engineering & installation
    - Support for regulatory requirements
    - Offshore Hook-Up & Commissioning support

- **Goeje, South Korea**
IV. R&D and innovation needs for tomorrow’s projects
What is the next technological break-through for FLNG?

- **Improved ROI** – larger capacities, economies of scale, lean gas
  - High power density refrigerant compressors and drivers
  - Compact processing, with gas pre-treatment offering opportunities
  - Improved availability - High amplitude LNG loading system
  - High capacity gas swivels

- **Improved safety**
  - Tandem offloading
  - Improved reliability, lower maintenance

- **Rough sea FLNG**

- **Deepwater FLNG**

**Major breakthroughs will result from the operational feedback from the first FLNG’s**
Winterized FLNG as an ultimate goal?

- Yamal LNG has come after 100 LNG trains onshore
- How many FLNG’s before we’re ready for Arctic FLNG?

- Compact processing
- Low staffing
- High reliability
- Compact HVAC
- etc
Conclusion

- Major operators need to lead major developments
- EPC contractors can cross fertilize and drive implementation
- Suppliers have a key role
- Small scale LNG enables innovation
- Research organisations can contribute to all of the above
Thank you