CRITICAL SUCCESS FACTORS FOR ELECTRICITY GENERATION
PROJECTS BASED ON LNG

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1. ABSTRACT

Several countries with no existing gas market have an increasing electricity demand. The expansion of the Liquefied Natural Gas (LNG) industry offers an opportunity to develop generation projects based on LNG. Although technology components (LNG storage and regasification, power generation, etc) are well established and available, many integrated projects fail to meet their targets and schedules.

This paper analyses an integrated project from different angles:

- Business model: contract interconnections and synchronization (Power Purchase Agreement (PPA) term vs. LNG Sales and Purchase Agreement (SPA) term, tender schedules), commercial risks, right investor mix profile.
- LNG infrastructure: alternative configurations for storage and regasification (floating vs. onshore, hybrids, etc.); capital expenditures (CAPEX) investment vs. charter/services schemes, etc.
- Generation technology: combined cycle generation turbine (CCGT), gas and dual-fuel engines, thermal integration, etc.
- LNG supply strategy: model for calculating LNG competitiveness (LNG ceiling price for electricity target market), flexibility, price formula and index risks, pass-through schemes, long-term versus short-term contract.
- Commercial barriers: project impact on existing players.
- Electricity and gas regulation: third party access, power purchase agreements structure, system and dispatching rules, tariff structure, marginal costs, etc.
- Environmental: LNG vaporization technology, CO₂ emissions, evolution.
- Upsides and new business: secondary LNG distribution, LNG by trucks for industrial utilization, liquid petroleum gas (LPG)/diesel substitution, etc.

A successful integrated LNG + power project deals with many levels of complexity. It requires an efficient and rational technical design, a realistic LNG supply strategy, and a business model that synchronizes properly all the commercial terms of the different contracts (Engineering Procurement and Construction (EPC), Terminal User Agreement (TUA), LNG SPA, PPA) in the existing and evolving energy framework of the country.
2. INTRODUCTION AND PURPOSE

The great development that LNG has had recently in the world market is mainly due to the use of gas as fuel for power stations. A significant number of countries without a gas market see in LNG an opportunity to attend the growth of electricity demand allowing them, on the other hand, to reduce electricity costs and the total amount of the power bill.

The world macroeconomic environment has taken oil prices sky high. As a consequence, an increase in the electricity bill in many regions has taken place. This environment motivates the advent of new projects set to reduce this cost.

Even though the technical components of the generation systems based in LNG are well known and well established, not all projects manage to fulfil their objectives in time and within budget. Commercial aspects and market conditions have a significant influence in the success probabilities. The best way to face these conditions is to know them and adapt the project accordingly.

The current document presents the challenges that the sponsor of these types of projects faces and the opportunities to overcome them and be successful.

3. INFRASTRUCTURE

3.1. Technical project basic scheme

The basic scheme of a system that allows electric power generation using LNG as fuel basically comprises two units:

- LNG reception, storage and regasification terminal.
- Electric power plant.

Image 3 3.1 shows the process basic blocks diagram, identifying the two indicated units.

The “LNG discharge and reception” system allows for a LNG carrier to be safely berthed, as well as to discharge LNG towards the shore facilities.

LNG is stored in cryogenic tanks. The volume of these tanks must allow the total discharge of the berthed LNG carrier and an allowance for possible delays in the ships arrival.

Finally, at the LNG facility the LNG is brought back to its natural gaseous state and is sent through pipes to the power station for its consumption.

At the power station, the natural gas is burned. In so, the fuel chemical power is extracted and transformed into electric power.

On the last stage, the electric power generated is adapted before being delivered to the transport and distribution network.
These basic blocks of the procedure have to be adapted for each project, optimizing possible solutions so that global costs are minimized, taking advantage of synergies and local opportunities.

3.2. LNG Infrastructure. Alternatives

LNG infrastructure must be located close to the coast or a navigable waterway: LNG supply is performed by sea transportation, using LNG carriers. From a theoretical point of view, it could be argued that supply could be made using trains or trucks, but the required LNG volume makes this solution impractical, except for facilities with a power generation capacity lower than 100 MW.

Considering the basic case of LNG supply by ship, two extreme alternatives can be proposed: locating the regasification terminal onshore or using a floating unit. Intermediate alternatives can also be considered: the use of regasification storage facilities onshore or on a platform. Image 3.2 is a summary of existing regasification terminals in the world, grouped by categories or typology:

As it can be observed, in most cases the project sponsor has decided to implement onshore solutions, which are called “conventional solutions”. It is necessary to mention that conventional solutions have a long history; the first terminals of this type date from the end of the 60’s of last century. Offshore terminals are more recent: the first one came into operation in 2005. Their development has been spectacular in these last years, shortening projects execution periods and allowing LNG to access markets that could not have been supplied by conventional solutions.

When making a decision for one or another alternative, the sponsor has to handle a large amount of information. Main variables are probably those of an economic nature: Capital Expenditure (CAPEX) and Operational Expenditure (OPEX). The floating terminals or those of mixed configuration allow reducing the project’s CAPEX, replacing the investment in assets by annual expenditures like, for example, the freight rates of the floating storage unit.

The sponsor must adequate the design to the project specific circumstances, its location and environment. The following items are to be considered:
• Gas or electric demand and market conditions.
• Timeframe, future development and expansions.
• Capital limitations.
• LNG supply logistics: vessels size, distance from the supply source, etc.
• Infrastructure reliability and availability.
• Regulatory framework.
• Land availability.
• Geo marine conditions and environmental issues.
• Uncertainties and risks.
• Etc.

Taking all of this into consideration, the designer has to choose unique solutions from many possible alternatives for each of the system components:

• General: Location and setting. Onshore, offshore or mixed configurations.
• Approaches and berthing: dock, jetty, breakwaters, dredging.
• LNG storage: total volume, number and size of the tanks, type of the tanks.
• Regasification: system pressure, number, size and type of vaporizers, thermal integration with electric power plant.
• Boil-off gas treatment: compression, re-condensation, fuel-gas.

Scheme under image 3.4 represents a flow diagram for an offshore regasification terminal.
As it has already been mentioned, the main issue is to select an offshore or an on-shore solution. In the last few years, initial capital limitation and intrinsic risks has made sponsors to opt for offshore solutions. Nevertheless, several projects foresee future developments that propose the construction of on-shore terminals, taking advantage of the already built infrastructure.

3.3. Generation infrastructure. Alternatives

The industrial development places in the hand of the project sponsor several options into how to turn the gas chemical energy into electric power. Even though some of those options are still under research and development stage, some others have been part of the industry for a long time.

Among the most conventional power generation systems that use gas as a fuel, the following can be outlined:

- Systems based on steam cycles, with steam boilers powered by gas and steam turbines moving power generators.
- Systems based on gas turbines operating in simple cycle: the gas is burned in a gas turbine attached to a power generator.
- Systems based in combined cycles gas turbines (CCGT): the hot exhaust gases from a gas turbine are used to generate steam and move a steam turbine.
- Systems based on internal combustion engines. Engines that follow the Otto four strokes cycle have often been used; although recently two strokes slow gas powered engines have become available.
- Systems based on internal combustion systems complemented with a heat recovery system operating in a combined cycle: a steam boiler and a steam turbine are added in a similar fashion to a CCGT.
It is common to request a high availability from the power plant. Coupling this fact with the LNG supply logistics, the project sponsors are faced with a new parameter that ought to be introduced in the design: the need for an alternative fuel.

All the aforementioned technical solutions can work with alternative liquid fuels. The systems based on gas turbines have the downside of requiring clean fuels, such as diesel oils. According to each design, engines and steam boilers may burn cheaper fuels like residual fuel oils.

Once again, the economic parameters are the ones driving the deciding making for any of the alternatives. Three are the main aspects which may tilt the balance towards one of the solutions:

- Investment or CAPEX.
- OPEX and its distribution between fixed and variable, namely fuel consumption.
- The expected load factor for the power plant and its seasonality.

These parameters, together with the plant power rating will provide the project sponsor with the tools to reach an adequate solution. The following general ideas are to be taken into consideration:

- With the same power rating, a gas turbine power station with an open cycle has a lower CAPEX than a power station with CCGT. In the other hand, OPEX are higher since they have a worse performance.

- Power stations with reciprocating engines have more flexibility than gas turbines power stations, since there are more units of lower power rating. However, the maintenance costs are usually higher as there are, in effect, more units.

- Simple cycle power plants are capable of attending power demand with lower investments. If the demand increases, it is possible to expand and transform them into combined cycle power plants, increasing the total power, with more investment but with similar OPEX.

The exact knowledge of the electric demand and its evolution are key issues to define the best solution. Introducing LNG in an already operational and established market generates disturbances that may cause the project to fail. The project sponsor must analyze the market in detail and estimate what will be its reaction to the arrival of a new fuel. A detailed risk analysis is basic to prepare the reaction against any adverse situations during the project life span.
3.4. Implementation. Optimization. Environment

Regardless of how the LNG regasification terminal is designed, it needs heat for the vaporization. Electric power plants generate heat as a byproduct. It is possible to efficiently integrate both systems. This allows for economic savings as well as reducing environmental impact in general.

The simplest integration system consists in using the electric power station refrigeration and condensation water to vaporize LNG (Image 3.6). Economic savings achieved are small, but the global environmental impact is reduced, easing the Authorities approval. If the cooling water comes from a natural source (lake, river or sea), the returned water will be cooler than if the power plant operated separately: the effect on the environment is reduced.

If the facilities are located in a cold area, where it is not possible to use seawater to vaporize LNG throughout the year, heat coming from the power station avoids burning gas for vaporizing and heating LNG, enabling significant savings.

Another system that allows the optimization of the terminal + power plant set is to use LNG cold temperature to cool the intake air for the gas turbine (Image 3.7). The performance of gas turbines is affected by intake air temperature; regulating the temperature of this air makes it possible to operate the turbine in an optimal performance situation, regardless of the specific local weather conditions.
This system needs an auxiliary circuit, normally with glycol-water mixture. Glycol is cooled in a shell-and-tube heat exchanger, in which LNG vaporization takes place. A glycol/air heat exchanger is placed at the turbine air intake: the air is cooled and the glycol is heated. An electric pump forces glycol circulation between both exchangers.

There is a big thermal difference between LNG and the fluids that are generated in the electric power plant. Taking advantage of this, it is possible to produce demineralized water or desalinate seawater in an economic way. Demineralized water can be used to supply the combined cycle steam boiler of the power plant or to be exported to other neighboring industries. Seawater desalination for its distribution to neighboring communities makes the approvals process easier.

Logically, the electric power plant specific location and the relative location of the plant and the regasification terminal will establish if the solutions are applicable. If the distance is very large or if the orography is very complex, investment in pipes for water transportation or cooling/heating fluid does not justify the savings that could be obtained.

If both facilities are close enough to each other, it will also be possible to share a large amount of auxiliary systems, reducing global investment:

- Control, safety and security systems
- Auxiliary fluids systems: compressed air, nitrogen, water
- Fire protection systems
- Auxiliary electric system: uninterrupted power supply, emergency power generation

Taking advantage of the synergies allows improving the economic results of the project as a whole. Nevertheless it is necessary to include the capital limitations that may exist, as well as associated risks: essentially related to the loss of operational independence of each part.

However, only between 10% and 15% of the analyzed projects have considered the use of wasted heat for LNG regasification. Merely 5% of the projects have implemented intake air cooling for their gas turbines.

### 4. BUSINESS MODELS AND CHALLENGES

Even though the basic scheme of a LNG powered generation system is very simple, as described in image 3.1, the company structure can be reflected in several formats. The decision about the model to be implemented falls on the project sponsor, who must take into consideration a large number of internal and external parameters. The ideal solution is far from universal, since each project has different characteristics.

Basically, the different possible models differ in their financial capability or in the funds available to the sponsor and the diversification of the risks associated with the project. The ideal solution for a specific project is determined by the balance between the investment costs and the annual operating costs; this balance must satisfy all parties involved in the project, in particular the sponsor.

A list of possible business models can be seen below. They are organized by the sponsor financial and investment capability. The purpose is not to reflect all possible alternatives, but only the most common configurations.

**Model A**

This model is the one that requires the maximum financial capability from the sponsor. In it, the sponsor assumes direct responsibility and participation in all installations. The scheme is reflected in image 4.1
The sponsor is identified as the Project Company in the image above. In this model, the sponsor executes the project engaging two Engineering, Procurement and Construction (EPC) contractor services companies. The Project Company ends up being the owner of all the facilities. It is also the supervisor of the whole operation, although it could use a service company for this purpose.

The Project Company is the one who receives the credit from the lenders and invests it in the facilities. The facilities, the supply contracts, the Power Purchase Agreement (PPA) and the EPC contracts are provided for the credit guarantee.

The LNG Sales and Purchase Agreement (LNG SPA) is also supported by the PPA. PPAs are the ones that guarantee the constant financial flow that holds up the entire model.

It is common that all or most of the contracts are managed in parallel, including condition precedent clauses that link the execution of one contract to the execution of the others.

In this model, the Project Company must fully disburse the CAPEX. It may be a self supported investment or, what is usual, from third party capitals through project financing models.

**Model B**

Image 4.2 depicts the scheme of this model B.
Once again the Project Company is identified with the project sponsor. In this case, the sponsor does not own the facilities. The owner and operator of the facilities is a different company: BOO Company (Build, Own and Operate).

This BOO Company will build the facilities either with its own funds or through project finance resources. Usually lenders will demand certain guarantees from the sponsor to grant the credit. As in Model A above, the PPA cash flow is the support for all the business case.

In this case, the Project Company must not face the CAPEX expenditure, but the cost of the services contracted to the BOO Company as continuous flow of payments. In this way, the Project Company does not need to show its financial strength, but does need to demonstrate the capability to generate the necessary funds for the proposed business. The sponsor does not need to become indebted with the lender, but to use part of the income from the power sale to pay the services of the BOO Company.

The BOO Company is the supplier and operator of the entire project physical infrastructure. This business model can be justified when the Project Company has no experience in the management of power infrastructures. This is why it needs to rely in the experience of another company. The BOO Company has no direct commercial relation with LNG supplier or the power purchaser. The sponsor maintains this commercial relation. The Project Company establishes the operating conditions for the entire infrastructure, planning the production levels, etc.

The real life application of this model usually comes with crossed share participations between the different parties involved. In each part of the project, the lead goes to the company most experienced in each activity.

**Model C**

Models A and B above reflect extreme situations. The following model takes into consideration an intermediate position between both: the sponsor or Project Company is the shareholder of the power station, but not of the regasification terminal. This terminal operates under the BBO mode explained under model B.

In this model the Project Company must face the financial need demanded by the power station. It must also face the payment for regasification services that will come as operational costs in the sponsor’s accounts.

Model C is usual when the Project Company is already an operator of the electric system; or wants to be one; and is not familiar with the management of LNG regasification facilities. The services of a BOO company are engaged and they will manage the supply and operation of the regasification terminal. The BOO Company has no direct commercial relation neither with the LNG supplier nor with the power purchaser. The sponsor plans the regasification allowance that BOO Company has to fulfil. This is all described in the services
agreement signed between the Project Company and the BOO Company: the Terminal Use Agreement (TUA).

Since the introduction of floating regasification units (Floating Storage and Regasification Unit, FSRU), project sponsors frequently use this model C for their business case. In this way, they solve two problems:

- It is easier to adjust execution times of all infrastructures, since the construction schedule of the infrastructure a FSRU needs is similar to that of the construction of a CCGT type power station.
- FSRU management is very specialized and very few companies have experience.

**Model D**

Model D is similar to model B, but with two different companies for the management of the necessary infrastructure. The scheme of model D is described in image 4.4.

![Image 4.4. Business Model. Model D](image)

Comments provided for the description of model B are also applicable for this model. Since it is hard to find companies with experience in the management of all infrastructure, the Project Company may contract two different BOO companies.

**Other Models**

It has already been mentioned that the specific application of theoretical described models can involve the existence of crossed shares participations between the different entities of the project that will not be completely independent.

Besides, during the project operational life it is very possible for market changes to occur and force changes in the business model. As time goes by, the shareholders of the project and the companies involved may change. In this way, the business case will evolve from one model to another.

Some changes might be scheduled at the signature of the project contracts. Such is the case of a variation in the models that include BOO: after a period of operation, the BOO contracts can establish the acquisition of the facilities by the Project Company, paying the residual value. This model is known as BOT: Build, Own and Transfer.

Another variation is the introduction of more entities in the model: separating the property of the assets from their operation. New service contracts are to be established: operation contracts. These contracts are independent of the infrastructure lease contracts.
Finally, a business model known by the name of “tolling” has to be mentioned. In it, the sponsor does not intervene in the power contracts: it is limited to the management of the infrastructures. The sponsor provides regasification and power generation services to the consumers. These electricity consumers will sign SPAs with the LNG supplier and service contracts with the Project Company.

For the development of the infrastructure projects it is also possible to create new entities: it is possible to introduce companies that perform BOO type activities for the LNG terminal or for the power station.

Once again it is necessary to point out that the existence of cross shares participation among the entities involved in the project is quite common.

4.1. Business Challenges

Energy has become one of the key factors in economic development. All business models base their feasibility in the existence of power demand. It is the might of this power demand and its characteristics which will make the LNG import business feasible for its use in power generation.

Power demand characteristics are included in the Power Purchase Agreement (PPA). This agreement, beside the price and other financial conditions, encompasses:

- Power demand
- Supply terms and duration
- Seasonality and temporary distribution of the demand
- Use and destination of the electric power
- Supply guarantee and reliability
- Force majeure and actions to mitigate their consequences
- Conditions precedent
- Etc.

The LNG Sales and Purchase Agreement (SPA) must be coordinated with the PPA. The PPA is the support and justification for SPA and all the other contracts and agreements of all business models. The challenge the project sponsor faces is the achievement of this coordination.

LNG SPA contracts mean huge investments. These grant them certain characteristics that are not common in other energy contracts. The following two are to be outlined among the others:
• Contract duration
• Take-or-pay clauses

In order to finance the LNG supply chain, by means of project finance or similar, lenders need guarantees that the down shore chain economics is solid enough to face the credits dues. For this purpose, LNG SPAs have a long duration: long-term contracts, with a life span from 15 to 25 years. These extended periods are not common in PPAs. The Project Company is tide between the LNG SPA and the PPA. It must convince both counterparts that the periods for both contracts should match. Generally this requires a lot of effort, since the purchasing part in the PPA considers it a very risky commitment to engage a sole supplier for such a long period of time. The selling part of the LNG SPA needs these long timeframes to strengthen the project.

The exigency of a regular income flow is also part of the take-or-pay clauses: the LNG buyer has to meet his obligations whether he takes the product or not. Obviously, this obligation is only applicable for LNG buyer own causes. Take-or-pay clauses usually do not have the same weight in the PPA as they do in the LNG SPA. Nevertheless, PPA contracts usually have firm payment commitments in relation to the power availability. These provisions help to partially counterweight the take-or-pay clause of LNG SPA.

There is another significant challenge that the sponsor has to face: a big part of the power market does not use PPA, but spot operations. Offer and demand matches on an hourly basis, with no long term commitment.

Another clause that consumes the sponsor’s efforts is the seasonality of the demand. Electric demand follows a market annual profile: climatic conditions, consumption seasonality, market size, etc. Generally these are out of the control of the power supplier: he has a very thin margin to change the demand profile.

On the LNG supply side, investment optimisation for the value chain calls for steady and uniform production. In an ideal world the production levels would always accommodate to the chain needs. Nevertheless, there is always some flexibility in the system, in the LNG production units as well as in the storage tanks and transportation chain. But this flexibility usually has an economic impact: greater consumption, greater product losses, greater costs, etc.

To face supply reliability demands from the PPA usually means increased investment in the LNG importation infrastructure. The sponsor must optimize the design to fulfil the demand minimizing the investment.

Another significant issue is price. Both electricity and LNG use reference indexes as a basis. Unfortunately, these indexes are different for each commodity. This introduces price mismatch uncertainties. Furthermore, as there is no LNG international price, comparing LNG prices with that of other power sources can be daunting.

Overcoming these challenges ought to be one of the sponsor company core activities. Otherwise the project will become more uncertain and it would be more difficult to find a LNG source.

5. LNG MARKET: COMPETITION, OBSTACLES, REGULATION

5.1. LNG supply and competition

The seed or original idea for an electric generation project using LNG as fuel usually comes from a will to reduce current generation costs. Motivation may be justified with two reasons:

• The will to reduce the average cost of power generation
• The commercial opportunity to sell power at a lower price than the market, profiting from the difference
The first of the reasons usually comes together with a public body, while private sponsors usually find the second reason more appealing.

In any case, result and consequences are similar: the project will only be feasible if the power generation costs are lower than the ones in the existing system. Therefore, it is necessary to know the generation cost structure.

Basically, power generation costs can be grouped in two categories: fixed costs and variable costs. Fixed costs are annual costs which have to be paid regardless of the power station operation. Variable costs depend on the production levels.

The following chart contains the detail of an electric generation power station costs structure:

<table>
<thead>
<tr>
<th>Fixed costs</th>
<th>Variable costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amortization</td>
<td>Fuel</td>
</tr>
<tr>
<td>Financial costs</td>
<td>Emissions (CO₂)</td>
</tr>
<tr>
<td>Rates</td>
<td>Taxes</td>
</tr>
<tr>
<td>Fixed Operation and Maintenance</td>
<td>Variable Operation and Maintenance</td>
</tr>
</tbody>
</table>

Each generation technology has different costs: values reflected in the chart depend on the power station characteristics. When taking into consideration an electric system composed by several power plants, transportation lines and auxiliary installations, the cost calculation becomes more complicated. To simplify the evaluation and the analysis, it is frequent to use linear correlation:

- Fixed costs are transformed into power capacity proportional costs
- Variable costs are transformed into a linear function of the produced energy

With these simplifications, system costs are reduced to the sum of two parameters: one proportional to the installed power capacity and the other proportional to the produced electric energy. Relative weight of the produced electric energy in each station has to be evaluated for the calculation of the system global costs.

The introduction of a power plant feed with LNG causes a modification in systems costs. Both its energy and power capacity costs will be part of the new system costs. The amount of electric energy expected to be produced in the station will be used as an evaluation factor.

In this way, it is possible to calculate the new electric system costs including the new power station. From the assessment of this new value in comparison with the one previously calculated, we can conclude if the LNG is attractive or not for this market.

The economic models used to evaluate costs include, logically, the performance expected by the sponsor. This is why LNG may or may not be attractive for a certain market depending on the sponsor’s performance expectations. These performance expectations have a high correlation with the risks assumed by the sponsor in the project.

One of the main variables in the calculation of the generation costs is fuel cost. It is a variable cost, tide with the station generated energy.
An economic model that evaluates the maximum price that LNG could reach when destined to a specific electric market has been developed. The model calculates existing electric systems costs without LNG and reaches the maximum price that LNG could reach so that the global costs are kept even.

The model is based on a linear LNG price formula based on an index rate. The usually used indexes are: crude oil prices, liquid markets gas prices (Henry Hub HH, National Balancing Point NBP, etc.), oil products portfolios, etc. The used linear formula will have two terms to be calculated: the slope and the constant. These are the two parameters that economic model calculates.

In a similar way to LNG, the model assumes that price of fuels used in electricity generation can also be represented with a linear formula in correlation with the same index. The model calculates the parameters of these formulas based on fuel historical rates and the chosen index.

The model transforms all the power stations system costs into two parameters:

- The slope (SLP) in the linear correlation with the index (RI)
- The constant (K) in that linear relation

Image 5.1 represents the followed calculation procedure.

In a nutshell, the economic model calculates two parameters of a price formula for LNG: the reference index multiplying coefficient and the constant. This maximum LNG price, delivered DAT in the considered port, must be adjusted taking into consideration:

- The expected savings after LNG introduction
- Project inherent risks

The comparison of this maximum price with the LNG market price shall indicate if the new market is considered attractive or not for this fuel. Nevertheless, it is necessary to adjust this calculation after careful consideration to the costs of LNG transportation, project timing, etc.
5.2. Market: competition, obstacles, regulations

The model developed and previously described is a theoretical simplification. Real markets are more complex. Some aspects that may affect LNG competitiveness and that the model cannot take into consideration are presented in the below diagram.

Image 5.2. The project in its market

The targeted energy market is currently being supplied by other energy suppliers who will try to keep their position. In general, they have a certain capability to adjust their costs, for which it is possible to modify the parameters the model uses and evaluate the new results. Existing generation facilities might already have some operational life: the investment may be totally or partially amortized. In regard to the operating facilities, the new gas powered station may have to compete with already amortized stations and with no debt. Their owners can temporarily reduce their profit and lower the price of the generated power. In this way, the project sponsor would be forced to compete with lower energy prices than those foreseen: the new station might operate fewer hours per year and the project profitability may suffer the consequences.

Existing Utilities, due to their presence in the market, usually have more links to the authorities than the newcomer. They can organize or support public or political campaigns against the arrival of a new competitor. They can influence the regulatory bodies in order to hindrance the implementation of the new station. It will not always be easy to face these entry barriers. It is necessary to have a thorough knowledge of the energy market in the area, the participating entities and their relations with other stakeholders.

Regulation can also be an important obstruction. The regulations for the use of LNG as fuel might not be available in a new market. There also may lack regulation regarding natural gas. The project must consider supporting the regulatory body in the development of the new regulatory framework. It is here where existing operators may attempt to impose their better historical relations. The negotiation and cooperation with the authorities becomes an obvious need.

The important environmental advantages of LNG and natural gas must be used by the sponsor at all times. The authorities and Society in general are usually very sensitive about these factors. Facts like lower CO₂ emissions than other fuels that can help in the project justification. In the same manner, possible CO₂ emission rights might help to improve the economic result.
In summary, the social and political environment must be taken into consideration by the sponsor. Plans must be developed to promote the project acceptance. The sponsor must be prepared for any contingency: prepare alternative plans in case any inconvenient arises and puts the project in jeopardy.

It is normal for the sponsor to manage the project through two political terms, due to the long development periods of LNG import projects. The sponsor must seek good relations with all social and political organizations. A confrontation with the opposition party can kill the project, if a government change takes place.

Another option is to execute the project in the “fast-track” mode: shorten the project schedule to a maximum. In this way the project can be operational before the next government change. It is not always possible to reduce all project stages. The execution of the “fast-track” project modes may have other consequences: being the main one that costs can soar.

5.3. Potential market evolution

The arrival of LNG to the new market can generate new business opportunities: natural gas can be available for industry, commerce and domestic use.

It will be the state of affairs of each market the one establishing if these possible developments will bear fruit. LNG competitiveness and its capability to compete with the current fuels will establish the feasibility of new opportunities.

Once LNG is available, it is easier to propose new regulations for its introduction in markets different from power generation:

- In Industry for steam generation or other direct applications
- In industry as raw material: production of ammonia, fertilizers, hydrogen, etc.
- In industry or the tertiary sector to feed combined heat and power (CHP) facilities
- For domestic and commercial use
- In transport use, as LNG or as compressed natural gas (CNG)

Gas can be commercialized and distributed by pipes. For this, it is necessary to develop a network that communicates the regasification terminal with the consumption areas. The development of this network is slow, as it requires a huge amount of different works.

Another alternative is to commercialize LNG with tankers, by road or railway. In this case the development can be somewhat faster and the demand of new consumers can be fulfilled earlier. Satellite storage and regasification plants for LNG must be constructed in the facilities of these new consumers.

All of these potential developments ought to be considered by the project sponsor. The sponsor must analyse the advantages and opportunities that these new markets pose. Anyhow, except for some specific industrial applications, all these possible developments must not be considered in the basic case: the economic feasibility of the project must not take them into consideration. They will be possible future improvements that will increase the sponsor’s balance sheet if they ever come to term.

These possible future developments do not make LNG more attractive. Only certain industrial uses can be an argument to justify the need of LNG: in applications where it removes other fuels with higher environmental risks or higher costs.
The economic model we present, can contemplate the existence of these industrial consumers. In these cases, the model evaluates a new maximum price for LNG, taking into consideration the expected consumption in these industrial applications and the consumption for power generation.

6. CONCLUSIONS

Today’s global energy market makes LNG available only to those able to compete with the current demand. LNG will only reach a new market if prepared to pay similar prices than the already consolidated markets, with the exceptions introduced by the transportation costs and fleet availability.

This condition is necessary but it is not enough. An LNG import project must be capable to give an answer to a large amount of uncertainties. The sponsor of the project must design its business model so that these uncertainties are conveniently overcome. He must try to reduce the risks of his future business as well as, at the same time, the LNG commercialization business. Otherwise LNG will be diverted to other destinations that can be considered safer and with lesser risks.

The table below shows the importance of the most relevant factors for 17 studied projects:

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<thead>
<tr>
<th>Financing</th>
<th>Access to LNG supply</th>
<th>Commercial aspects</th>
<th>Gas regulation</th>
<th>Environment</th>
<th>Electricity regulation</th>
<th>LNG technology</th>
<th>Power generation technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project 1</td>
<td>Project 2</td>
<td>Project 3</td>
<td>Project 4</td>
<td>Project 5</td>
<td>Project 6</td>
<td>Project 7</td>
<td>Project 8</td>
</tr>
<tr>
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<td>Project 10</td>
<td>Project 11</td>
<td>Project 12</td>
<td>Project 13</td>
<td>Project 14</td>
<td>Project 15</td>
<td>Project 16</td>
</tr>
<tr>
<td>Project 17</td>
<td>Project 17</td>
<td>Least Important</td>
<td>Most Important</td>
<td></td>
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</tr>
</tbody>
</table>

The proposed economic model allows the calculation of the maximum price LNG may reach in the studied market. The comparison of this value with the international LNG market will establish if the new market has any option to be supplied with LNG. Nevertheless, as it has been exposed throughout the present document, this maximum price is not the only variable that the project sponsor must know and handle.