Innovation in the LNG Industry: Shell’s Approach

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Three Hard Truths.

- World energy demand is accelerating
- Supply of “easy” oil and gas will struggle to keep pace
- Environmental pressures are increasing

History of Shell’s Involvement

- Technical Advisor to nearly 40% of world LNG capacity
- Innovations focusing on
  - Reduced Capex, minimising technical risk, EE and GHG, Project delivery, fast starts and robust operation.

40% of global supply
No More “Easy” Oil & Gas

- Remote location, harsh climate
- Deep Water
- “Tight Gas”
- Depleted fields
- High N₂, CO₂ content
- Sour gas

Photographs courtesy of SEIC, Orman Lange

Continuous Cycle of Improvement

- Over 45 years through:
  - Research & Development
  - Design & Engineering
  - Implementation & Execution
  - Operation & Maintenance
Technical Challenges

*SCOT is a Shell trademark

Gas Treating Technology Application

*Sulfinol is a Shell trademark
Gas Treating Developments

- ADIP™ & SULFINOL™ innovations
- Post combustion applications: CANSOLV™
- Column Internals – Shell HIFI & CONSEP™-X tray design
- CRYOCELL™, C3-Sep, membrane separation
- Sulphur recovery, including development with Paques B.V.

Biological desulphurisation process, developed with Paques B.V.

Liquefaction Technology Development

- Shell has liquefaction capability across large capacity range
- Exploring alternatives to C3-MR technology

Source: Wood Mackenzie

World Liquefaction capacity 1964 - 2000
New liquefaction technologies added between 2001 – 2012
Sakhalin II – Project of “Firsts”

- First Russian LNG production plant
- First offshore oil platform, Molikpaq, installed on Russian shelf
- First of their type, PA-B platforms installed anywhere
- First access to Russian gas by Asia-Pacific market

Photos courtesy of SEIC

DMR – Dual Mixed Refrigerant Technology

- Both refrigerant cycles use Mixed Refrigerants, which can be optimised for a wide range of Ambient T.
- DMR offers higher capacity for same driver set than C3/MR would
- Due to better balance between pre-cool and main cooling cycles in colder climates

Photos courtesy of SEIC
DMR – Balancing Power

- DMR
- C₃/MR

LNG capacity (MTPA)

Ambient Air Temperature (deg C)

Offshore LNG Production

- Floating LNG solutions
- When on-shore facilities are unfavourable
- 3.5 – 5 Mtpa gFLNG

- Facility Dimensions
  - Length between perpendiculars: 468m
  - Width: 74m
  - Circumference: 1.0 km
  - Design Draught: 17.4m
  - Displacement weight (fully loaded): 600,000 metric tonnes
  - Lightship weight (empty hull & topsides etc.): 205,000 metric tonnes
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**Prelude FEED**

**gFLNG**

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Innovation in Existing LNG Plants

**North West Shelf**
- Creating vendor competition for cryogenic exchangers
- Introduction of air cooling

**Oman**
- Low cost
- Production optimisation

**Brunei**
- Extended lifetime beyond 60 years due to second rejuvenation project
- Integration with power station
- Over the years, producing 140% of its original design

**Malaysia**
- Debottlenecking
- First axial compressor (increasing efficiency)
Operational Excellence

- Gas-GAME
- Advanced Process Control
- Automated MCHE cool-down
- Remote monitoring

Concluding Remarks

- Innovate throughout the value chain.
- Structured approach
- Based on identify, develop, deploy and operate cycles.
- Contributes to step change and incremental innovations.
- And successful project delivery.
- The LNG industry will continue to benefit from innovation as it evolves to meet the energy needs of the future.