Transformational gas solution for the upstream industry

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Industry perceptions of GTL?

• **GTL plants are huge?**
• **GTL needs cheap gas?**
• **GTL needs a large gas reserve?**
• **GTL needs excellent site logistics?**
• **GTL is complicated & unreliable?**
• **GTL is expensive?**

Facts or Myths?
3 proven and operational GTL processes

World scale GTL
Gas monetization
300MMscf/d ++

CompactGTL
Oilfield access
<= 150MMscf/d
Conventional GTL vs. CompactGTL

Shell Pearl Plant - Qatar
140,000 bbl/d GTL products
350 football fields

CompactGTL
Modular Plant
1,000bbl/d plant,
1 Football field
An ISO 9001 company; established 2006

Abingdon, UK Head Office
Rio de Janeiro Office
Wilton, UK Operations
Aracaju, Brazil Operations

> 100 man-years commercial GTL plant design & operations experience in SA & Qatar
Strong functional organization for project delivery & continuous improvement

Strategic Analysis → CEO Nicholas Gay → SHE & QA

Director of Business Development
Iain Baxter → Finance and Admin Manager
Jane Bardell

Business Development
Proposals
Contracts
Finance
IT
HR & Administration

CEO Nicholas Gay

COO Simon Clark

CTO Lary Kocher

Technology & Process Engineering
Reactors & Catalyst Management
IP / Commercial

Project & Contract Management
Brazil Office
Plant Operations
CompactGTL
The market
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
Options for associated & stranded gas

Distance to market for converted product [km]

- Reinjection & Flaring
- LNG
- CNG
- Pipeline

Power generation

Associated Gas MMscf/d

- 50
- 500
- 150
- 75
- 400
- 200
Flexible deployment

CompactGTL plant features

- Wide range of feed gas compositions
- Configurable for railcar transportation
- High availability – multiple modules
- High turn-down & flexibility
- Exchangeable 100 bopd CGTL reactor modules
- Configurable for utility self-sufficiency
- Fully modularised yard construction options

The number of active reactor modules can be adjusted to match the associated gas production profile over time.
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
CompactGTL
Technology overview
Why is this now possible?

Conventional steam Reformers / 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
Technology demonstration & qualification

Pilot plant
Wilton, UK - 2008

- > 5 years operations
- Full GTL process from NG to syncrude
- Reactors from candidate suppliers
- Catalysts from candidate suppliers
- Operator training centre & R&D facility

Commercial demonstration plant
Aracaju, Brazil - 2010

Technology approval by Petrobras 2011

- > 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 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
World’s first modular fully integrated and operational GTL facility!

Plant commissioned in Aracaju, Brazil, December 2010.

CompactGTL technology now approved by Petrobras for deployment

- Gas pre-treatment
- Pre-reforming
- Reforming
- Waste heat recovery
- Process steam generation
- Syngas compression
- Fischer Tropsch synthesis
- FT cooling water system
- Tail gas recycling
Technology scale up completed

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

Modular SMR Reactor

61,000 hours
SMR reactor & SMR catalyst in operation
FT reactor core construction

Modular FT Reactor

52,000 hours FT reactor & FT catalyst in operation
Typical 1,000bpd CompactGTL plant

FT
40’ FT modules

SMR
20’ SMR modules
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
Modular process overview

1. **Gas Treatment**
   - Gas feed
   - Pre-wash
   - Mercury removal
   - Heating
   - Sulphur removal

2. **Syngas Production**
   - SMR 1 reactor modules
   - SMR 2 reactor modules
   - Steam generation (WHB)
   - Syngas compressor
   - Water treatment
   - No Oxygen Required!
   - High CO₂ Possible!

3. **FT Synthesis**
   - FT cooling System
   - FT 1 reactor modules
   - FT 2 reactor modules
   - Product flash
   - HC rich tail-gas
   - GT drivers
   - H₂ rich tail-gas
   - Syncrude

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GulfPub.com/GTL
Hybrid process overview

Gas treatment:
- Pre-wash
- Mercury removal
- Heating
- Sulphur removal

Syngas production:
- Conventional ATR
- Oxygen separation unit
- Steam generation (WHB)

FT synthesis:
- FT 1 reactors
- FT 2 reactors
- FT 1 reactors
- FT 2 reactors
- FT 1 reactors
- FT 2 reactors

Water treatment:
- Fuel gas
- Tail-gas
- Syncrude

Gas feed flow:
- Pre-wash
- Mercury removal
- Heating
- Sulphur removal
- Conventional ATR
- Oxygen separation unit
- Steam generation (WHB)
- Water treatment
- Syncrude
Example – 100MMscf/d plant

Completed client study

- 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
25MMscf/d GTL integrated FPSO

- Fully integrated design
- 32,000 bbl/d crude production
- 2,000 bbl/d GTL liquids production
- Approval in principle from certifying authority
CompactGTL
Supply chain partners
World-class partners

- Each partnership represents a well established, long term relationship
- Certain exclusivity rights have enabled pre-investment & joint development funding by the supply chain, ensuring early capacity to deliver
- Reactor manufacturing by Sumitomo in Japan, and catalyst manufacture by Johnson Matthey in Europe, utilise established mass production techniques
- CGTL & Sumitomo jointly developed automated catalyst insertion & removal systems for the reactors
CompactGTL
Project economics
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 %

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<thead>
<tr>
<th>State</th>
<th>IRR %</th>
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<tbody>
<tr>
<td>Texas</td>
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<td>Louisiana</td>
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<td>22%</td>
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<td>Arkansas</td>
<td>23%</td>
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<tr>
<td>Pennsylvania</td>
<td>23%</td>
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Analysis based on royalty and tax regimes specific to each state.
Conclusions

• **GTL plants are huge?** Historically Yes
  – CompactGTL now available @ 200 to 15,000 bopd

• **GTL needs cheap gas?** It helps
  – Associated gas projects insensitive to gas ‘price’

• **GTL needs a large gas reserve?** No
  – Small strategic stranded gas projects now viable

• **GTL needs excellent site logistics?** No
  – CompactGTL deployed in 40’ modules < 35T

• **GTL is complicated & unreliable?** No
  – CompactGTL Brazil plant proven, 2 years operations

• **GTL is expensive?** No
  – Compelling economics & robust performance