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

CEO
Peter Riches

Strategic Analysis

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
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Commercial Demonstration Plant, Brazil video
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- >10 x projects worldwide
- Conceptual engineering @ 1,000-10,000 bpd
- Pre-FEED @ 2,500 bpd
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Figure 1. Map of basins with assessed shale oil and shale gas formations, as of May 2013

Legend
- Assessed basins with resource estimate
- Assessed basins without resource estimate

Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.
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Legend
- Interstate Pipelines
- Intrastate Pipelines

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Image courtesy of EIA
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ND output up x10 in 5 yrs!

Bakken Oil Fields

Minneapolis

Chicago

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Image by Ceres.org
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25 MMscf/d
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2,500 bpd
LPG
naptha
diesel
export power

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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

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

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

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

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
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.
Development Strategy

3rd Party conceptual engineering

Lab  Pilot  Demo  Commercial

3rd Party technology verification
Development Strategy – Reactors & Catalysts

SMR Catalysts
Combustion Catalysts
FT Catalysts

SMR Reactors
FT Reactors

Pilot
3 x Manufacturers

Demo
4 x Manufacturers

Catalyst Partner

Reactors Partner
Why is this now possible?

Conventional Tubular steam Reform / 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

**Modular Plants**
- 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

**Hybrid Plants**
- 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

- CGTL SMR
- CGTL FT

Multiple CGTL modular reformers

Conventional SMR or ATR

- CGTL FT

Single large scale conventional reformer

Gas Treatment Package

- CGTL SMR
- CGTL FT
Modular plant - 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

FT synthesis
- FT cooling System
- FT 1 reactor modules
- FT 2 reactor modules

No Oxygen Required!

High CO₂ Possible!

Gas feed
- pre-reformer

Steam
- water treatment

HC rich tail-gas
- GT drivers

H₂ rich tail-gas
- syncrude

Product flash
Typical 1,000bpd modular plant

- Blend Syncrude with the Crude Oil Export

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

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

Pre-reformer

Conventional ATR
- Steam generation (WHB)
- Air Separation Unit

Syngas production
- Oxygen
- Steam

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

Gas treatment:
- Fuel gas

Water treatment

Tail-gas

Product flash
- Syncrude
Hybrid plant- 100MMscf/d

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

- CompactGTL
- FLUOR

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

FEED

- CompactGTL
- FLUOR

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
- Johnson Matthey Catalysts
- Kawasaki

Balance of Plant
CGTL FT
CGTL FT
CGTL FT

Operations and Maintenance

- Training Support OR Operate
- Reactor Refurbishment Service

Balance of Plant
CGTL FT
CGTL FT
CGTL FT

Deliverables include:
- Process data sheets
- P&IDs
- SLDs
- Operating guidelines

FEED package ready for EPC tender stage

Cost estimate (+/- 10%)
Deliverables include: PFDs, H&MB, utility assessment and sized equipment list
Optimisation strategies considered for client

FEED package ready for EPC tender stage
Options for associated & stranded gas

- Reinjection & Flaring
- LNG
- CNG
- Pipeline

Distance to market for converted product (km):
- 500
- 500
- 150
- 75

Associated Gas MMscf/d:
- 50
- 200
- 400

Reinjection & Flaring overlaps with:
- Power generation
- Pipeline

Distance to market for converted product (km):
- 500
- 500
- 150
- 75

Associated Gas MMscf/d:
- 50
- 200
- 400

Reinjection & Flaring overlaps with:
- Power generation
- Pipeline
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
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.