The transformational upstream gas solution

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The transformational upstream gas solution

Abingdon, UK Head Office  
Wilton, UK Operations  
Aracaju, Brazil Operations

> 100 man-years commercial GTL plant design & operational experience
Strong functional organisation for project delivery & continuous improvement

Strategic Analysis  
CEO Peter Riches  
SHE & QA

Business Development Director Iain Baxter  
CTO Lary Kocher  
Manager of Projects Phil Hawker  
Finance and Admin Manager Jane Bardell

Business Development  
Proposals  
Contracts  
Technology & Process Engineering  
Reactor & Catalyst Management  
IP / Commercial  
Wilton & Aracaju Operations  
Project Management & Controls  
Training  
Finance  
IT  
HR & Administration

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5 years
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2.5 years

Image courtesy of Petrobras
Commercial CompactGTL FT Reactors have been constructed by Sumitomo and comprise proven reactor units modularised into 40’ containerised packages by KHI.
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- >10 x projects worldwide
- Conceptual engineering @ 1,000-10,000 bpd
- Pre-FEED @ 2,500 bpd
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25 MMscf/d
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Summary of deliverables

- PFDs and H&MB
- Develop flare, drain and product export system configuration
- Basic Engineering Design Data
- Fix Basis for Design
- Sized Equipment Listing
- Main P&IDs
- Emissions Listing and Waste Water Strategy
- Licensor Evaluation for Reformer and Product Upgrade Packages
- HAZID / ENVID Procedure
- DCS Sizing / Philosophy
- Single Line Diagram
- Enhanced Class IV AACE TIC Estimate
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25% IRR
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Project Cash Flow – before tax

USD Millions (Nominal)

Year

-300
-200
-100
0
100
200
300
400
500
600
700

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

USD Millions (Nominal)

Net Cash Flow
Cumulative Cash Flow
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Sensitivity Analysis - Project IRR after tax

- Opex
- Capex
- Gas price
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Pre FEED Project

Project Management and GTL expertise

Exclusive Partners
- Sumitomo Corporation
- SPP
- Kawasaki
- Johnson Matthey Catalysts

Contributing Parties
- Qualified EPC Contractor
- Reformer package licensor
- Product upgrade package licensor

Engineering
- FLUOR®
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- Robust project economics – low sensitivity
- Reliable EPC schedule – committed supply chain
- Reliable CAPEX estimates – committed supply chain
- Robust proven technology & integration
- Over 100 man years of World scale GTL experience in project team
The transformational upstream gas solution - reserve slides
Technology demonstration & qualification

13 years in development since year 2000
IP 100% owned by CompactGTL
246 granted patents worldwide
340 pending patents worldwide
Independent verification by Bayer, SBM Offshore, Nexant, Fluor, TWI
Independent verification by Oil companies
Intellectual Property

• Strategic use of Intellectual Property to drive the business
  – Significant patents & know-how related to design and operation of GTL plants
  – IP used to underpin strategic relationships with partners and clients
  – Key patent covering two stage Fischer Tropsch synthesis upheld without amendment after opposition and now licensed to Shell globally

• Significant patent portfolio
  – Wholly developed and owned by CompactGTL
  – Includes syngas generation and Fischer Tropsch
  – 270 granted patents in over 30 territories
  – Over 300 pending applications
  – CompactGTL will assert its patents against infringers if necessary

• Litigation initiated by Velocys against CompactGTL
  – CompactGTL has strong legal opinion that the Velocys infringement cases will not succeed
  – No ruling to date on the merits of the cases
  – CompactGTL will vigorously defend itself against all legal action.
Onshore & Offshore plants are custom engineered for each project via engineering partners, but CompactGTL reactor modules are standardised and mass produced.

- 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
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

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

Plant commissioned in 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
Development Strategy

3rd Party conceptual engineering

Lab → Pilot → Demo → Commercial

3rd Party technology verification
Development Strategy – Reactors & Catalysts

Pilot

SMR Catalysts
Combustion Catalysts
FT Catalysts

FM Catalysts
Combustion Catalysts
FT Catalysts

SMR Reactors
FT Reactors

3 x Manufacturers

4 x Manufacturers

Demo

Catalyst Partner

Reactors Partner
Why is this now possible?

Conventional Tubular steam reformer / ATR

Conventional FT reactor e.g. slurry phase

10x increase in specific throughput

Compact SMR Reactor

Compact FT Reactor

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

Brazed plate-fin reactor construction minimises metal content and weight

Complete set of GTL reactors despatched by air-freight to Brazil

Corrugated metallic catalyst inserts maximise active surface area per channel

Automated catalyst insertion and removal
Technology scale up completed

Commercial CompactGTL FT Reactors:
- Constructed by Sumitomo
- Comprise proven reactor cores modularised into 40’ containerised packages by Kawasaki Heavy Industries
Onshore projects – plant options

- 200 – 5,000 bpd [2 – 50 MMscf/d]
- Using CompactGTL modular reformers
- Accessible to sites with severe logistical constraints
- High Turn-Down and flexibility as field production declines

- 3,000 – 15,000 bpd [30 – 150 MMscf/d]
- Using conventional reforming suppliers
- Suitable for reasonably accessible sites
- Suitable for more sustained gas flow rates
- Lower capital & operating costs

Gas Treatment Package

- Multiple CGTL modular reformers

Modular Plants

- 200bpd
- 3,000bpd
- 5,000bpd
- 10,000bpd
- 15,000bpd

Hybrid Plants

- CGTL FT
- CGTL SMR
- Conventional SMR or ATR

Single large scale conventional reformer
Modular plant - process overview

Gas treatment
- Pre-wash
- Mercury removal
- Heating
- Sulfur removal

Syngas production
- SMR 1 reactor modules
- SMR 2 reactor modules
- Steam generation (WFB)
- Syngas compressor
- Water treatment

FT synthesis
- FT cooling system

High CO₂ Possible!

No Oxygen Required!
Typical 1,000bpd modular plant

- Standardised mass produced SMR & FT modules
- Road / rail transportable reactor modules
- Bespoke balance of plant to suit client project

Blend Syncrude with the Crude Oil Export

- 20’ SMR modules
- 40’ FT modules
Hybrid plant – process overview

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

**Pre-reformer**

**Syngas production**
- Air Separation Unit
- Steam generation (WHB)
- Oxygen
- Steam

**Conventional ATR**

**FT synthesis**
- FT 1 reactors
- FT 2 reactors

**Air Separation Unit**

**Fuel gas**

**Water treatment**

**Product flash**
- Syncrude

**Tail-gas**
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
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
CGTL FT
CGTL FT

Operations and Maintenance

Training Support OR Operate
Balance of Plant
CGTL FT
CGTL FT
CGTL FT

Reactor Refurbishment Service
Local Reactor Refurbishment Facilities

Qualified EPC Contractor

Cost estimate (+/- 10%)
Deliverables include: Process data sheets, P&IDs, SLDs and operating guidelines

Optimisation strategies considered for client
Options for associated & stranded gas

- **Reinjection & Flaring**
- **LNG**
- **CNG**
- **Pipeline**

- **Power generation**

Distance to market for converted product: [km]
- 500
- 400
- 200
- 50
- 150
- 75

Associated Gas MMscf/d
- 500
- 200
- 50

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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
GTL Partner of choice

- 5 – 150 MM scf/d
  50 – 1,500 MMscm/yr

- Monetise stranded gas or unlock stranded oil

- Flexible solutions for challenging locations & high feed gas CO2

- Compelling economics

- Lease & operate options

- Robust technology, field demonstrated & oil company qualified

- Established World-class supply chain