Modular GTL Solution for Associated Gas

Rio Gas Forum
13th April 2011

Iain Baxter
CompactGTL plc
Upstream Oil & Gas Solution Company

*Focussed on delivering an associated gas solution to enable oilfield development*

- Incorporated in 2006 - Highly committed private equity owner
- Unique, protected technology, 100% owned
- Advanced stage of commercial development
- Major client, engineering & supply chain partners
- World-scale GTL team experience
Associated gas is a huge global problem

> 9 TCF (= 4.2 mmboe per day)

Associated gas particularly problematic at < 50 MMscf/d

E&P TRENDS
More development in deepwater
More development remote from gas markets

Image courtesy of Chris Elvidge, National Geophysical Data Centre, Boulder, CO, USA
Emerging gas utilization options

- **CNG**
  - Compressed Natural Gas
  - Economics favourable at 200+ MMscfd
  - Economics depend on distance to shore

- **FLNG**
  - Economics favourable at 400+ MMscfd
  - Project studies underway

- **Gas to Wire**
  - Needs market for power
  - Economics depend on distance to shore
CompactGTL solution @ 2-50Mscf/d

**Modular GTL:**
Convert the associated gas into syncrude
Co-mingle and transport with the natural crude

- Incremental NPV of >$100MM possible
- Early production – Standalone unit
- Increased revenue from syncrude
- Savings in gas re-injection wells or pipelines
- Gas can be booked as reserves
- No separate storage, transportation or market access required for syncrude

Concept Design
10Mscfd GTL plant on FPSO

Image courtesy of SBM Offshore
Distinct market for modular GTL

- Modular GTL
- Reinjection
- CNG
- Gas to Wire
- FLNG
- Pipeline

Distance to market for converted product [km]
- 500
- 50
- 200
- 400

Associated Gas MMscf/d
- 75
- 150
- 500
Basis for enhanced oilfield NPV

Gas Re-Injection or Pipeline to Market

- Facilities Capital Cost PV
- Gas Disposal
- Operations & Tax PV
- Penalties or Delay
- Crude Revenue PV

Integrated CompactGTL

- Facilities Capital Cost PV
- GTL Plant
- Operations & Tax PV
- GTL Opex
- Syncrude PV
- Crude Revenue PV
- Oilfield NPV
## Indicative economics

### PRE-TAX Incremental Economics – Oilfield FPSO Project
GTL module replaces $250 MM Re-injection well

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed gas at first oil</td>
<td>20 MMscfd [converts to 2,000 bpd syncrude]</td>
</tr>
<tr>
<td>Feed gas at end of field life [15 years]</td>
<td>5 MMscfd [converts to 500 bpd syncrude]</td>
</tr>
<tr>
<td>Incremental capex</td>
<td>$ 50 MM</td>
</tr>
<tr>
<td>Oil price [assume natural crude]</td>
<td>$ 75 / bbl</td>
</tr>
<tr>
<td><strong>PRE-TAX Incremental Oilfield NPV</strong></td>
<td><strong>$ 150 MM</strong></td>
</tr>
</tbody>
</table>

### Pre-Tax IRR Sensitivity

<table>
<thead>
<tr>
<th>Incremental GTL IRR</th>
<th>Oil Price</th>
<th>Capex</th>
<th>Opex</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40.0%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Oil Price**: -20% -15% -10% -5% 0% 5% 10% 15% 20%
Commercial plant conceptual design

- 10 MMscfd gas feed
- 1,000 bbl/d syncrude production
- 2,400 T operating weight
- Configurable for:
  - Aframax
  - Suezmax
  - VLCC

SMR modules

FT modules
Modular plant design gives scaleability, inherent reliability & operability

- Modules can be removed as production falls
- Modules re-furbished and catalyst replaced onshore
- Modules can go on-line and off-line to accommodate production variability
- Multiple modules provide inherent reliability

The number of active reactor modules can be adjusted to match the associated gas production profile over time.
Process & Technology Development Overview & Status
Solution development approach

- Lab Reactors
- UK Pilot Plant
- Brazil Plant
- Commercial Plant

- Commercial Plant Studies
- Reactor & Catalyst Supplier Engagement
- Prototype Reactor & Catalyst Evaluation
- Supplier Selection
- Pilot Reactor & Catalyst Manufacture
- Commercial Supply Chain Establishment

Requirements
Supply chain development with World-Class companies
Process overview

- **Gas treatment**: pre-wash, mercury removal, heating, sulphur removal
- **Syngas production**: pre-reformer, SMR 1 reactor modules, SMR 2 reactor modules, steam generation (WHB), syngas compressor
- **FT synthesis**: FT cooling System, FT 1 reactor modules, FT 2 reactor modules

- **Gas feed**: pre-wash, mercury removal, heating, sulphur removal
- **High CO₂ Possible!**
- **No Oxygen Required!**
- **HC rich tail-gas**: GT drivers, H₂ rich tail-gas
- **Syncrude**: product flash

**Notes**:
- Possible high CO₂ concentration
- No oxygen required
Compact mini-channel reactors are key

- High heat transfer plate & fin reactor construction:
- High specific heat input to SMR reaction
- High specific heat removal from FT reaction
UK Pilot plant achievements

Installation at Wilton, NE England

Plant commissioned July 2008

- Confirming catalyst & reactor performance from manufacturers
- Integrated operation – ‘gas in to liquids out’
- Operational stability, start-up & shut down procedures
- Variable feed gas composition & CO₂ content
- Operator training for larger plants
Petrobras GTL demonstration plant contract

- Contract confirmed with CompactGTL in July 2008
- Funded by Petrobras
- Capacity of 200,000 scf gas (20 bpd)
- Plant required to demonstrate all aspects needed for commercial application
Plant constructed in Canada & Japan

Plant constructed by Zeton Inc, Burlington, Canada

SMR & FT Reactors fabricated by Sumitomo Precision Products, Osaka, Japan
Complete set of GTL reactors despatched by air-freight to Brazil
World’s first small scale fully integrated GTL facility!

Final commissioning December 2010
Plant running and under test

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

<table>
<thead>
<tr>
<th>'Standalone' solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strong economics where gas infrastructure or re-injection are avoided</td>
</tr>
<tr>
<td>Manufacturing route &amp; partners established</td>
</tr>
<tr>
<td>UK pilot plant operational for &gt;2.5 years</td>
</tr>
<tr>
<td>Petrobras plant commissioned and now running under test</td>
</tr>
</tbody>
</table>

*With special thanks to Petrobras for their valued contribution*