Modular GTL as an Offshore Associated Gas Solution

Iain Baxter – CompactGTL plc
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As gas flaring becomes more unacceptable from a political and environmental viewpoint, oilfields with no viable associated gas solution may be required to curtail production or in the extreme case, cease production entirely. There is evidence that this is starting to occur and proposals for new oilfield projects in remote or deepwater locations must increasingly demonstrate how the associated gas will be processed without continuous flaring. Gas re-injection sometimes offers a solution but this is expensive for deep wells and not desirable for all reservoir structures.

This paper describes a modular, compact, GTL technology designed to process Associated Gas offshore. Petrobras funded a pilot GTL plant to be installed in Brazil during 2010 and the initial test results from that plant will be presented. Commercial aspects of implementing offshore GTL as an associated gas solution are also briefly discussed.

Abstract

Originating from technology first developed at the UK Atomic Energy Authority in the year 2000, CompactGTL has introduced new modular GTL plant designs integrated with FPSO's. This has been achieved through close collaboration with major partners in the Upstream sector serving to independently qualify the technology as well as creating a supply chain for commercial plants. The solution converts the associated gas into syncrude for blending with the natural crude cargo aboard the FPSO. This eliminates the need for additional transportation infrastructure or access to market for the converted product. In addition, the plant can handle up to 35% CO2 in the feed gas without additional gas treatment, and in fact utilises much of this CO2 for syngas and ultimately syncrude production.

The pilot plant construction project undertaken by CompactGTL for Petrobras is summarised in the paper along with the test results to date. The technology features proprietary catalysts and reactor designs derived from plate and fin heat exchanger manufacturing techniques. Modular plant design, incorporating multiple reactors in parallel, provides a flexible, operable solution to accommodate gas feed variation and decline over the life of the oilfield. Conceptual commercial plant designs integrated with FPSO’s have been completed that demonstrate both technical and commercial viability and one of these designs is also described in the paper.

Introduction & Background

Over the past 10-15 years, a number of small scale GTL technology initiatives have been conceptualised and tested at laboratory scale. Some progressed to pilot plant projects which ran successfully, although not all were able to demonstrate all the steps of the GTL process in an integrated fashion, from the pre-treatment of the feed gas through to liquid product output. Why then, have none of those technology demonstrations subsequently become a commercial reality to date? For sure, the reasons include the inherently high cost and complexity of GTL. High costs derive from a number of factors including the need to employ exotic materials of construction, high design temperatures, aggressive/corrosive environments and the use of large quantities of multiple types of specialised catalysts at the different stages of the process. Utility provision, air separation, steam generation equipment and syngas compression are also major items. Significant challenges also lie in plotting a predictable plant scale-up route along with the necessary insight into the required process control interactions between the different steps of the process.
However, focusing on potential offshore applications, it is arguable that roadblocks to commerciality for small scale GTL have occurred for other reasons:

1. **Cost of floating facilities:**
The economics for conventional GTL projects are challenging, relying on large economies of scale to make them viable. Offshore however, the floating facility itself becomes a significant additional cost. In the past, most conceptual studies for offshore GTL contemplated a dedicated GTL vessel or barge. In very approximate terms, the cost of the vessel can match the cost of the plant itself, making it impossible to achieve a return as a standalone project.

2. **Sensitivity to Sea States:**
Most GTL technologies rely on relatively tall, cylindrical reactor geometries. These are high centre-of-gravity units making application offshore a particular challenge. Many also feature high volumes of liquid inventory, (e.g. slurry bubble Fischer Tropsch reactors), which would be highly susceptible to wave motion.

3. **Oxygen / ASU Requirement:**
Several established syngas generation processes require a pure oxygen supply. Whilst not insurmountable, this clearly poses significant safety challenges for the offshore operating environment and particularly from a certification standpoint.

4. **Scaleability & Turndown:**
A dedicated offshore GTL facility clearly has to be sized for the maximum anticipated feed gas flow-rate. Conventional GTL processes do not exhibit high turn-down capability. In addition, over the life of the oil or gas field, the production curve will be such that the plant will only operate at full capacity for a few years. So, in order to support positive economics, the project must 'seek' developments where a consistent supply of gas is achievable over a long period. This is effectively 'putting the cart before the horse', see fig 1.

5. **Catalyst Replacement:**
For conventional reforming and Fischer-Tropsch processes this would not be possible in an offshore operating environment and the whole facility would need to be returned to an onshore base for this to be performed.

The small scale GTL technology now owned by CompactGTL plc was acquired from a JV between FMC Technologies and Accentus plc during 2005. The original process innovations and fundamental research were substantially complete at that time, having commenced in the year 2000 as part of the UK Atomic Energy Authority R&D programme at Harwell in Oxfordshire. CompactGTL soon recognised that, given the economic challenges referenced above, it would be necessary for the selected market opportunity to be particularly compelling and to attract strong economic returns to justify the required development investment. Initial market research and team knowledge of the Upstream sector, together with externally validated conceptual GTL plant design studies, pointed to an attractive application for the technology. The application utilizes key aspects of the technology to serve as an offshore associated gas solution to enable the development of remote oilfields. A risk-managed commercialization route was then developed and implemented.

### Market Analysis and a Viable GTL Solution for Associated Gas

The World Bank Global Gas Flaring Reduction Forum (GGFR), regularly publishes data on gas flaring activity. In 2005, this was about 6 TCF globally as shown in fig 2. Based on further oilfield statistics, it can also be estimated that about 4 TCF is re-injected for reasons other than to enhance oil recovery, in the main, to avoid gas flaring. This takes the total amount of wasted non-commercial gas to about 10 TCF annually. The environmental ramifications of these numbers are clear. However, this situation also represents a huge cost to the industry, equating to about 4.6 mmboe every day. Fig 3 shows data, derived from Wood Mackenzie statistics, illustrating the number of oilfields for varying ranges of associated gas production up to 100MMscf/d.

The market is undoubtedly complex, with a high number of variables, but it was clear at the time that significant opportunity existed for associated gas conversion, for new oilfield developments, remote from gas infrastructure, with flow rates in the range of 10 to 50 MMscf/d. This aligned well with an initial conceptual study conducted in partnership with Genesis Oil & Gas Consultants, for an oil production FPSO incorporating the CompactGTL technology. This showed that a 30-40MMscf/d plant could be accommodated on a VLCC FPSO whilst retaining sufficient deck space for the required oil processing and other necessary auxiliary equipment. The key technology aspects that make this feasible are described later, but in essence the commercial and economic highlights of this solution are as follows:

![Fig 1 Decline Curve vs Plant Requirement](image-url)
1. The objective is not to produce high value synthetic fuels. The associated gas (after FPSO fuel gas demand and any DP requirement) is converted to a waxy syncrude which is co-mingled and stored with the natural crude cargo. This avoids the additional storage, transportation and access to market infrastructure costs and logistics that would otherwise be required. This is effectively a ‘gas disposal’ solution enabling the oil company to develop a remote oilfield where continuous flaring is prohibited and/or where gas re-injection wells will be expensive or potentially damage reservoir performance.

2. Because the GTL facility is incorporated into the development FPSO, there is no additional capex burden, in most cases, associated with the floating facility itself. Additional capex is mainly limited to the cost of the GTL topsides modules themselves.

3. The economics become compelling, when the capex for the GTL modules is offset by capex savings achieved by avoiding the need for deep gas re-injection wells and/or new sub-sea gas pipelines to connect to distant gas infrastructure. In such cases the incremental capex for GTL can be low or even negative. Fig 4 shows an economic illustration for a 20MMscf/d case, where the drilling of a deep gas re-injection well, at a cost of $250MM, is avoided. Based on a 15 year field life, with declining production, the oilfield pre-tax NPV is enhanced by about $150MM, due to the increased crude production revenue and minimal incremental capex.

4. In cases where the capex for a sub-sea pipeline to the nearest market access point is reasonable, the oil company may still face project delay for the required 3rd party negotiations that can ensue (which may also negatively impact project NPV). Even with reasonable terms and tariffs agreed, the value that can be expected for the gas is likely to be low.

5. In many jurisdictions, the approach provides a ‘win-win’ for multiple parties. The solution utilizes what would otherwise be waste gas, converting it to additional crude revenue. For the national government this increases tax revenue (or profit oil in a PSC regime) and eases concerns over preservation of natural resources. For the oil company, the associated gas can be booked as reserves and deployment of the technology may actually assist in E&P licence negotiation and award.

Of course this is by no means a complete picture and, as with any process technology, the approach will not be appropriate in all cases. Factors include acceptable feed gas composition and contaminant levels, oilfield life, GOR and API, hull size and suitability of the FPSO for the sea conditions, to name a few.
CNG

FLNG

Gas to Wire

Fig 5 Emerging Gas Management Options

Lab ReactorsUK Pilot PlantBrazil Pilot PlantCommercial Plant

Commercial Plant Studies

Reactor & Catalyst Supplier Engagement

Prototype Reactor & Catalyst Evaluation

Supplier Selection

Requirements

Pilot Reactor & Catalyst Manufacture

Commercial Supply Chain Establishment

Fig 6 Commercialisation Steps

Fig 7 Reactor & Catalyst Development
Other Gas Utilization Technologies

Other emerging gas utilization options do exist for offshore applications, namely Compressed Natural Gas, FLNG and Gas-to-Wire, see fig 5. However, none of these compete in the same opportunity ‘space’ as the small scale GTL solution.

Firstly, CNG entails high infrastructure cost in the form of a number of dedicated high pressure shuttle tankers. The number of vessels required (vs capacity of each) is clearly linked to the distance to the nearest market access point for the gas. Depending on these variables, CNG projects have typically been studied for gas rates of the order of 200MMscf/d or above. In addition, the infrastructure capex and opex are strongly linked to distance to shore/market, so for very remote developments this will be prohibitive. Gas off-take from the FPSO will need to be frequent and disruption by prevailing weather conditions will be a consideration. To date no CNG project of significance has been implemented.

FLNG also brings with it high infrastructure cost. Studies for offshore liquefaction projects to date address high gas rates of the order of 400MMscf/d and above. Being a dedicated floating facility, the FLNG unit is suited to taking gas feeds from multiple oil and/or gas production points in a locality, as part of a large scale remote development solution that can support multiple floating units. As such it represents a complementary solution to the much smaller scale GTL proposition.

Finally, the Gas-to-Wire concept utilizes the waste gas as fuel for gas turbine driven power generation sets on board the FPSO. Power is then transmitted via sub-sea power line to the nearest access to market. As with CNG, no significant schemes for this purpose have been implemented to date and the cost and feasibility are highly linked to the distance to market for the generated power. Clearly, thermal efficiency for the offshore power generation units will not compare with combined cycle facilities, and transmission losses in the subsea cable will also be a factor.

Modular GTL – Solution Development Path

Rather than embarking on simply scaling up the technology that had already been researched at laboratory scale, it was necessary to first define the end point, in the form of what a commercially viable range of plant solutions would need to look like. The development and necessary commercialization activities to achieve that could then be planned and implemented. At an overview level, the requirements were:

- Ultimately favourable RAM (Reliability, Availability & Maintenance) analysis to take priority over process (carbon conversion) efficiency
- Long term catalyst stability to take priority over actual conversion efficiency and selectivity
- Ability of the process to accommodate short and long term fluctuations in feed gas composition and flow rate, as well as fast shutdown and re-start scenarios
- Scaleable plant with high turndown and ability to economically accommodate oilfield production decline
- Reformer and Fischer-Tropsch synthesis reactors to be designed as low centre of gravity modules individually weighing no more than 25 tonnes for ease of offshore exchange using FPSO installed cranes
- Reactor modules to be ASME VIII code compliant, all equipment design to use existing manufacturing techniques and be suitable for future offshore certification
- Capex and opex to fall within the ranges required for economic viability
- Lead times for the specialised reactor and catalyst equipment to fall in line with a typical EPC contract timeline for high-end FPSO topsides construction projects
- Plant footprint and weights to be compatible with FPSO applications
Clearly, at the heart of the programme, the reactor and catalyst commercial development represented the most significant technical challenge. Fig 7 illustrates the approach adopted, using an iterative process of computer model prediction and validation, multi-vendor prototype unit manufacture and testing both at lab scale and at the UK pilot plant. Fig 8 shows an example of how the modelled FT reactor performance agrees with reactor test results for conversion as well as selectivity to methane and C5+ products.

Key to the success of this whole approach was the extent to which 3rd party independent input and validation was sought and engaged. Once the prototyping process was completed, Sumitomo Precision Products Co Ltd, located near Osaka in Japan, were selected as the partner of choice for the manufacture of both the SMR and FT reactors at commercial scale.

UK Pilot Plant
In July 2008, CompactGTL’s first pilot plant was successfully commissioned at Wilton in North East UK, see figs 9 and 10. For the first time, this demonstrated the fully integrated process from input of feed gas through to waxy, paraffinic, syncrude production. The plant has been in operation on a 24/7 basis almost continuously since then. The facility incorporates the capability to mix a wide range of feed gas compositions, to mimic commercial project parameters, that have enabled the full operating envelope for the process to be explored. The test programmes have enabled the evaluation and development of appropriate start-up, shut-down and normal operating procedures along with the refinement of process control techniques and trip scenarios. It has also proved to be an excellent facility for operator training in preparation for the next step up, the Brazil pilot plant.

Technology & Process Overview
Having provided the context, this is a good point to describe the fundamentals of the CompactGTL technology and process itself, highlighting the factors that make it appropriate as an offshore associated gas solution. Any GTL process comprises the three main steps of feed gas treatment, syngas generation (a mixture of carbon monoxide and hydrogen) and then syncrude production by Fischer Tropsch synthesis. Large scale GTL has a fourth step, which is product upgrading by hydro-processing, in order to maximize product sales revenue. As outlined previously, for the offshore associated gas solution, high end product value is not a commercial driver, so the process can end at the production of syncrude which can then be co-mingled with the natural crude cargo. A simplified process block diagram is shown in fig 11.

Some commercialization activities are illustrated in fig 6. By running these activities in parallel but with certain common denominators as part of a formal management of change programme, an accelerated, risk managed commercialization process was achieved. The primary activities were:

- Continuation of laboratory scale reactor and catalyst testing
- Development and verification of SMR & FT Reactor process simulation models in partnership with Bayer Technology Services in Germany
- Engagement of multiple world-class reactor and catalyst suppliers worldwide, to assess then down-select the best manufacturing routes and viable commercial supply chain
- Small scale pilot plant in the UK (CompactGTL funded), to evaluate prototype reactors and catalysts supplied by the manufacturers, under varying process conditions. Latterly the plant has been used for overall process operability and reliability testing once the suppliers had been selected.
- Brazil pilot plant, (funded by the first client, Petrobras), incorporating reactors and catalysts from the down-selected suppliers
- Commercial plant conceptual studies, in co-operation with Genesis Oil & Gas Consultants in London and SBM Offshore in Monaco, enabling process schemes for the balance of plant equipment to be optimised in concert with the proprietary SMR and FT reactor combinations. The studies, conducted for both onshore and offshore plants, gave estimates for capex, opex, footprint and weight, required utility and waste stream integration aspects etc.
- At later stages, engagement with certification / classification bodies to ensure approval in principle for offshore implementation was attainable
Gas Treatment

The feed gas taken from the separators on the FPSO (after other FPSO fuel gas demands) first undergoes a sequence of treatment and conditioning steps using commercially available equipment packages. This consists of cooling and filtering before various stages of heating and contaminant removal to remove mercury, chlorides and sulphur compounds. Steam is then added to the clean natural gas stream prior to heating and entry to a catalytic fixed bed pre-reformer (again commercially available equipment) in which the higher hydrocarbons are reacted to give methane, hydrogen and carbon monoxide.

Steam Methane Reforming & Syngas Compression

The methane rich stream then enters the first stage of the proprietary CompactGTL SMR process. This takes place in a high temperature alloy reactor fabricated using brazed plate-fin heat exchanger manufacturing techniques, see fig 12. The reactor comprises arrays of mini-channels, typically less than 10mm across. Every channel contains low pressure-drop catalyst coated metallic foil structures as illustrated in fig 13. There are two process streams, in a co-linear flow configuration. The SMR process stream contains a proprietary reforming catalyst which converts the methane and steam into syngas at operating temperatures in the 650-750°C range and at approximately 4 bar. This reaction is endothermic, and the energy is provided by the other stream via a catalytic combustion process. The combustion stream is fuelled by clean fuel gas pre-mixed with combustion air.

This first stage SMR reactor achieves about 50% of the required conversion to syngas, with un-reacted methane and steam still present at the outlet. This outlet stream is fed directly to an identical, second stage SMR reactor which completes the conversion. Performing the process in
two steps enables a useful degree of process control to be exercised, as fuel gas and combustion air admission flows and temperatures can be independently regulated for each stage. Resultant temperature gradients across each reactor block are also more uniform, increasing process stability, enhancing catalyst life and reducing thermal stresses in the reactor blocks.

After the 2nd stage SMR reactor, the hot exhaust from the combustion stream is used to preheat the combustion air as well as the feed streams to the feed gas pre-treatment, pre-reformer and SMR units. The hot syngas stream passes into a waste heat boiler to generate the process steam, before being compressed by a two-stage compressor package to about 25bar in preparation for the Fischer-Tropsch process.

It will be observed that this is a low temperature reforming process, in contrast to more conventional reforming methods operating at over 900°C and at higher pressures. This was a deliberate move from an early stage in the reactor development programme, to ensure that the cost-effective brazed plate-fin manufacturing technique could be adopted at commercial scale. The ASME VIII design temperature limit for brazed structures is 815°C.

A further benefit of this particular reforming process is the ability to accommodate relatively high amounts of CO2 in the feed gas. Up to 35mol% can be accommodated and the SMR reactor utilises this CO2 in the reforming reaction, actually assisting the production of syngas and ultimately syncrude. This avoids the need to remove the CO2 prior to processing, which is normally a requirement for the common forms of gas processing including simple compression for re-injection.

Fischer Tropsch Process

In the FT process, the composition of the syngas is first controlled by membrane separation to give the desired H2:CO ratio for the first of two stages of FT synthesis. In each stage, the syngas is pre-heated to about 220°C before entering the reactor. Again, the proprietary FT reactor stages are identical and comprise arrays of mini-channels typically less than 10mm across and constructed using brazed plate-fin construction, with two streams in a co-linear flow configuration. The units are fabricated from stainless steel due to the relatively low operating temperature. The FT process stream contains foils carrying the Cobalt based, proprietary FT catalyst. As FT synthesis occurs along the length of each mini-channel, some liquid hydrocarbons start to form a film on the surface of the catalyst and run down under gravity to the outlet header after which it is cooled and collected. The FT reaction is highly exothermic so the other stream carries high flow rate pressurised water coolant to maintain the reactor block at a constant and highly uniform temperature. FT synthesis creates approximately one barrel of waste water for every barrel of syncrude product. This means that a partial pressure of water vapour develops in the process channels as the reaction progresses and it is well known that this can cause hydro-thermal ageing of many FT catalysts. To preserve catalyst life, the CompactGTL FT process is arranged in two stages, fig 11, whereby conversion of the syngas to liquid product is limited in the first reactor. The resultant water vapour is then condensed from the tail gas from the first stage before the gas is passed into the 2nd reactor. Further conversion occurs in the 2nd reactor, taking overall conversion to about 80% whilst preserving catalyst life.

The remaining tail gas from the 2nd FT stage passes to further, optional membrane units producing a hydrogen rich stream and a hydrocarbon rich stream (predominantly CH4, CO2, CO). Dependent upon the overall balance of plant and utilities design case, there are different options for tail gas utilization. In some cases, it is beneficial to recycle some of the hydrocarbon rich stream back to the pre-reformer at the start of the process. This boosts the overall carbon conversion efficiency but there can be capex penalties. Hydrogen rich streams can be mixed with fuel gas for gas turbines, either for mechanical drive (e.g. the syngas compressors), or for FPSO power generation.

Mini-Channel Reactors with Catalyst Inserts are Key

The mini-channel configuration and plate-fin mechanical construction of the reactor blocks described above provide two characteristics that are key to making this technology workable offshore: Firstly, very high specific heat transfer coefficients between the streams. Secondly, high ‘voidage’ or, put another way, relatively low metal “content”, per unit of throughput. The high specific heat transfer coefficients between the streams in the reactor block enable thermal stability to be achieved for the SMR and FT catalytic reactions, at rates not attainable to date in conventional reactor designs. Together, these two aspects enable the plant to meet the size and weight constraints critical for a workable FPSO solution. In the case of the SMR reactors, when compared to conventional tubular or fixed bed reformers (ATR’s), these compact reactor blocks occupy about 10% of the space for a given throughput. The same improvement is true when comparing the compact FT reactors with, say, slurry bubble FT reactor structures.

A further consideration regarding the supply chain for commercial implementation is the availability of an established and scaleable manufacturing route for plate-fin type reactors. The same is true of the catalyst coated inserts. The technology for producing these derives from the mass production of catalytic converters for vehicle exhaust systems, where high volumes of mechanically robust catalyst coatings are produced on corrugated metallic foil structures.
Conceptual Pre-FEED Studies

Pre-FEED engineering studies, some of them client funded, have been conducted for the proposed modular associated gas commercial plants in varying configurations, for differing FPSO hull sizes, to suit both specific and generic project cases. These have demonstrated the technical and economic viability of the proposed solution within the target market as outlined earlier. Fig 15 shows the layout of a generic 10MMscf/d plant, to produce 1,000 bbl/d syncrude, configured in two topsides modules for a vessel deck width of 48m. The SMR and FT reactor modules can be seen arrayed on the upper decks for ease of access by the on board FPSO cranes. Also noticeable are the combustion air intakes and exhaust stack.

The remainder of the plant is laid out on the lower deck, and in order to achieve appropriate RAM requirements vs process performance criteria, it proves highly beneficial to integrate the balance of plant with the FPSO systems to the maximum extent. Integration aspects include power generation, steam generation, waste water treatment, waste heat management and the storage and utilization of other process gases and liquids such as nitrogen and methanol.

Brazil Pilot Plant

In 2008, Petrobras committed to a US$45MM Joint Testing Agreement directly with CompactGTL, including the design, construction and testing of a 20 bopd pilot plant. CompactGTL established and managed an EPC contract with Zeton Inc in Canada, for the overall GTL plant, and the reactor supply arrangements with Sumitomo Precision Products in Japan. Fig 14 shows the plant nearing completion in Canada as well as the reactor blocks under construction in Japan at the end of 2009. At the time of writing, start-up of the plant is due to commence, so it is unfortunate that test results are not available to discuss here. However the expected commercial plant performance, which would align with the performance of the Brazil pilot plant, is shown in fig 15. The pilot plant represents all the key aspects required of the target commercial plant design, including full gas pre-treatment package, process steam generation, syngas compression and membrane trim for syngas ratio control. The SMR and FT reactors for the Brazil pilot plant represent the manufacturing building blocks necessary for the commercial scale reactor module designs.

This means that successful operation of the plant will not only verify the process technology without further scale-up risk, but will also confirm the feasibility of the chosen manufacturing route.

Fig 14 Brazil Pilot Plant & Reactor Block Under Construction

Fig 15 Topsides Module Configuration for 10MMscf/d CompactGTL Plant
To complete the picture, it is worth summarizing the specific attributes of the compact reactor technology that support the viability of this FPSO based solution, and maybe enable some of the previously mentioned ‘roadblocks’ to offshore GTL applications to be better appreciated:

1. Cost of floating facilities: In the 10-50MMscf/d range, the modular GTL solution can be accommodated along with the required oil processing equipment on the FPSO (subject to GOR, API and other specific oilfield & production parameters). Incremental capex is thus limited to the plant itself.

2. Sensitivity to Sea States: The CompactGTL SMR and FT reactor modules are inherently low centre of gravity units. Liquid inventory in the FT reactors is minute, with hold-up in the reaction channels equivalent to only a few seconds of production.

3. Oxygen / ASU Requirement: By adopting a steam-methane reforming process, there is no requirement for a pure oxygen supply. The oxygen donor originates from the steam.

4. Scaleability & Turndown: By adopting multiple trains of relatively low throughput, standardised reactor modules, the plant is scaleable and capable of high turndown. Over the life of the field as production declines, reactor modules can be taken out of service or removed altogether, maintaining the plant at the required capacity.

5. Catalyst Replacement: Again due to the standardised reactor modules each weighing under 25 tonnes, they may be changed-out individually over time whilst the remainder of the plant continues to operate. The modules are to be returned to the manufacturer where they would be inspected and the removable catalyst inserts replaced. Refurbished reactor modules could also be deployed on other plants.

Additional aspects include:

6. The modular approach brings with it an inherent degree of reliability and availability. The individual failure of reactor modules would not shut down the whole plant.

7. Ability to handle high CO2 content in the feed gas without separation.

8. Ability to handle range of feed gas composition, as the pre-reformer serves as a ‘buffer’, converting all the higher hydrocarbons to methane.

Conclusion

The market demand for a small scale offshore associated gas solution is without question. Two trends in E&P are clear, development prospects in deepwater and development prospects remote from gas infrastructure. Political pressure is driving more stringent environmental regulation of E&P activity around the globe, particularly the development of new oil & gas discoveries. National governments are applying legislation on associated gas utilization to varying degrees. The World Bank influences this, through its Global Gas Flaring Reduction Forum and pathways it facilitates to project finance. In addition, many major IOC’s are applying self-regulation, their corporate environmental polices preventing development plans being considered that are to involve continuous gas flaring for long periods. Yet there is a gaping technology gap considering the current, and many of the emerging, management options for non-commercial gas. FLNG and CNG, with their high infrastructure costs, address gas flow rates of the order of 200MMscf/d and above. Furthermore CNG is highly sensitive to the distance to shore, likewise Gas-to-Wire.

The development of the modular offshore GTL solution outlined in this paper has not been without its challenges. Having a clear vision, from the outset, of the economic and technical requirements for the commercial scale plant, has been instrumental in the success of the programme to date. Likewise, the expertise and resources brought to bear by world-class partners have been equally crucial (acknowledgements below).

The result, is a true ‘standalone’ associated gas solution for remote offshore oilfield development with strong economics. Pre-FEED studies to date have identified and addressed the key engineering aspects, with the technology verified by world-class partners and the long term operability of the UK pilot plant at Wilton. The manufacturing route and supply chain are established, with large scale testing at the Brazil pilot plant imminent.

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