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Creating Opportunities for Gas-to-Liquids Projects Through Market Organization

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Abstract – The Gas to Liquids technology (GTL) consists of a chemical conversion of natural gas into a stable liquid by means of the Fischer-Tropsch Process. This conversion makes possible to obtain products that can be consumed directly as a fuel (for example, Diesel) or special products such as lubricants. The decade of the 1990s witnessed the return of the Fischer-Tropsch Process to the centre of attention in the world petroleum and natural gas industry. This technology, developed in the 1920s and put into large-scale operation by Germany, was abandoned due to the low prices of petroleum and the development of abundant markets for natural gas. Nevertheless, the growing environmental restrictions in both the upstream and the downstream sides of the oil and gas industry have created opportunities for the development of niche markets for GTL projects. This paper estimates the potential of these niche markets and analyses possible business strategies to develop them. The paper also calls the attention to the role of these niche markets for the necessary technological improvements of the GTL technology in order to make possible the enlargement of these niche markets.

Keywords : Gas-to-liquids, market opportunities, environment

1. Introduction

The Gas to Liquids technology (GTL) consists of a chemical conversion of natural gas into a stable liquid by means of the Fischer-Tropsch Process. This conversion makes possible to obtain products that can be consumed directly as a fuel (for example, Diesel) or special products such as lubricants. The products that are derived from the GTL technology have two types of economic advantages: i) Their transport cost is much less than that of the transport of natural gas, which due to its volume, that is 1000 times more than the volume of petroleum, not only presents high transport costs but also requires specific assets (gas pipelines or methane ships); ii) The products produced by GTL plants present important environmental advantages compared to traditional products, as they are derived from a clean fuel: natural gas.

The decade of the 1990s witnessed the return of the Fischer-Tropsch Process to the center of attention in the world petroleum and natural gas industry. This technology, developed in the 1920s and put into large-scale operation in Germany, was abandoned due to the low prices of petroleum and the development of abundant markets for natural gas. Nevertheless, a radical transformation in the sphere of the application of this technology has opened the door for the renovation of the GTL technology. The increase of stranded gas reserves and the development of niches in the market for synthetic fuel, due to environmental legislation, prompted the renewal of interest of petroleum companies in this technology. The development of several projects for the construction of GTL plants reveals a truly technological rush to seek the development of more efficient and cheaper processes.

The success of the innovation process in the GTL technology has a very important potential impact on the dynamics of the world markets of oil and gas. The GTL technology represents the maximum limit for the long-term petroleum prices in the oil market. In case this price is maintained above the cost of GTL, new companies will be attracted to this business, transforming into cash great gas reserves, which are today stranded because of the limits of traditional transport technologies. The GTL technology represents a minimum level for gas prices in the gas market, since it is an alternative option for monetizing gas reserves.

This article analyses how an increase in environmental restrictions are contributing to the bursting of competitiveness of GTL projects by the development of potential niche markets for GTL projects. The article presents the niche markets for GTL products and analyses the market organization activities necessary to remove the obstacles for the development these niche markets. The first section analyses how environmental restrictions in the fuel market open a window of

opportunity for marketing GTL fuels as "environmental additives". Finally, the third section tackles the problem of environmental restrictions on the gas flaring. This section analyses the programs being implemented to reduce gas flaring at the global level, and how the carbon emissions trade can contribute to reduce the price of gas to GTL projects. Finally, the article concludes discussing the necessary actions that should be taken in order to organize these niche markets for GTL.

2. Environmental Restrictions and Niche Markets for GTL

Development of GTL technology will depend on the creation of niche markets where this technology could be competitive compared to the current technological paradigm, which is the oil refining technology. The oil refining technology and GTL are in competition because synthetic and natural fuels dispute the same potential markets. However, if we look at the fuel markets, it is clear that oil refining technology is poorly adapted to some niche markets. Increasing environmental restrictions at demand level has pushed up the cost of oil refining technology. New standards require the production of oil products with very high quality and low level of pollutants. This represents a window of opportunity for alternative fuel technologies, since they could eventually beat the cost of traditional technology in specific niche markets, for example diesel for metropolitan urban areas.

The cost of the raw material is also a factor of decreasing returns for oil refining technology. Firstly, new reserves being discovered tend to be of lower quality (heavy and sour), which also results in higher refining costs. Second, the cost of producing new oil reserves being discovered also tends to increase, since the share of deep water offshore has augmented dramatically in the last 20 years. Stark and Chew (2001) shows that in 1984, nearly 75% of the acreage awarded for E&P purposes in the world laid onshore, whereas 3% laid in onshore blocks that extended offshore, and 22% of awarded acreage lay offshore. By 2001, onshore acreage awards had shrunk to 42%, and offshore acreage awards topped 53%. Offshore oil production, especially deepwater, is increasing its share in total oil production in the world.

While the cost of oil is increasing, the available gas reserves have augmented in the last 20 years, due to the increasing exploration efforts. Therefore, we can see significant opportunities for the development of niche markets for the GTL technology due to the increasing competitiveness of natural gas as raw material.

2.1 - development of niche markets in the fuel market

The decade of 1990 was characterized by a radical evolution in the pattern of demand for oil products. The upsurge of concerns related to global and local environmental problems pressure governments for new fuel standards. Fuel standards in the developed countries reduced the level of particulates and other pollutants that are aggressive for the environment at local level in the 1980s and in the beginning of the 1990s. The suppression of Plumb in the gasoline contributed for the reduction of pollution in large cities while the reduction of sulfur in diesel helped to moderate acid rain problem. After 1995, fuel standards tackled the problem of global pollutants. In order to reduce global environmental problems, the main objective of new fuel standards have been to reduce the level of non-burned Hydrocarbons and NOX.

New fuel standards increased the cost of refining, contributing to the deterioration of the profit level in this business segment. The capital yield has been traditionally low in refining segment. However, it has shrunk further during the 1990s. According to the US Department of Energy, capital yield for the refining business of the 25 biggest oil companies in the US was only 2,5% between 1985 and 1995. The share of capital expenses related to the accomplishment with new environmental restrictions in total investment in the refining sector increased from about 13% 1989 to about 40% in 1995. The low profit levels have induced a shake-out in the industry, where about 45% of the refining capacity in the US changed of owner between 1994 and 1998. It is clear than that oil refining will face an increasingly difficult business environment. This represent an opportunity of the development of niche markets for GTL as an alternative technology.

Fuels produced from GTL technology have undeniable advantages compared to conventional oil products as far as local pollutants are concerned. As shown by Snyder (2000), synthetic diesel made by Syntroleum can by far comply with new American standards (USA EPA2). Table 1 shows that while EPA #2 contains 300-ppm sulfur, Syntroleum S-2 diesel contains no detectable sulfur. The author emphasizes that EPA #2 contains aromatics and olefins, which are hydrogen deficient molecules. This is reflected in a Cetane index of <47 for the EPA #2. In contrast, Syntroleum S-2 is hydrogen saturated, consisting of >99% paraffins and contains no detectable aromatics, olefins, or alcohols. This results in an exceptionally high Cetane index (>70) for Syntroleum S-2.

Table 1

Comparison of properties of Syntroleum S-2 and EPA #2

	SYNM SD-2	USA EPA#2
Specific Gravity (60 F)	0.7716	0.8455
API Gravity (60 F)	51.9	35.86

Aromatics (%)	Nd	28.3
Olefins (%)	Nd	1.4
Saturates (%)	>99	70.3
Sulfur Content (wt %)	Nd	0.03
Cetane Number	73.6	46.7
Cetane Index	74.1	46.6
Cloud Point (C)	-23	0

Source: Snyder (2000)

Proposed standards for the next decade envisage to further increase the environmental restrictions. As shown in table 3, these standards intend to limit to a very low level the Nox and particulates emissions. This represents more pressure on the oil refining technology. According to Freund (1998), the production of the new fuel that comply to the restrictions of standards to be introduced in the first decades of the twenty one century will not be possible without a radical innovation. Incremental innovation in traditional oil refining technology will be blocked by increase in costs. Freund sustains that the Fischer-Tropsch synthesis can be this radical innovation required to produce the super-fuel of the future.

Metropolitan diesel represents a clear niche market for GTL technology. GTL diesel can be sold to be used an "environmental additive". In other words, cleaner GTL diesel can be mixed to conventional diesel in order to improve the fuel quality. This type of "environmental additive" already exists. Europe produced about 700,000 tones of Biodiesel in 2000. The average cost of biodiesel is the double of the price of conventional diesel. Currently, Germany, Austria and Sweden use 100% pure biodiesel in adapted vehicles. In France, biodiesel is blended at 30% in captive fleets and also used in blends of 5% in normal diesel fuel. In Italy, it is blended at 5% in normal diesel fuel. In all, biodiesel captures about 1% of diesel markets in Europe.

The European Union intends to multiply by a factor of 5 the production level of biofuel in the region. This kind of fuel is perceived as an important way for improving the fuel quality and reduce CO2 emissions. Of course, the biodiesel industry could not develop without strong subsidies of European Union and National Governments.

The GTL diesel could take advantage of the development of the "environmental additive" market. Since GTL diesel can improve the normal diesel quality when blended, it can aggregate value to conventional fuel. Therefore, part of this value should be capture by GTL producers by means of a higher price as compared to conventional diesel.

In order to make possible a premium value to GTL products, it is necessary to work together with distributors and environmental agencies to create the market differential. One of the first steps is the development of standards and fuel labels indicating to consumers the presence of GTL diesel in the fuel. It is necessary that consumers know about the environmental advantages of GTL, in order to develop the niche market for GTL diesel.

Another way to create niche for GTL fuel is to associate the project to corporate marketing strategy. Once GTL fuels have found their pace to the "environmental additive" market, oil companies that invests in GTL projects could link their image to the technological capacity to produce this type of fuel. Therefore, GTL can be an important tool for marketing campaigns.

2.2 – Niche markets in the upstream

One of the most important problem for the gas industry is the higher cost of transportation as compared to liquid fuels. Natural gas has a volume of about 1000 times the volume of oil for the same energy content. Therefore, gas transportation requires specific technological options that are very cost intensive (pipelines or gas liquefaction and cryogenic transportation – LNG). The cost transportation of the same amount of energy in the form of gas is 3 to 10 times more expensive then the cost of oil transportation, depending on the distance. Therefore, when associated gas reserves are far from end market and when the amount of gas produced is low, investments in the infrastructure necessary for the monezation of the reserve are not profitable. Gas Flaring and ventilation is then the best economical option.

Proven world gas reserves have increased very rapidly in the last 20 years. It has increased from 82,44 Trillion Cubic meters in 1981 to 155 trillions of cubic meters in 2001. However, about 80% of world gas reserves are located in small fields - until 2,8 billion cubic meters (bcm) – that are difficult to explore commercially. Therefore, an important share of current gas reserves cannot be monetized using conventional technologies (pipelines or LNG[1]). Given the size of these fields, LNG is not a viable option. Small scale GTL plants is instead the appropriate option. A plant of 10,000 barrels/day would require about 25 billions cubic meters during 25 years project.

[1] LNG projects require significant amount of gas reserves (about 200 bcm) due to the size of economical liquefaction trains (3,5 millions tons per year).

The presence of stranded gas reserves can be seen as a necessary but not sufficient condition for the creation of niche markets for GTL, since there is the option of letting the gas in the ground. Some stranded gas reserves have an additional problem. It has to be produced since it is associated to oil. About 30% of offshore oil reserves have gas associated. Very frequently, the commercialization of this associated gas is not economical, especially gas produced from small fields. In this case the option is to burn the gas in the flare in order to produce the oil.

2.2.1 – Gas Flaring

The World Bank estimates that about 102 to 130 bcm of gas are flared and ventilated every year in the World (see table 2). This represents 12.9% of gross world gas production, or about 70% of the total gas traded via LNG chain. In Africa this problem is more acute given the low level of industrialization of gas producing countries. In the absence of potential markets for the associated gas produced, oil producers are obliged to burn most of the gas produced. According to Esmap (2001), 70% of the gas produced in the continent is not commercially used.

Table 2
Gas Flaring and Venting in the World

Region	billion cubic meters/year
North America	12-17
Central and South America	10
Africa	37
Middle-east	16
Asia	7-20
Former Soviet Union	17-32
Europe	3
Total	102-135

Source: World Bank

Gas Flaring and ventilation represents a very important environmental problem at the global level. In one hand, the gas flaring represents emissions of greenhouse gases contributing for global warming. The worse, this emission is not associated to useful work. The gas ventilation is even worse since non-burned hydrocarbons contribute for ozone depletion. These environmental problems have pushed governments to impose restrictions on gas flaring and ventilation. Furthermore, the growth of carbon emissions was declared no longer acceptable under the Kyoto protocol of 1998, that aims at mitigating global warming through the reduction of carbon emissions by industrialized countries.

The environmental restrictions to flaring are being introduced by several means. National governments and regulators are creating rules and standards making difficult the development of gas fields that requires substantial flaring. Some governments have signed agreements with oil producers in order to implement "zero burn" programs. This type of agreement gives companies some time to adapt to more strict rules that punishes gas flaring with heavy penalties. This approach has been adopted by regulators in Brazil and Nigeria, for example. In Brazil, Petrobras launched the Zero Burn Program in 1998. The company intends to reduce the flaring from 23% of total production on that time to new levels compatible to international standards[2]. The national oil regulator has enacted new regulations with strict control over gas flaring. In Nigeria, gas producers have signed a zero-flare agreement, imposing the end of gas flaring until 2008.

Some other countries have anti-flare legislation already in place. That's the case of Norway and Canada, for example. These countries are using a combination of regulatory and fiscal policies to induce companies to avoid flaring. It is important to mention that the environmental awareness in developed countries is affecting the industry even in countries where anti-flare legislation is not in place. Some international oil producers - mainly European - faces pressure in their homeland against projects that results in increasing gas flaring abroad. That's the case of Shell that has faced sanctions by Europeans consumers associations in order to improve environmental and social practices in Africa. Eni is another exemple of European company that has launched a zero gas flaring program in order to comply with environmental pressure in its homeland.

Even though, it is clear the existence of an important effort for reducing gas flaring at global level, the level of flaring has not reduced dramatically in the last 10 years. The flaring reduction efforts have been compensated by the rise in oil production, increasing, as a consequence, the associated gas production (see figure 5)

2.2.2 - The Carbon Credit Market

[2] In Brazil the high level of flaring is related to the volume of associated gas reserves and production. Currently, 77% of gas production in Brazil is associated to oil.

The carbon credit trading represents an excellent opportunity for making viable the monetization of gas being flared currently. It is estimated that the volume of gas being flared corresponds to the emission of at least 350 million tonnes of CO2 equivalent, assuming that the average combustion efficiency of the flares is 98%. This quantity corresponds to approximately 60% of Europe's entire commitment to reduce greenhouse gases under the Kyoto Protocol. Countries of annex B can either reduce carbon emission domestically or abroad. In this last case, projects can be implemented through Joint Implementation, Clean Development Mechanism or International Emission Trade. This last option represents an important window of opportunity to GTL.

Currently, some European national governments have already committed resources to promote the reduction of CO2 emissions. Several agencies and funds have been created to implement a carbon market at national and international level. In the year 2000, the World Bank launched the Prototype Carbon Fund (PCF), which was the world's first market-based mechanism to promote carbon emission reduction in developing countries. This fund was established with contributions from governments (Netherlands, Finland, Sweden, Norway, Canada, and Japan) and private companies, and intended to pilot project-based carbon emission reduction activities within the framework of two of the flexibility mechanisms of the Kyoto Protocol – the Joint Implementation and the Clean Development Mechanism[3]. Currently, this fund has a total capital of US$145 million and has a portfolio of 30-35 projects and carbon purchase contracts.

The Netherlands has committed to reduce in 6% its carbon emissions until 2008. In order to do so, the government has created a special fund for promoting carbon emissions reductions in developing countries. Senter International, which is the international branch of Senter, a governmental agency for environment, has created the carbocredits.nl. This portal has the objective support projects that contributes for reduction in greenhouse gas emissions. The support comes in the form of carbon credits, thus creating an additional source of income to boost the economic feasibility of projects and accelerate their implementation. Similar initiatives are being implemented in other countries of the world (Denmark, Germany, United Kingdom and Australia).

According to the World Bank, about $500 million worth of carbon emissions - representing roughly 200 million tonnes - have been traded at the international market since trading began in 1996. The carbon trading market is rapidly growing and is expected to triple this year, reaching about 67 million tonnes.

The carbon purchase contracts implemented by the World Bank averaged $3 to $4 per tonne of CO2. This price represents an important reduction in the gas price for GTL projects. At current CO2 prices, a gas producer could receive about $ 25 cents per million of Btu not flared. This represents about 50% of price of gas normally considered for GTL projects ($ 50 cents per million of Btu).

3 - Conclusions

This article has shown several factors are conspiring to increase the competitiveness of the GTL technology. The renewal of environmental legislation regarding fuel quality, gas flaring and carbon emissions has contributed to create niches in the market for clean GTL fuels.

The environmental regulations have contributed to increase the cost of oil refining during the 1990s. This paper have shown that proposed standards for the next decade envisage to further increase the environmental restrictions. In order to respond to these new regulations, several countries are developing the market for the "environmental additive". In Europe, for exemple, biodiesel is produced at large scale to be blended to conventional diesel. Since GTL diesel can improve the normal diesel quality when blended, it can aggregate value to conventional diesel. Therefore, GTL diesel could capture an important share of world diesel market. Since it can aggregate value to conventional diesel, it can be sold at a premium price. The paper have shown that companies should work together with distributors and environmental agencies to create the market differential for GTL products. Standards establishing blend specification and fuel labeling are very important to build the product differentials.

This paper has also shown that environmental regulation in the upstream is also contributing for the development of niche markets for GTL. Regulatory restrictions to gas flaring are inducing companies to invest in the monetization of an important amount of gas reserves being burned each year. The gas flared each year in the world would be enough to anchor about 1 million barrels a day in GTL capacity. The paper emphasized the potential impact of the development of carbon emissions international market. Since each tonne of CO2 has a price of $3 to $4, the gas currently being burned has a price in the international market. This represents about US$ 1,05 billions or US$ 25 cents per million of Btu. Therefore, an important way to burst GTL projects would be to capture the value of the CO2 reduction.

In order to GTL projects participate of carbon credit market, it is necessary an important work of market organization. Companies should work together with environmental and energy authorities in order to establish the basis of this

[3] See http://www.worldbank.org

markets. Sharing and diffusion of information and business concepts are crucial for considering GTL an interesting option of carbon emission reduction.

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