GNL MEJILLONES FAST TRACK PROJECT: START-UP UNDER HR VISIÓN

**Alain Goy**
Head of Technical Department
Elengy, GDF Suez
Paris, France
alain.goy@elengy.com

Bernardo Echavarria and Claudio Ulloa
Deputy Plant Manager and HR Manager
Sociedad GNL Mejillones S.A.
Mejillones, Chile
bernardo.echavarria@gnlm.cl, claudioulloa@gnlm.cl

**KEYWORDS:** regasification; LNG; GNLM; HR; operation staff

**ABSTRACT**

The accelerated construction of an LNG regasification terminal demands two challenges: (i) in overcoming the barriers of technical design, procurement of materials and equipment, installation, quality control, testing, commissioning and start of commercial operations and (ii) the operative, get qualified human resources for its operation taking account of non-standard forms of short-term performance, while changes in business models dynamically impact both in the shape and volume of the organization needed to operate the plant. This paper describes the organizational structure implemented in various stages of construction and operation, the forms and sources of recruitment, selection procedures for key positions and forms of training in a country without culture LNG, without developed petrochemical industry, insert in an environment far from the production centers and non-mining industry with a clear orientation towards mining and mining services which are of a very different nature to the LNG industry. We describe the impacts, issues of recruitment and turnover in a labor market with unemployment rates near zero, describes the policies applied to the retention of highly qualified persons and potentially desired by the surrounding industry.

**Definitions, Acronyms and Abbreviations**

- **GNLM:** Sociedad GNL Mejillones SA
- **SING:** Northern Interconnected System, electricity
- **SIC:** Central Interconnected System, electricity
- **FSU:** Float Storage Unit
- **GN:** Natural Gas
- **LNG:** Liquefied Natural Gas
- **BOG:** Boil-Off Gas
- **BOGC:** BOG Compressors
- **CFP:** Pipeline Compressors
- **SCV:** Submerged Combustion Vaporizers
- **ESD:** Shoot-Down Emergency
- **MC:** marginal cost of production in U $ D / MW

**I. INTRODUCTION**

Designing a productive organizational structure serves, of course, (a) the technical nature of the facility, (b) complexity and when built from greenfield (c) should respond to the development time of the actual solution. Other organizational moulders are (d) the business model, (e) to develop production functions, the importance / relevance of these (e ') over other productive functions and (e '') the inherent importance of each particular function (such as levels of safe operation for example). All the above subject to (f) the
availability of qualified human resources and (g) technical skills available in the labor market incumbent or better access. None of this makes sense for the host community – Mejillones-but through an inclusive work and explicit, taking or developing "social capital" to transform it into highly skilled local workers.

This paper shows the timescale of dimensioning organizational actions to provide and retain qualified human resources in the Mejillones LNG terminal in the second region of Antofagasta.

The paper is organized as follows. Section II describes the original context of the project design, with their respective original organization. Section III describes the development, adaptation and implementation of the original model for a plant operating with Fast-Track FSU. Section IV shows migration with changing business model from TOP to TUA during construction and subsequent operation with tank on earth (FSU replacement per tank). Section V shows the labor market dynamics that have affected the redundancies in the existing organization and how they faced.

II. ORIGINAL DESIGN

Understanding organizational evolution necessarily contextualizes for each conditioning factors, problems and stages:

A. The Context

The SING is an interconnected electric system that supplies 90% of the mining industry, while 10% are mining services and residential who work directly or indirectly for mining. The indigenous population is relatively small and not served by such a system.

At the beginning of the 2007 SING has generating capacity from 3.5 GW coal, heavy oil, diesel and natural gas that is fully saturated. As shown in Figure 1, in the period 2007 to 2010 on spinning reserve capacity is of the order of 100% which indicates that the system as a whole is barely able to serve safely and without remaining supply. From the cut of supply of natural gas coming from Argentina, all plants to combined cycle must be operated with diesel, considerably increasing the non-combustible variable cost, supporting a very stressed diesel supply chain, impacting heavily on the marginal costs of the electrical system (as shown in Figure 2, through the CMg) and raising CO2 emission rates (as shown in Figure 2) to enter the diesel to the energy matrix strongly and increase the specific gravity of the coal.

If the above were not enough the price of diesel to 2007 found in high levels, but not the worst that would come the second half of 2008 as shown in Figure 3. Possible to replace diesel generation level and that he was previously served by GN does not reach 100%, reason by which the system suffered minor rationing at times of high prices of copper on international markets.
The preceding two paragraphs imply that security of electrical supply was an imperative systemic solution, both because the cost of failure on the productive work that it depend by the level of demand for electricity to meet the usual requirements of electric power quality.

Confidence in the GN, concerning all events fuel availability, was badly damaged and after the commissioning of the terminal discussion of the replacement price finally obtained.

The GDF-Suez and then Codelco through GNLM decided to build a LNG regasification terminal in Fast-Track mode is in operation in early 2010 and allows oil to replace diesel generation by GN, while new power plants are built to reduce or eliminate the generation saturation. The effort allowed GNLM (i) reduce variable costs noncombustible, (ii) increase the generation capacity of the system, (iii) reduce emissions of CO2 and (iv) eliminate stress from the supply chain of petroleum redound in the elimination of rationing and consequently improving the quality, availability and security of electricity supply.

B. The Objective

Implement productive a LNG regasification terminal in early 2010. Terminal capacity should be sufficient to alleviate congestion generation, improve nonfuel variable costs and particularly raise the security of electricity supply system. The operating horizon is the time to build new coal-fired power plants, estimated at three years.

Construction is established through an EPC contract includes the supply of spare parts for two years operation. The total cost of the project at an early stage is 530 MMU $ D and considers the plant on-shore, a dock with two mooring sites, a pipeline of 8 km. linking the regasification plant and the City-Gate. The lease is part of the FSU apex that GNLM must assume for the operation and functioning of the terminal.
C. The Technical Solution

The urgency of the availability of GN in the SING implied that the technical solution to avoid the construction time of a conventional tank but without the service of storage, while steaming trains must be such that its technology deployment time as small as possible according to time of development. The arrangement of equipment resulted in low Capex standard equipment (construction shortly), but intensive Opex (short time installation) as the SCVs.

The main innovation undoubtedly is the installation of a LNGC as tank. The above demand change pumps LP on board for a reduced flow, according to a daily send-out not dimensioned to a normal discharge profile. While the jetty must allow the operations of discharge ship to ship through the jetty, without interruption of the shipment of GN. But the most important challenge is to operate continuously with a ship and the jetty and its permanently connected unloading arms, from then on by the board room has been an appendix to the control room of the plant. The jetty has two sites for LNG ships up to 300 m long, 12.5 m deep and between LNG 135,000 m³ to 165,000 m³. The terminal has a site for FSU with three unloading arms (two liquid and one vapour). There is a place for Shuttle docking arm that has a liquid LNG and one vapour.

The FSU can use the Shuttle site, against their respective maintenances of their respective sites, with the restriction that it is impossible to perform the send-out zero mode with recirculation.

The download process, this means the transfer between Shuttle and FSU should be in their respective positions, so that the unavailability of a site allows operational continuity but not supply with new shipments.

Issues as simple as ensuring the continuous work of the dock defences, tie down hooks, avoid cuts of spies, allow the provisioning of both fuel and consumables form FSU does not hit in the “direct download” say relationship with the productive organizational structure and maintenance. Finally the availability of terminal not set but limited the availability of the plant.

Another condition to overcome is that the terminal must be in condition to allow zero send-out for periods of several days. This was solved with recirculation modes so that the pipes do not heated up or vapour pockets from forming and ensure quick start and safely wind the lowest practicable after that stop. The consequence of remaining at zero send-out is that it should be dealt with BOG compressors online or burned at the Flare. Both above situations involving low efficiency because of the high electricity consumption compression or inventory loss by burning gas in the flare.

As indicated in figure 4, BOG handling is performed through BOG compressor on a recondenser discharging, while the remaining not condensate is compressed at high pressure for injection into the internal

![Figure 4. Original technical solution](image-url)
pipeline to City-Gate. Such operation, high pressure compression, is highly demanding electric power and therefore costly.

The original design has been considered that the GN is delivered in a city-gate eight kilometers from the plant to the pipeline revaporization coming from Argentina and transporting fuel to large SING consumption centers and one point of consumption in SIC.

D. The Business Model

With an original business horizon of three years, in the meanwhile of building new power plants, the business model is the cancellation of capital through ToP contracts (take or pay) to diesel price - 1%. It may seem draconian cost structure, however the entry in terminal operations GNLM strongly relaxed SING marginal cost (as shown in Figure 2) and on several occasions I contribute to SIC. While improving security of supply (as shown in Figure 1, through the reserve) was solved.

![Figure 5. [1] Proyected Fuel Matrix, coal based](image)

![Figure 6. [1] Proyected Fuel Matrix, Natural Gas based.](image)

E. The Methods of Operation

Operation modes of the plant are: (i) sending normal mode, this implies that the level is sufficient to recondense sendout significant part BOG, the LNG flow rate is greater than the technical minimum of high pressure pumps and at regular intervals should contact the PPC service. The flow of low pressure LNG is served from the FSU, as are BOG management part through the fans or compressors of high service (ii) sending to download mode, consider keeping the send-out through refer to the onshore plant a portion of the transfer flow from the shuttle to the FSU. The rest of the process is similar. (iii) zero mode without
recirculation send-out handling considers maintain BOG through BOGC and PPC, while not exceeding the stop 8 hours and not became necessary the recirculation prevents heating of pipes and eliminates pockets of vented vapour may determine the portion of GN. Finally (iv) send-out mode without recirculation is such that through LNG pumps FSU LP. The use of both arms of liquid, vapour arm and a proper alignment in the terminal is able to maintain the operating temperature of the LNG lines for long time. This mode of operation is similar to send-out without recirculation, the mayor advantage is to allow a quick startup and avoid to flaring gas.

III. ORGANIZATIONAL ADAPTATION AND EVOLUTION

A. The first Organizational Modification

The first organizational changes occur in mid-2009 (Fig. 7) in the areas of maintenance, Marine Operations and Industrial Protection

![Figure 7. Organization at COD](image)

Although inventory management function is supplied for EPC contract, spare parts for two years of operation, the position of warehouse assistant is changed for the post of "Inventory Supervisor" dependent on new planning unit maintenance, not considered in the first approximation.

The second and third modification is set simultaneously in the area of Maritime Operations, adding an assistant and transferred Industrial protective function to the same area. The marine operations assistant arises by the need to secure the succession to a position of high complexity, while the tuition of protection is highly compatible with the profile of maritime operations, which was defined as the naval area of origin: armed or Shipping (both militarized).

B. LNG Plants on the Continent and its Interrelation

Quintero plant started six months before and since the beginning GNLM cooperation was the way they relate to GNLM. Some of the major teams are identical, casuistry which imposes climate we face the same challenges, while confronted processes of a similar nature in a different way to start creating a sort of aid, transfer of knowledge, practice and experience. Have made maintenances crosses SCVs, share experiences on arms discharge phenomena in continuous operation undoubtedly improved knowledge GNLM has through its management systems and human resources.

Little further born Latin American congresses operational excellence in LNG facilities all an opportunity to share and learn lessons about the LNG operation, transfer that continues year after year from countries like
Brazil, Argentina, Peru, Spain, Mexico & Chile. Chile started the cycle & the last year was Peru and is in its third version Mexico is whom will take up the challenge.

C. Organization Mature for ToP

During this period (see fig. 8) is reinforced process area to add an assistant engineer processes to enable redundancy and continuity the measurement processes and conciliation of billing information.

On the other hand the Maintenance Department takes an organized form of knowledge in areas with a functional leader (supervisor) for each, while disappears the position of superintendent of maintenance.

The area of Health and Safety and Environment maintains its structure from the beginning, regarding production processes, but during this period incorporates a risk prevention adviser in order to specialize in the risks inherent in the regasification process and sub process related to unloading LNG storage and presentation.

IV. FROM TOP TO TUA

A. Change of Business Model

During ToP GNLM keeps LNG supply contracts and therefore owns the inventory that stores the FSU. As a NG provider of SING clients, should design and manage the logistics chain that will supply contracts and its variations. The model involves selling TUA downloading services, storage, regasification and delivery of GN in delivery points. The property inventory is those who maintain TUA contracts with the terminal in different proportions, for which concur in operating agreements (OCA: Operation Cooperation Agreement).

It marked the importance of the Global inventory balance, for the inventory individually. Similarly those operational concepts as GN uses and losses should be treated with high diligence although efficient as ever.

Another important item for future compatibility will ship terminal, where a fleet fully known from now will transit to a fleet not only new but also spot. Then make fast and accurate studies is a must with high impact.

The optional dilution of LNG, means that LNG the loads should be evaluated not only on compliance with the standard Chilean natural gas, but also consider the added office profile and compatibility that the aging occurred during the residence time in the inventory can be managed.

The advantages of change of modality are of the following nature: Customers can now get their own LNG prices even spot, swap market short medium or long term, transferring from GNLM each customer the benefit (price)and risk. If this, as many experts have predicted, it happens due to growth and depth of the LNG market, then prices in the domestic market penetration and GN as generation and industrial fuel allowed as a matrix of Figure 6. If the energy matrix rather tends to coal, then the GN will be relegated to meet demand during construction periods for new coal plant.

Whatever happens, the SING need to have a fuel storage that can cope with the demand, either backup or base.

B. Organization during LNG Tank Construction

TUA period may be in the current technical configuration of the terminal and will be partially done, however there is a high operational cost: the FSU. So the first item to move from OPEX to CAPEX is the storage device. Therefore GNLM starts in 2010 to build a 175,000 m3 LNG storage tank net. Stop operations for tank construction is not the way, so keep a plant in production and allow people to work within it is the objective, care and unusual but possible.
Figure 8. Organization tuned for ToP

The business model is in the last years of ToP and will soon lead to TUA (Terminal User Agreement), without a transition period or by adaptation. Organizationally means that in full epoch ToP, you must create the means of mitigating human and technical resources in order to enable safe compatibility of both tasks: Produce and Build.

Departments that from the beginning have maintained their structure are now subject to the reinforcement (see fig. 9): Operations is added to the position of Assistant Shift Supervisor, Risk Management Assistant and a reinforcement of 5 operators that allows deal to high rate of job turnover generated by the excellent performance of the mining sector in particular and productive sector. The Risk prevention department creates two spaces to support the internal workings of the plant, while reinforces the equipment of supervision to direct constructive tasks.

Figure 9. Organization during Tank Construction
V. LABOUR MARKET

A. General Context in Recent Years

Chile has experienced steady growth in economic, based mainly in the mining and industrial activity. Mejillones LNG plant is located in a region where mining is the main activity, which has strongly promoted the demand in the labor market, recording the region, unemployment permanently below those seen nationally. This has led to a highly mobile workforce from other parts of the country, shortage of skilled labor, increased personnel costs via higher prices, increased levels of staff turnover, among other effects.

B. Experience GNLM

One of the first difficulties at the start of the project was to have qualified human resources and the expertise to operate an LNG terminal. At that time, there was only one plant of similar characteristics in the central region, which was under construction.

For the initial organization was necessary to perform search processes internationally capable personnel to operate the terminal together with the local search of technical personnel with the skills necessary to begin a process of intensive training, which was developed during the construction phase and operation of the terminal.

In terms of work during the construction period was gestating a strong social pressure from workers by establishing working conditions and professional development, which eventually led to two months of being officially opened GNLM operation is initiated at the request of workers, and protected under Chilean labor law, a process of collective negotiation. The process took a number of complexities given the immaturity of the organization, increasing expectations of workers, media effects that could reach a process of this nature and the possibility of suspension of activities, designed for these purposes must plans to maintain operational continuity based mainly on experience as well as in setting assumptions. Finally, the process was completed successfully for both parties involved.

In parallel to the process outlined above, we worked hard on providing a solid structure for operational management of human resources to move after to career development and training plans.

On the other hand, given the growing mining and industrial activity in the region, via development of new projects, was observing changes in the levels of staff turnover in the company. Added to was the need to strengthen the teams for both the period of construction of the tank on land and also to face the strong work activity experienced by the area where the terminal GNLM. To address this situation, encouraged the development of internal mobility as a primary source of recruitment, so it was necessary to hire several companies head hunting for the search and selection of personnel, and must increase the search range to other regions of the country. Added to this, they began to develop strategies for staff retention and loyalty, reformulating and performance benefits to the employee and also by the realization of initiatives in the areas of education, recreation, family involvement, among others.

In study are initiatives to create training plans and study in alliance with municipal organizations, whilst establishing a link with the local community and providing GNLM technical staff with the necessary skills to fill the first line of work.
REFERENCES

Figures representing evolutions of power generation market are taken from public sources and recognized authors.
