USE OF LNG AS ALTERNATIVE TO MITIGATE THE ENERGY CRISIS IN THE WESTERN VENEZUELA

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1. Background

Since the last century the principal incomes of Venezuela comes from Petroleum Industry. In consequence, little attention has been given to Natural Gas Industry; usually the gas is used in secondary petroleum recovery. This situation explains in part, the slow progress in projects related with transport and distribution of Natural Gas, which in turn has contributed to a significant natural gas shortage in the domestic market. The low offer affects the availability of gaseous hydrocarbons necessary in the Petrochemical Industry and to generate electric energy.
In 2010, the annual NG production of Venezuela was 6904.3 MMS CFD [(1)]. Currently, the country has a NG deficit to supply the internal market, especially in the Western, the Zulian region, which is one of the most industrialized areas of Venezuela. This region requires NG for different industrial sectors. In 2010, Zulia presented several and frequent problems related with the electricity supply in industries, stores and residences. The NG demand of the area is not satisfied with the NG transported by the Antonio Ricaurte pipeline from Colombia (150 MMSCFD) and the NG provided by the pipeline Ulé-Amuay (160.29 MMSCFD).
To confront and mitigate the Zulia's energy deficit, in this study was analyzed the possibility to import Liquefied Natural Gas (LNG) from Trinidad & Tobago, considering the available technologies to commercialize LNG, such as: 1) installation of a regasification plant and, buy or rent a floating storage and regasification unit (FSRU).
To develop this evaluation two scenarios were considered, setting a minimum profit over the LNG price sales of: a) 1.6 $/MMBTU, which corresponds to the condition of NPV=0 and, b) 4.0 $/MMBTU, average of Henry Hub price in the year 2011, taking a discount rate of 15%; this value is required by PDVSA (the Venezuelan State Oil Company) to approve a project execution.
In the present work was developed a proposal based on a financial study of different LNG supply alternatives. According with the obtained results, the best option was to rent a FSRU (NPV = MM $ 1630.20 and IRR = 67.13%), however this alternative was not selected because the payback period is greater than the contract period, which was established in three years, and it's suppose that Rafael Urdaneta Project will begin in the year 2015. In consequence, it was selected the option to buy a FSRU (NPV = MM $ 90.10 and IRR = 18.67%), this ship could be sold or rented after the energy crisis overcome. A statistical simulation analysis of the last alternative revealed that FSRU buying is rentable with a 51% of accuracy.

2. Aims

The main purpose of this study is to develop a proposal to import LNG from Trinidad to Venezuela, in order to improve the supplies of NG and mitigate the energy deficit that currently exists in the Zulia State.
The specific objectives of the present study were:

1. - Determine the current situation of internal NG demand, using as fundamental framework the Venezuelan NG production.
2. - Develop a proposal of LNG supply, which allows high process rentability, taking into account two scenarios: 1) a regasification plant and, 2) buy or rent a FSRU.
3. - Validate the designed proposal, through the application of a financial study, in order to determine the feasibility of LNG imports to Venezuela.

3. Methods

The current statistics related with the NG consumption, especially in the Zulian region were analyzed, estimating the supply and the potential NG demand required in each industrial sector.

NG Supply: Currently, Venezuela has proven reserves equal to 195.1 TCF [(2)], around 86% of these reserves corresponded to associated gas [(3)]. Figure 1 shown the distribution of NG gas reserves in the year 2008, most of the reserves are located in the eastern of Venezuela, and they are associated with the crude oil.

The amount of reserves allows the whole internal market to be supplied and offers the possibility to export the NG surplus. However, near 51% of produced NG in 2008 (2155 MMSCFD) was used in secondary recovery of petroleum (i.e. gas lift) and released to the atmosphere. Only 41% of the total NG produced was used as fuel (NGL) and sold in the market [(3)].

The Antonio Ricaurte's pipeline which provides NG from Colombia was held in consideration during the study, it provides NG for 2 thermoelectric plants and it connects with the pipeline network that feeds the Petrochemical Industry.

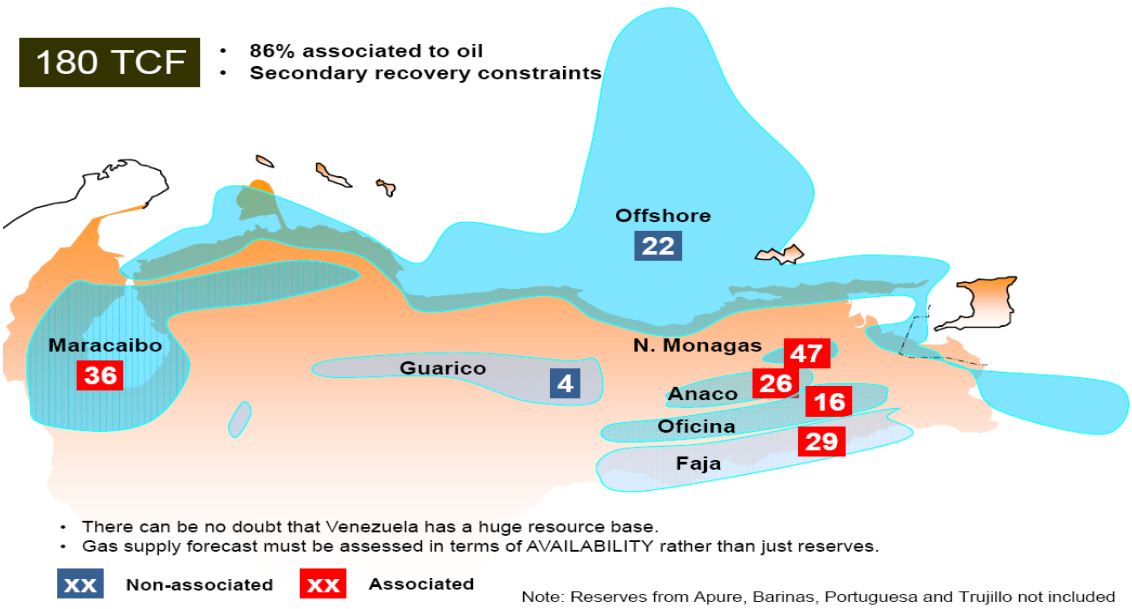

Figure 1. Natural Gas reserves distribution in Venezuela, associated and non-associated [(3)].

According with the Ministry of Popular Power for Energy and Petroleum, in the year 2010, the NG average production was 6904.3 MMSCFD, which represented a negative variation of -183.8 MMSCFD, regarding to the planned production 7088.1 MMSCFD (see Figure 2). From this production, it was delivered 2075 MMSCFD to the Internal Market, which corresponds to 75.8% fulfillment respecting the established sales plan.

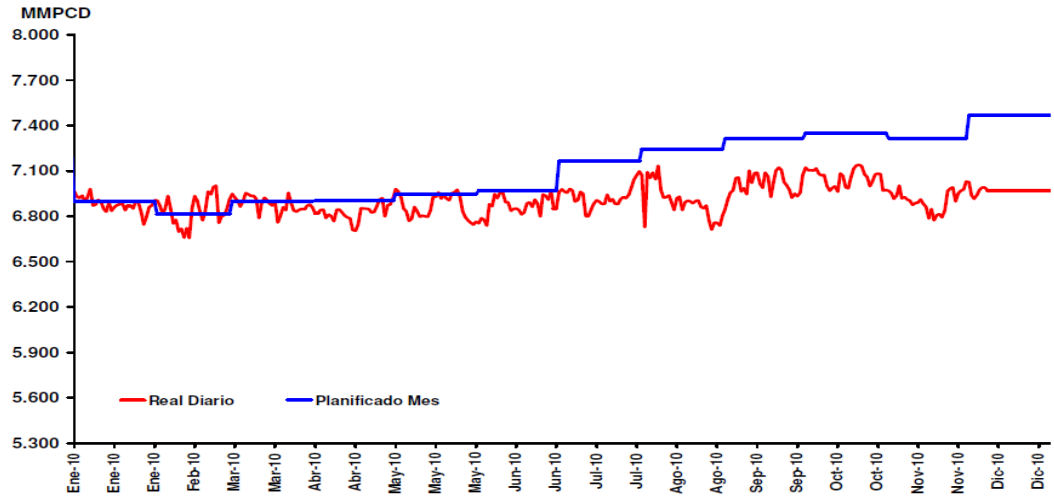

Figure 2. Average production of Natural Gas in 2010 [(1)].

NG Demand: Venezuela has a NG deficit of 2349 MMSCFD. The Zulian region has in average a NG consumption of 382.42 MMSCFD (that represents 20% of the whole country) [(4)], divided in these sectors: Electricity, Petroleum, Domestic and, Petrochemical; each one requires these NG volumes: 71.17, 179.05, 91.28 and, 25.16 MMSCFD, respectively. All of these sectors present currently a deficit in the NG quantities totalizing 213 MMSCFD [(3)].

It was developed a proposal based on a financial evaluation, which included: inversion (CAPEX), cost structures, NPV, IRR, repayment period and, capital amortization. These parameters were considered for both alternatives: regasification plant or FSRU, including two scenarios for profit over the LNG price sales, such as: 1) a minimum profit of 1.6 $/MMBTU, which corresponds to NPV =0 and, 2) profit of 4.0 $/MMBTU, average of Henry Hub in 2010. A 15% discount rate was fixed, to satisfy the requirements established by PDVSA (the Venezuelan National Oil Company) to approve a project.

The Montecarlo method was applied to validate the selected proposal. A statistical simulation was used with the objective to characterize the reality of the economical evaluation that was developed. With the simulation results it is possible to determine cause and effect relationships and make predictions, which permit to create scenarios to prognosticate the risks and take decisions according with the obtained results. A probabilistic distribution was generated, that represents the possible values for each variable, in this case: Inversion (CAPEX), NPV and the IRR. It was used a normal distribution also known as Gauss distribution and a standard deviation of 10%.

The regasification plant's capacity was fixed considering the current NG deficit in the Zulia region (213 MMSCFD), and then the total amount of LNG processed by this plant should be 1.51 MMTPA. The location was planned in Puertos de Altagracia (Zulia), at 5 km of the Petrochemical Complex "El Tablazo".

It was considered a storage capacity of 129000 m^3. FRSU will be connected to the pipeline network of the Petrochemical Complex "El Tablazo". It would have 6 loading arms to receive LNG from carriers and 2 loading arms to transfer the regasified NG to the pipeline network.

4. Results

In the Table 1 results of the evaluation of both LNG price sales scenarios are shown. In the first scenario, corresponding to profit over LNG price of 1.06 $/MMBTU, it seems that the

best option is to rent a FSRU, because the rentability of the project is higher than the other cases, even though the rest of the alternatives are also feasible. However, there are two strategic factors that would be considered to implement one of the evaluated alternatives in order to mitigate the NG deficit; these factors are: the investment and time. Rent a FSRU needs a lower investment than the other two alternatives and, the installation of a Regasification Plant requires at least, 34 months to begin the operations, considering some technical activities related with the project such as: engineering, procurement, authorizations, etc. For this reason, the option of the regasification plant is rejected.

Comparing the scenarios to buy or rent a FSRU, is important to analyze the discounted payback period. The period is similar in both cases, and greater than 6 years. This time exceeds the rental contract, or lease, which is supposed to be equal to 3 years considering that the beginning of Rafael Urdaneta Project is expected for the year 2015. This project will produce 1000 MMSCFD; this volume will be used to supply the internal market and the surplus will be destined to the international market [5]. In consequence, the option to rent a FSRU is also rejected, choosing then to buy a FSRU. This ship could be rented or sold when the NG deficit in the Zulia is overcome, or used in the Venezuela's LNG projects when they begin.

Table 1. Economic results corresponding to each one of the alternatives considered (regasification plant and FSRU buy or rent) for two scenarios of profits over LNG price.

	LNG IMPORT ALTERNATIVES	REGASIFICATION PLANT	BUY OF FSRU	RENT OF FSRU
SCENARIO	INVERSION (CAPEX) (MM $)	418.66	399.15	283.55
1	NPV (MM $)	396.39	90.10	398.64
	IRR (%)	13.55	18.67	20.26
	DISCOUNTED PAYBACK PERIOD	6 years, 9 months	6 years, 8 months	6 years, 3 months
2	NPV (MM $)	1189.12	882.83	1630.20
	IRR (%)	44.10	50.19	67.13
	DISCOUNTED PAYBACK PERIOD	7 years, 9 months	4 years, 8 months	3 years, 3 months

A similar situation happened with the second scenario (profit over LNG price = 4.00 $/MMBTU), where the best option is buying the FSRU, considering the same reasons exposed before.

It is important to mention that the LNG price fixed in a value of 4.00 $/MMBTU competes with the current price of NG that Colombia sales to Venezuela through the pipeline Antonio Ricaurte, which is 3.89 $/MMBTU, then it will be a point to consider to PDVSA if they want to apply the proposal of the present study.

It is important to mention, that the buying of FSRU will not affect significantly the execution of Natural Gas projects already planned, because the use of this ship it's suppose to be only for

three years. However, the deficit in the Natural Gas supply will persist for at least four years more, until the projects like the Rafael Urdaneta are not completed. If the deficit is not overcome, the consumption of liquid hydrocarbons (fuel oil and diesel) will continuously increasing.

The proposal to buy the FSRU was validated for the two scenarios of profit over LNG price, applying the Montecarlo Method. To develop the simulation of the studied economical parameters, it was considered two statistical variables: the supposed and the prognostic. As premise the supposed variable was the Total Inversion, because the parameters considered calculating the CAPEX could change during the time between the statistical analysis and the final moment when the FSRU will be bought, especially the prices.

The prognostic variable is the variable that will be calculated and it includes formulas that are affected by the supposed values. In this study the prognostic variables were the NPV and IRR.

Based on the results shown in Table 1, it was analyzed the case where a FSRU is bought, considering the two profit scenarios, in order to validate the proposal of this study and determine if the accuracy level was greater than 50%. This accuracy level allows reducing the risks of the project and the incertitude. The results obtained for both scenarios are shown in Table 2, they demonstrate that the two alternatives are viable.

Table 2. Accuracy leveles for both scenarios of profit over LNG price. Buy of FSRU.

ACCURACY LEVEL	NPV	IRR
SCENARIO 1	50.89%	51.07%
SCENARIO 2	50.20%	50.19%

The results of statistical simulation for prognostic variables NPV and IRR are shown in Figure 3 and 4, respectively.

5. Summary/Conclusions

- It was determined that the Zulian region presents a current NG deficit of 213 MMSCFD which affects the production of different sectors, such as: Electricity, Petroleum, Domestic and, Petrochemical.
- Through a financial analysis, considering the values of NPV, IRR and, the discounted payback period, it was determined that the three different technologies of LNG regasification (plant installation, to buy or rent a FSRU) are feasible, considering the two price scenarios for the LNG supplied by Trinidad & Tobago.
- Even though the option which offers higher values of IRR and NPV was renting a FSRU, this option was rejected, due to the value of the discounted payback period, which is greater than 3 years, and it is supposed that after this year (2015) the Rafael Urdaneta project will be operating, supplying the NG that Zulia needs.
- It was selected the option to buy a FSRU for mitigating the NG deficit that currently exists in the Zulian region. The principal advantage of this option is that FSRU could be sold or rented when the energy crisis has been overcome.

- The statistical simulation applying the Montecarlo method, demonstrated that the option to buy a FSRU, considering the two scenarios of profit over LNG price, are feasible with acceptable levels of accuracy for prognostic variables NPV and IRR.

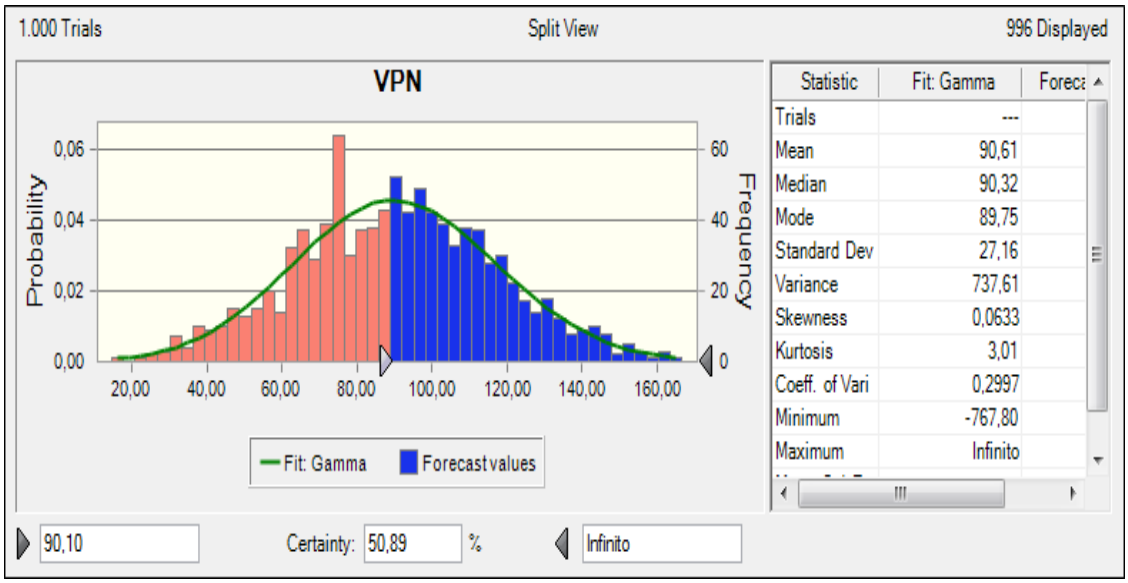

Figure 3. Statistical simulation for prognostic variable NPV, case: Buy a FSRU.

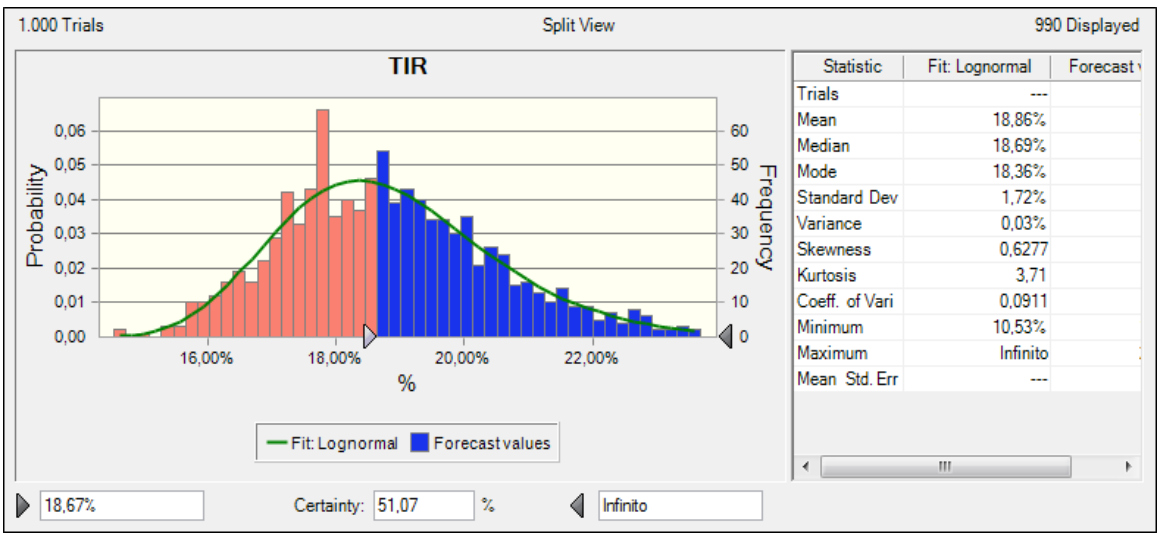

Figure 4. Statistical simulation for prognostic variable IRR, case: Buy a FSRU.

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