Modular GTL: Transformational gas solution for the upstream industry
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Proven FEED, EPC and O&M capability

Projects ready for FEED

Solution for stranded gas & shale gas and oil

Industry approved and operating
Proven FEED, EPC and O&M capability

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Proven project execution capability

Feasibility Study
- Cost estimate (+/- 40%)
- Deliverables include: PFDs, H&MB, utility assessment and sized equipment list
- Optimisation strategies considered for client

FEED
- Cost estimate (+/- 10%)
- Deliverables include: Process data sheets, P&IDs, SLDs and operating guidelines
- FEED package ready for EPC tender stage

EPC and Commissioning
- Qualified EPC Contractor
- Balance of Plant
- CGTL FT

Operations and Maintenance
- Training Support OR Operate
- Balance of Plant
- CGTL FT
- Reactor Refurbishment Service
- Local Reactor Refurbishment Facilities
Project delivery and contracting strategy options

- Plant Sale
- Sale & Operate
- Plant Lease
- Reactor Lease
- Lease & Operate

Oil company

Guarantee

Finance
- Japan Export Credit Finance
- Banks
- CGTL Supply Chain

CGTL Engineering & PM Partner

Project Execution Partner

CGTL Supply Chain

Qualified & competitively tendered EPC Contractor
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CompactGTL - Wide ranging applications

**Onshore**

5 - 150 MMscf/d  
50 – 1,500 MMscm/yr  
≈ 500 – 15,000 bopd syncrude or diesel

- Monetise stranded & shale gas
- Convert associated gas
- Avoid flaring restrictions & penalties
- Unconventional gas – UCG, CBM

**Offshore**

5 – 50 MMscf/d  
≈ 400 – 4,000 bopd syncrude  
FPSO production ≈ 30 – 60 mbopd crude

- Avoid costly gas export or re-injection
- Avoid flaring restrictions & penalties
- Extended Well Test Facilities
- Early Production Systems
- Full Field Development FPSO
Completed engineering studies for NOC and IOC clients

Example 10,000 bopd project:

- 100 MMscf/d & 10,000 bopd
- Footprint ≈ 335m x 290m
- Capex ≈ $100k per bbl syncrude capacity
- Opex ≈ $18 per bbl syncrude produced
- 4.5 m³/hr water make-up
- 16 MW power demand
Completed study for EWT vessel with CompactGTL facility

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
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<tbody>
<tr>
<td>GTL Gas Feed</td>
<td>37 MM scf/d</td>
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<tr>
<td>Crude production</td>
<td>30,000 bbls/d</td>
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<tr>
<td>Syncrude product</td>
<td>2,200 bbls/d</td>
</tr>
<tr>
<td>NGL product</td>
<td>200 bbls/d</td>
</tr>
<tr>
<td>Produced water</td>
<td>10,000 bbls/d</td>
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Image courtesy of SBM Offshore
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CompactGTL deployment areas

Onshore

- Stranded gas
- Shale gas
- Shale oil
- Associated gas and stranded oil

Offshore
**Stranded gas**

- Over 40% of the world’s discovered natural gas is classified as stranded.
- Distance to market, lack of alternative solutions and location of reservoirs restricts development.
- The abundance of gas and sustained high arbitrage between gas and oil prices, represents a compelling opportunity for CompactGTL projects.

> 6,000 Trillion cubic feet of proven natural gas reserves worldwide

Source: BP Statistical Review and IEA
Shale gas and oil

- 48 major shale gas basins in 32 countries
- 97 Tcf proven recoverable shale gas reserves in US
- Total shale oil resource in US potentially exceeds 6 trillion barrels of oil
Associated gas and stranded oil

800 oilfields with problematic associated gas @ <50MMscf/d.
Reserves of 73 bn barrels of oil

Analysis carried out by Wood Mackenzie and Fugro Robertson
North America GTL potential

North America project drivers:
- Gas price uncertainty and lack of utilization locally
- Large number of shale gas, stranded gas fields and oil plays
- High demand for liquids products and good distribution network

Example economic analysis for 5,000 bpd CompactGTL plant in Texas:
- 23% IRR, 6 Year pay back
- Supply chain pre-investment ensuring reactor manufacturing capacity
- Reliable capex data @ $100,000 /bbl
  - Fluor studies and long term supply agreements with Sumitomo, KHI & Johnson Matthey
- Opex @ $18 per bbl product including all reactor refurbishment costs

Economic analysis:
Top 5 US states for CompactGTL projects.
IRR %

<table>
<thead>
<tr>
<th>State</th>
<th>IRR %</th>
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<tbody>
<tr>
<td>Texas</td>
<td>23%</td>
</tr>
<tr>
<td>Louisiana</td>
<td>20%</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>22%</td>
</tr>
<tr>
<td>Arkansas</td>
<td>23%</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>23%</td>
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</tbody>
</table>

Analysis based on royalty and tax regimes specific to each state.
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CompactGTL plant configuration

Feed Gas Quality

- Wide range of gas compositions and variability during operation
- Up to 50% CO2 accommodated and utilised by the process – no need for removal
- Contaminants (H2S, Cl, Hg ..) addressed by project specific gas treatment packages
Why is CompactGTL now possible?

Conventional steam reformer / ATR

Conventional FT reactor
Fixed bed or slurry phase

10x increase in specific throughput

Compact SMR Reactor
Compact FT Reactor

CompactGTL reactors using brazed plate & fin construction
Mini-channel CompactGTL reactor cores

- Brazed plate-fin reactor construction minimises metal content and weight

- Corrugated metallic catalyst inserts maximise active surface area per channel

- Automated catalyst insertion and removal
Technology demonstration & qualification

13 years in development since year 2000
IP 100% owned by CompactGTL
222 granted patents worldwide
275 pending patents worldwide
Independent verification by Bayer, SBM Offshore, Nexant, Fluor, TWI
Independent verification by Oil companies
Training centre and pilot plant
Wilton, UK 2008

- Operator training centre
- Petrobras operators successfully trained
- Full GTL process from gas to syncrude
- Continuous improvement

5 year operations
Commercial demonstration plant
Aracaju, Brazil 2010

- > 2 years operations
- > 90% availability
- Project fully funded by Petrobras
- Associated gas feed from offshore
- Fully integrated GTL process
- Commercial scale reactors – Sumitomo
- Catalysts – Johnson Matthey

Technology approval by Petrobras 2011
Technology scale up completed

Commercial CompactGTL FT Reactors: Constructed by Sumitomo
Comprise proven reactor cores modularised into 40’ containerised packages by Kawasaki Heavy Industries
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