Modular GTL: Converting a liability into economic value

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Director of Business Development
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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?
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
3 proven and operational GTL processes today

- World scale GTL
  - Gas monetization
  - 300MMscf/d ++

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

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

CompactGTL Modular Plant
1,000 bbl/d plant, 1 Football field
Why is this 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
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

Image shown courtesy of Petrobras
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
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

Gas Treatment Package & Pre-reforming
- CGTL SMR Modules or Conventional SMR or ATR
- Optional Hydroprocessing
- Diesel

Clean C1
- CGTL FT
- CGTL FT
- CGTL FT
- CGTL FT
- CGTL FT

Syngas
- CGTL FT
- CGTL FT
- CGTL FT
- CGTL FT
- CGTL FT

Syncrude
- CGTL FT
- CGTL FT
- CGTL FT
- CGTL FT
- CGTL FT

Syncrude: Waxes, Middle Distillates, Naptha

Diesel Naptha
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 – SBM Offshore

- Fully integrated design
- 32,000 bbl/d crude production
- 2,000 bbl/d GTL liquids production
- Approval in principle from certifying authority
Technology overview
Technology demonstration & qualification

Pilot plant
Wilton, UK - 2008

- > 4 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

- > 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 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
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.
Brazil plant movie
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
CompactGTL - process overview

**Gas Treatment**
- Pre-wash
- Mercury removal
- Heating
- Sulphur removal

**Syngas Production**
- SMR 1 reactor modules
- SMR 2 reactor modules
- Steam generation (WHB)
- Syngas compressor
- Pre-reformer

**FT Synthesis**
- FT cooling system
- FT 1 reactor modules
- FT 2 reactor modules

**FT Cooling System**
- Product flash

**Gas Feed**
- High CO₂ Possible!

**No Oxygen Required!**

**Steam**

**HC rich tail-gas**
- GT drivers

**H₂ rich tail-gas**
- Syncrude
Typical 1,000bpd CompactGTL plant

- **FT** modules: 40’
- **SMR** modules: 20’
Supply chain partners & projects
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
## Supply chain commitment

<table>
<thead>
<tr>
<th></th>
<th>Exclusive in field</th>
<th>Equity investor</th>
<th>Pre-investment in manufacturing capacity</th>
<th>Pre-invested 4 years work for conceptual FPSO design</th>
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<tbody>
<tr>
<td>Sumitomo Corporation</td>
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## Project examples – global footprint

<table>
<thead>
<tr>
<th>Client</th>
<th>Region</th>
<th>Feed gas rate</th>
<th>Project driver</th>
<th>Project Status</th>
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<tbody>
<tr>
<td>IOC</td>
<td>MENA</td>
<td>50 MMscf/d</td>
<td>Liberate crude production</td>
<td>Completed</td>
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<tr>
<td>NOC</td>
<td>Americas</td>
<td>25 MMscf/d</td>
<td>Extended Well Test Vessel</td>
<td>Ongoing</td>
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<td>NOC</td>
<td>Russia-CIS</td>
<td>10 MMscf/d</td>
<td>Remote location</td>
<td>Ongoing</td>
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<tr>
<td>NOC</td>
<td>MENA</td>
<td>20 MMscf/d</td>
<td>Liberate crude production</td>
<td>Ongoing</td>
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<td>NOC</td>
<td>Russia-CIS</td>
<td>100 MMscf/d</td>
<td>Remote location</td>
<td>Completed</td>
</tr>
<tr>
<td>IOC</td>
<td>Asia-Pacific</td>
<td>30 MMscf/d</td>
<td>Eliminate flaring</td>
<td>Completed</td>
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</table>
The market
≈ 800 Oilfields with problematic Associated Gas @ <50MMscf/d

800 oilfields with reserves of 73 bn barrels of oil

Analysis carried out by Wood Mackenzie and Fugro Robertson
Options for associated & stranded gas

- **Reinjection & Flaring**
  - Associated Gas MMscf/d
  - Distance to market for converted product [km]
  - Power generation
  - LNG
  - CNG
  - Pipeline
Project economics
Compelling economics - Gas flaring limit

- Onshore oilfield is subject to a flaring limit
- Field has associated natural gas leading to shut-in production

<table>
<thead>
<tr>
<th>Economic Metrics</th>
<th>NPV 10 $MM</th>
<th>Reserves MMboe</th>
<th>NPV10/Boe $/Boe</th>
<th>Payback Year</th>
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<td>62.8</td>
<td>3.7</td>
<td>17.20</td>
<td>2015</td>
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CompactGTL allows production to be brought forward

Sensitivity: Leasing half of GTL capex
-0.8 81.4 3.7 22.31 2015
Sensitivity: Bringing forward production 7 years
9.6 92.7 3.7 25.39 2015

Case study provided by Fugro Robertson - March 2012
Compelling economics – 5,000 bopd

- 23% IRR : 6 Year pay back, based on $100 oil, Texas location
- Reliable 3 year EPC schedule : Supply chain pre-invested & tested
- Reliable capital cost data : Fluor studies & long term reactor supply contracts
- Opex @ $18 per bbl including all operational, catalyst & technology costs
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