PERU LNG: A GRASSROOTS GAS LIQUEFACTION PROJECT OPTIMIZED FOR COST IN DIFFICULT TIMES

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1. **Introduction**.-

PERU LNG as of July 2009 had started the commissioning of its Liquefaction Plant in Pampa Melchorita (Peru). This will be the first Liquefaction plant in the whole Western Pacific coast in 40 years, after Kenai (Alaska), and the first ever in South American continent. Besides the LNG producing Plant the project also includes a marine Terminal for LNG tankers and a gas supply Pipeline, making it in the whole the largest single investment in Peru –at US$ 3.8 billion, all costs included (even financing)- as well as the largest project finance in Latin America –with loans obtained up to US$ 2.2 billion.

The project has been developed during the last 8 years through difficult times for reasons as the:

- -increasing capital costs for new investments,
- -extended delivery times for equipment and materials,
- -shortage of skilled labor and experienced contractors,
- -stringent environmental and social conditions, and
- -sour conditions for project financing.

But in spite of all those difficulties PERU LNG is about to complete its task by delivering the project:

1) as specified for production capacity, energy efficiency and plant reliability,
2) within the approved budget, and
3) at the pre-established time for completion.

From day one the driver for the Team managing the project was Cost Optimization. Through a combination of project management techniques PERU LNG has been able to lock building a liquefaction plant at a unit EPCC cost of US$ 420 /ton of annual LNG production capacity (including both Processing Plant and Marine Terminal), probably the lowest price for Liquefaction plants around the world nowadays. In this paper we describe the project characteristics and its development in time, with a special emphasis on cost optimization issues.

2. **Project Background**.-

2.1 ***Initial steps***

PERU LNG was incorporated as a Peruvian company with the purpose of buying natural gas from local producers and selling LNG for export to reputed LNG marketers. In order to do that PERU LNG had to develop a Liquefaction project in Peru consisting of the promotion, planning, design, construction, and operation of:

- a gas Pipeline,
- a liquefaction Plant, and
- a marine Terminal.

From 2001 to 2004 the Company was a joint venture of HUNT OIL (USA) and SK (S. Korea). In September 2005 PERU LNG was formally incorporated by HUNT OIL with 50% of the shares, SK 30% and REPSOL (Spain) 20% when the Shareholding Agreements were signed after negotiations amongst the concerned parties. In 2008 SK sold one third of its own shares to Marubeni (Japan).

Project localization and main components

After that Conceptual studies in 2001 confirmed the technical feasibility and economical interest of the project initial sponsors performed the LNG Plant Front End Engineering and Design (FEED) in 2002 by contracting specialist company K.B.R. of Houston (USA). F.E.E.D. was based on the well-proven Air Products C3-precooled M.R. cycle for gas

liquefaction. It was also confirmed that air cooling and gas turbine drivers were the most efficient and reliable solutions for the Peruvian plant.

At that time a site for the LNG producing Plant and export Terminal was selected at Pampa Melchorita, 170 km south of Lima. F.E.E.D. work was followed in 2003 by physical and geotechnical studies on the selected site –both onshore and offshore- and the Environmental Impact Assessment (EIA). The EIA activities had to be extended to 2004 and 2005 until obtaining final approval by Peruvian authorities and potential lender agencies; design optimization and technology improvement works were undertaken during all that time.

Pampa Melchorita site during Excavation works (2006)

As for the Pipeline project the initial activities concentrated on Route Definition studies and Environmental Impact Assessment works. These activities were performed during 2004 and 2005. Special attention was dedicated to social impacts along the pipeline route as previous experience on the area proved that conflictive situations were likely to occur. Several route alternatives were considered, including: 1) a parallel route to the existing “Transportadora de Gas del Peru” (TGP) pipelines, 2) a shorter direct route to Pampa Melchorita, and 3) an optimized parallel route.

2.2 ***Commercial framework***

Simultaneously to performing EIA work PERU LNG negotiated the Commercial framework for the project. These negotiations proved to be very complex and intense as the different Companies, Organisms and Operators with interests in the project had diverse commercial motivations and economical incentives. On the other hand commercial conditions for LNG making were difficult to match for the PERU LNG project

as the project faced high prices for gas supply on one side, and marketing pressures for LNG sales on another side.

As the PERU LNG value chain was not an integrated business and –at the same time- prices were difficult to balance, careful and detailed analysis were required in order to ensure that commercial terms and conditions agreed with the different players provided a sustainable economical result from Upstream to Marketing. Eventually three main Agreements were signed off, namely:

1) The natural gas for the project is being supplied, in amounts of 620 MMscfd nominal, by a Consortium of companies out of Camisea gas fields pursuant to Gas Sales Agreements signed 4 years ago in early 2005. Pick-up point was to be at the gas treating plant located in Malvinas (Cuzco region), close to the gas fields, with PERU LNG being responsible for gas transportation all the way from Malvinas to the Liquefaction plant (600 km in total). Initial supply of gas was scheduled for March 2010

2) All LNG produced by the Liquefaction plant will be sold –with a minimum Annual Quantity of 4.2 MTA- to REPSOL Comercializadora de Gas by means of a Sales and Purchase Agreement signed in June 2005. Contract is F.O.B., with LNG tankers to be provided by LNG off-taker, at the port being built by PERU LNG in Pampa Melchorita. Date agreed between the parties for first LNG cargo was May 2010

3) Legal framework, taxation regime, investment requirements (local content) and other provisions, together with supporting conditions for the project by the Government of Peru, were established through an Investment Agreement that was signed in January 2006.

Malvinas gas production Plant in the Amazon jungle

Notwithstanding the difficulties everything was in place from the commercial side at the beginning of 2006, so that Final Investment Decision could be taken during that year as planned.

2.3 ***Gas production and initial transportation***

Camisea gas fields had started production back in mid 2004 in order to create a domestic market for the gas in the country, as demand for natural gas was inexistent until then. Natural gas and natural gas liquids were separated at a processing Plant located in Malvinas near the gas fields' area. Dry natural gas (90% methane; 10% ethane) was transported to Lima through a 790 km long gas pipeline while the propane (+) liquid was pipelined separately to a fractionation Plant in Peruvian coast for sale.

With a nearly non existent gas market in Lima, gas produced was treated at Malvinas, the liquids transported to the coast for fractionation process and sale and gas volumes not sold were re-injected. Once the Liquefaction plant is up and running, re-injection at Camisea fields will be reduced and the installed compression will be re-directed to increase PERU LNG gas pressure under a Compression Service Agreement between the parties.

When initially deciding on investing at the Camisea field the gas producers have adopted provisions in order to supply the gas volumes for PERU LNG export project at a later stage. One of those provisions was pre-investing in the pipeline transporting gas to Lima by selecting a higher diameter for the initial 210 km of the pipeline: that section of the line runs through dense forest and rough terrain in the Amazon jungle. In that way PERU LNG had the possibility to either use that extra-capacity in the existing line or extend its own pipeline those 210 km up to the Camisea fields.

TGP compression installations at PERU LNG pipeline kp 0

After performing initial studies on the possible route for the new pipeline and careful evaluation of contractual conditions offered by the operator of the existing line, TGP, PERU LNG chose this last alternative and signed a Gas Transportation Agreement with TGP on June 2007 covering the gas transport through the initial 210 km of the route to the LNG Plant, so avoiding installing a second pipeline through that forest region. (The remaining 410 km to the LNG Plant is the pipeline currently being installed by PERU LNG).

2.4 ***LNG Off-take***.-

REPSOL will be buying all LNG produced by PERU LNG at the loading arms in Pampa Melchorita site. Main destination of the LNG will be the Mexican market for power generation.

In September 2007 REPSOL was awarded by Mexican state-owned “Comision Federal de Electricidad” (CFE) with a contract for the supply of LNG to the Manzanillo re-gasification Terminal, located on the Mexican Pacific coast. Initial re-gasification capacity is 500 MMscfd. Construction of this terminal started in July 2008 with a completion date planned for end of 2011 and estimated investment above US$ 700 million.

LNG Tankers for this trade will be supplied by STREAM (50% REPSOL, 50% Gas Natural of Spain) under long-term charters with ship owners. Three newly built dual fuel vessels will be dedicated to this project -with an additional vessel available if necessary- each capable of loading 173,400 cubic meters of LNG. Expected delivery date for the first LNG Tanker is March 2010.

STREAM LNG Tanker

On its part PERU LNG , through a long-lease Agreement with a shipping Services provider, is also building four 80 tons pollard pull tug boats to help on the mooring of

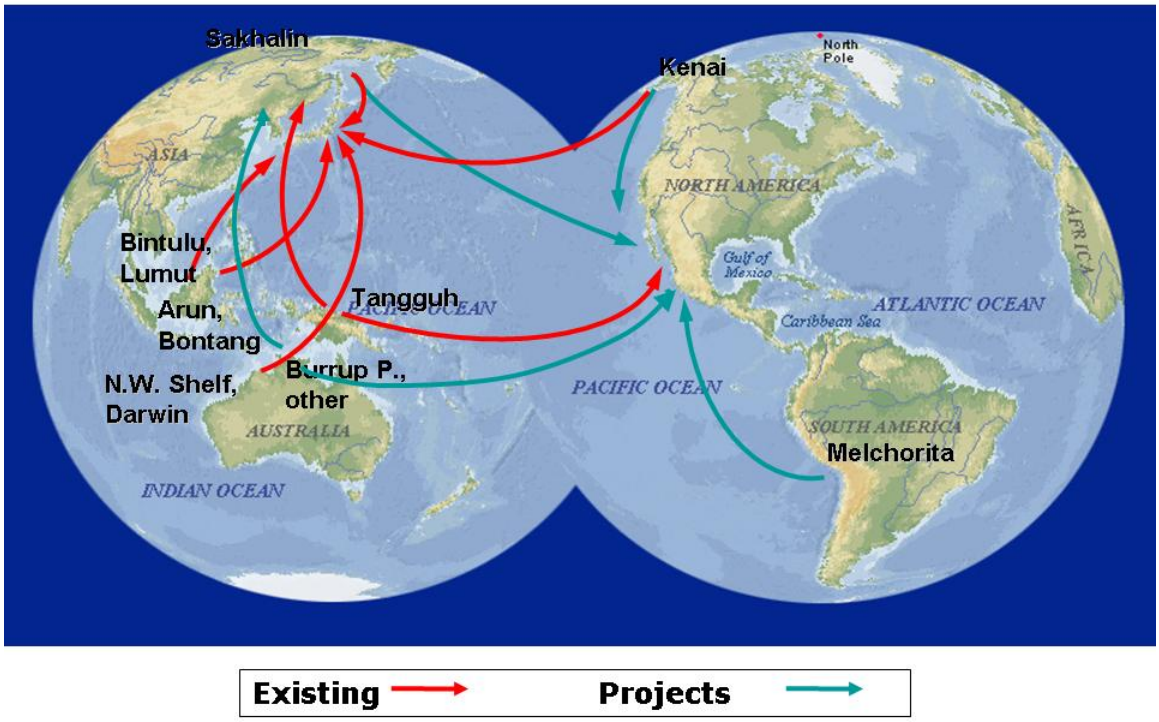
STREAM LNG Tankers when they arrive to Pampa Melchorita. Both, PERU LNG and STREAM, have already agreed the Procedures and Conditions of Use for operating the Marine Terminal and safely dock the incoming vessels.

3. **Project Challenges**.-

3.1 ***Commercial challenges***

Unlike many Liquefaction projects around the world PERU LNG project has not the benefit of a large low cost gas reserve base. As a promotional tool to start up a gas market inside Peru Camisea gas has a regulated price policy for local users of gas - mostly Industrial and Power- while gas supplies to the LNG export project has to stand internationally-rated prices, and depending on the World economy these could be of an order of magnitude higher. In addition to that gas reserves in the country are still in the exploration phase and only 4.2 tcf have been committed to the export project.

When this project was decided 8 years ago Peru was leaving behind troubled times for reasons of leftist terrorism and political corruption. New governments at the turn of the century were re-establishing a political scenario and a legal framework that favored new investments and could improve the country ratings for project financing. But the project tested all new legal framework, opening the investment scenario to many other opportunities.



LNG Markets on the Pacific Basin

As for the LNG market side things did not look any easier. Asian markets were too far apart from Peru, and USA Western coast was not developing any LNG Terminal. Only Mexico seemed promising but local competition was strong as pipeline gas was already installed and demand for gas was not rising that much. Eventually the LNG off-taker for

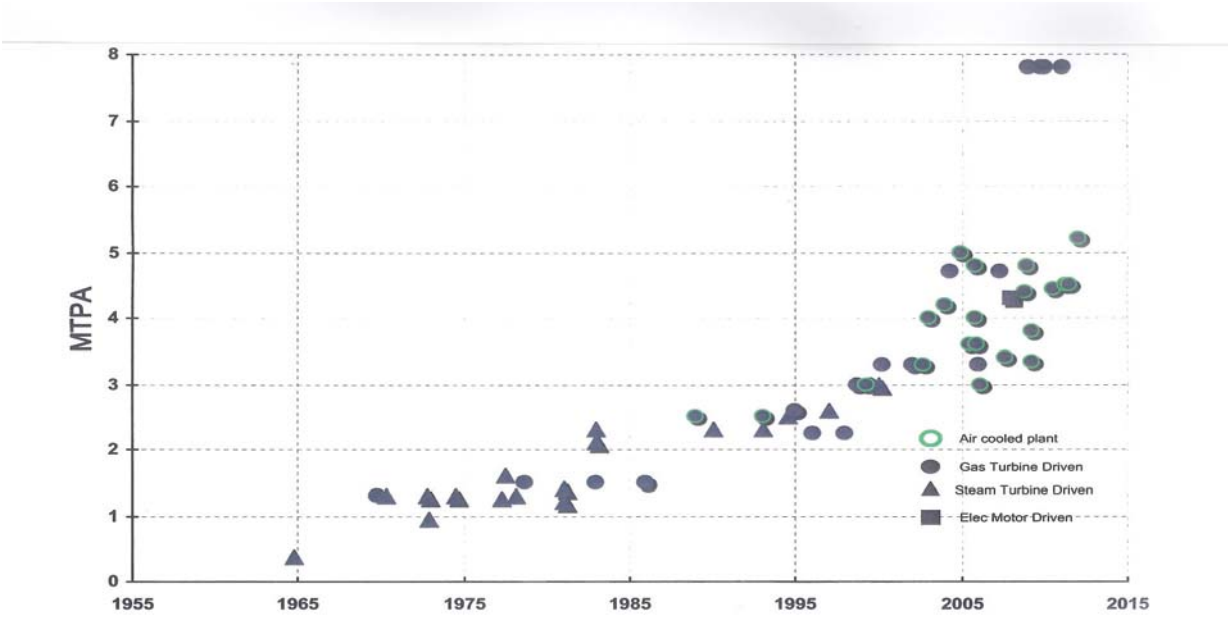
the project could secure a contract with CFE, the state-owned Electricity company in Mexico, though with a narrow price margin.

So with commercial conditions at both ends of the project being very restrictive – feed gas price higher than average and LNG sale price lower than normal- developing a low cost liquefaction plant was the only way to make the project viable. More so as this was a greenfield 1-train plant. As a consequence of that the main goal for the Project Development Team that PERU LNG put in place in 2002 was to implement a project that was cost efficient.

3.2 ***Cost Trends in LNG Industry***

With only one exception all Liquefaction plants built in the world from the outset of the industry in the 1960's and up to 2008 (Commissioning date) had a unit cost between 200 and 400 US$/tpa (2008 value), more or less, as it can be appreciated in papers delivered by well-known experts D. Jamieson (ATLANTIC LNG) in LNG-12 and G. Humphrey (CB&I) in CWC-2008.

This situation changed dramatically for liquefaction projects for which the EPC contracts have been awarded after 2004, for Plants that would start up after 2008. Most recent projects (excluding Qatar extra-huge trains) EPC's have been awarded or are expected to be completed at unit prices ranging from US$/tpa 400 to 1,200 starting with Nigerian LNG later train by KBR and followed by projects in Yemen, Peru, Angola, Nigeria, Algeria and Australia. Unprecedented materials price escalations, extreme currency fluctuations, increased project complexity and excessive number of projects for same number of contractors were some of the reasons explaining the jump in prices.



Liquefaction Plants capacity (G. Humphrey, CB&I)

Considering either the recent trend for higher EPC prices or what happened in previous period of more or less self-contained unit cost, we noticed a large fluctuation in unit cost amongst the different projects. This could be, in the first place, because of liquefaction train unit size (since the early times of the LNG industry the train size has increased one order of magnitude from 0.7 to 8 Mt/y) but while liquefaction technology improved enormously, the corresponding economies of scale -as size increased- were not happening, only just enough for compensating inflation through the years.

Another possibility could be technology selection. Numerous papers by SHELL, KBR, LINDE, BECHTEL and other were produced in late 90's and early 00's comparing various gas liquefaction processes. There was also the evidence of several LNG plants that were built in recent years based on different technologies. Advantages of one process in energy efficiency were offset by better Plant availability in another process. The obvious conclusion was that process selection had little to do with detected differences in cost between the projects.

After these and other careful observations the overall conclusion had to be that these cost fluctuations did not correspond to whether the plant project was a grass-root or an expansion or whether it was a 1-train or 2-trains project; and neither train size nor technology selection seemed to play a major role. Price dispersion appeared to be more related to good or bad project management practices by existing and new operators in the industry.

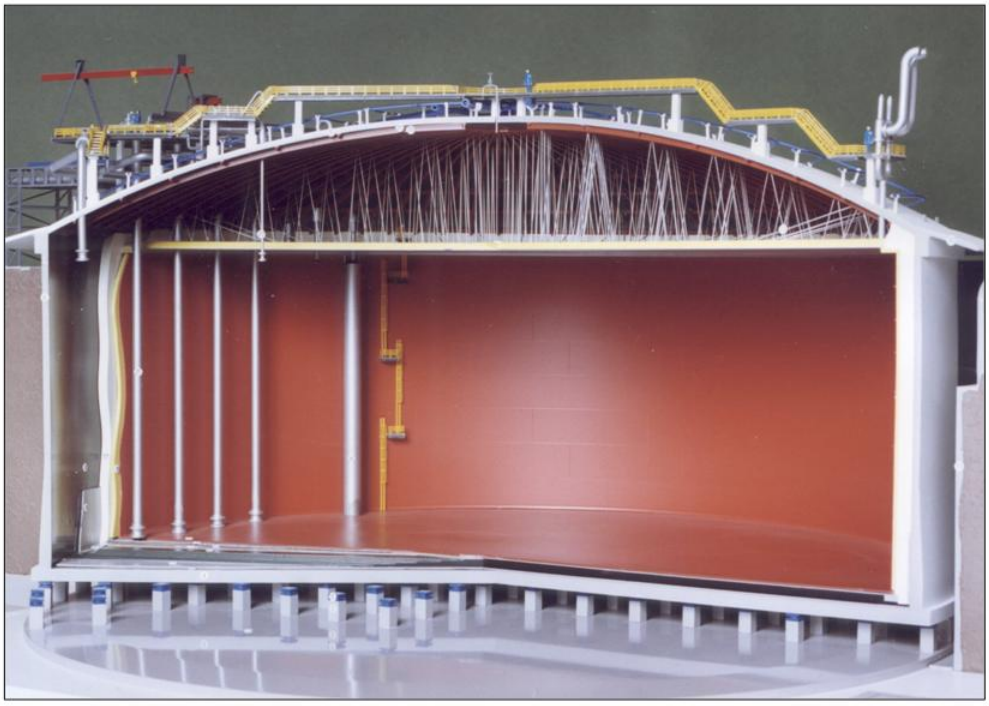
Considering what has been mentioned in the above paragraph in PERU LNG project extreme care was taken when organizing and selecting the Project management team: experienced and professional individuals yet a simple organization. Another decision taken was to rely on classical project management techniques, namely:

-Project planning,
-Task scheduling,
-Expenses budgeting,
-Design optimization,
-Contract strategy and risk profile definition, and above all
-Contractor selection,

all these subjects played a fundamental role in PERU LNG project.

3.3 ***Technical difficulties***

The most challenging difficulty faced by the LNG Plant project was the highly seismic nature of the site where it is located. (As an example in August 2007, during initial construction works, the Peruvian coast experienced a Richter scale 7.9 degrees earthquake with epicenter at less than 30 km away from the LNG Plant site). As a consequence of the high seismicity most elements in the plant had to be designed to safely stand an 8.6 degree earthquake with neither damage nor loss of contention. Specially designed tank foundations (see model by contractor CB&I), thicker concrete rebar, increased sections of structural steel and bracing of equipment and valves are some of the measures implemented to deal with the issue.



Model of LNG Tank with Tank Base Seismic Isolators

The marine Terminal faces the physical condition that the Plant process unit and storage tanks are 140 m above sea level so that special provisions had to be adopted to prevent water hammer effects. Besides the continental shelf (sea bottom) has a very gentle slope into the ocean so that the jetty needed to be very long and dredging operation played an important factor. Finally rough sea and long period waves required designing innovative mooring devices and the construction of a massive protective breakwater in the middle of the Pacific Ocean.

As for the 410 km Pipeline to be built almost half of its route is located above 4,000 m in very rugged mountainous terrain across the Andes (PERU LNG is currently claiming official recognition for highest pipeline on Earth at 4,901 m top altitude). Rest of its length is through dessert landscape close to the Pacific coast crossing as well some agricultural land. In all cases access to pipeline right-of-way is either inexistent or extremely difficult. Numerous geological hazards are to be found along the whole pipeline route from very steep slopes to unstable terrains and landslides, and from moving sand dunes to torrential rivers.

3.4 ***Environmental and social impacts***

Since PERU LNG launched the first Environmental Impact Analysis in 2003 it was evident that the project was facing very special situations. It needed to comply with Peruvian environmental and social regulations as well as with the standards from the financial institutions (World Bank and other organizations lending money for the project).

More importantly, PERU LNG was seen as an opportunity for long forgotten areas and had to deal with local communities and authorities demands, unknown at the outset of the project.

Peru is a living history and wherever someone starts digging relics are meant to be found. PERU LNG approached this challenge with a major mobilization, never before being done in country, as dozens of Archaeologists teamed together to evaluate the plant site and the 408 km of pipeline and propose solutions for what it came to be very frequent archeological findings. In that way, Peruvian Cultural Heritage as described in the EIA was being protected and preserved.

Environmental and Social Impact Assessments were undertaken -starting as early as 2003- for all 3 installations (Pipeline, Plant and Terminal) as well as for the Quarry that was developed for the sole purpose to provide rocks for the breakwater. Eventually all of them were approved by the Government of Peru and validated by the Lending agencies in time for construction to begin in all fronts. EIA commitments and approvals went far beyond the existing rules requirements and compliance with environmental standards; additional requirements were specified especially on the social / economical side.

Camelids social program

Audits by several Government agencies were specified in approved EIA to be done almost weekly for technical and quality supervisions, health and safety inspections, environmental checking, social requirements compliance and archeological surveys. Lenders on their part have been auditing the project implementation on a monthly average in order to supervise social and environmental compliance.

The social impact of the project was also a complex factor to consider. As an example, the pipeline route passes through the poorest areas of Peru such as Huancavelica region that has a 86% poverty rate and half of their homes have no water at all, and Ayacucho where 50% of the homes have no electricity. By PERU LNG being present in

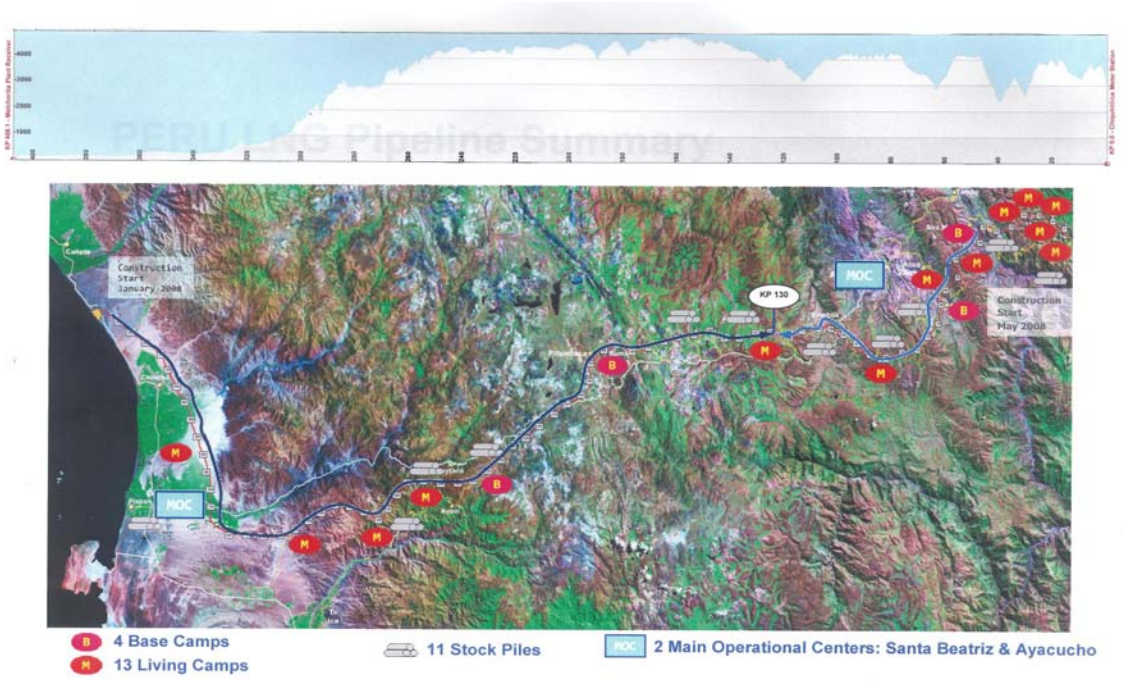
areas where modern basic needs as water or electricity are lacking, it is understandably that once work actually started local Municipalities and Communities along the pipeline route expected that the company would fulfill their demands in terms of special taxes, monetary compensations, additional jobs for their people or social investments.

Land ownership in vast regions of Peru rests with the Communities, and people living or using the land are simply possessors. It is very common in isolated areas along the Peruvian sierra region that communities owning the land along the pipeline ROW would try to impose on to the company the role and obligations of the central and regional governments in the area. The ample variation, intensity and time-constrained requests have been a major challenge for the Pipeline project, and have caused significant delays and extra-expenses.

4. **Description of PERU LNG Facilities**.-

4.1 ***Transportation Pipeline***

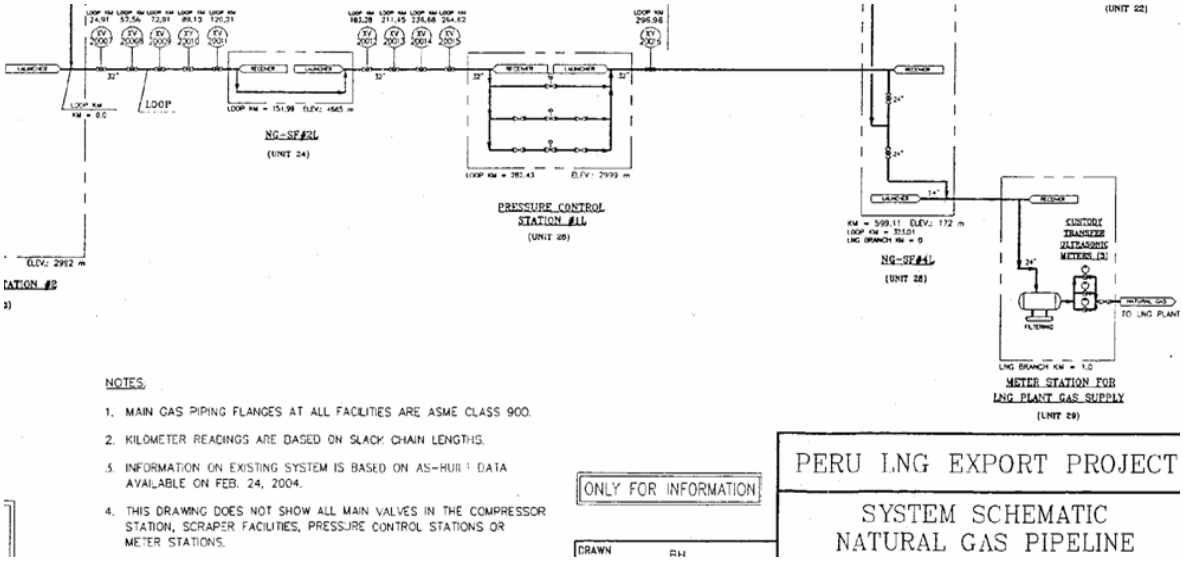
PERU LNG Pipeline is 408 km long stretching from the outskirts of the Amazon forest – where it connects at the KP 211 of the TGP pipeline- to the LNG Plant site at the Pacific coast through the Andean cordillera. Its diameter is 34" and it is currently capable of delivering 1.2 billion scfd at Pampa Melchorita delivery point, of which approximately 700 MMscfd are dedicated to the LNG production and up to 500 MMscfd will be third party transportation. With adequate compression and gas supply the final capacity of the line will be 1.9 billion scfd.



PERU LNG Pipeline cross-section profile and route plan

Initial scraper launcher and connecting valves to TGP line and compressor station are located in the fiscal metering station at Chiquintirca, in Ayacucho region. Two more traps are located along the line together with 12 additional positions for block valves and 1 pressure control station –located just after the line slopes down from the Andes sierra to the Pacific coast, in order to prevent over-pressurization of the pipeline when line pack conditions (caused by LNG Plant shutdown or slow gas flow) occur. Final pipeline position sits in the LNG Plant at Pampa Melchorita where arrival facilities are located (filter, metering /analyzing, cut-off valve and scraper receiver trap).

SCADA system has been installed inside LNG Plant main control room in order to monitor pipeline operations and control gas flow through the line, with a complete back-up set in another location. A dedicated fiber optic cable has been laid adjacent to the underground pipeline as the primary communication system, with satellite links as contingency.



Pipeline installations

The pipeline system has been designed in accordance with ASME-ANSI B 31.8 standard to an operating pressure (M.A.O.P.) of 147 bara with associated facilities rated as ASME class 900. Line pipe specification is API 5L, grade X-70. The pipeline is protected against corrosion by a 3-layer polyethylene external coating and an impressed current cathodic protection system along its entire length.

PERU LNG pipeline traverses 310 km of mountain terrain with numerous river crossings and unstable areas. For that reason measures have been taken to ensure the integrity of the system. In the first place very detailed geotechnical and geophysical surveys have been performed to clearly identify those areas and the reasons for geo-hazards. Selective routing and measures to control effects of instable terrains were defined at the design phase, with additional geotechnical surveys performed during construction. Slope breakers, rock gabions, retaining walls, pipe drainages, diversion channels and other protections have been installed on numerous locations along the pipeline.

On most occasions archeological findings, environmental concerns, social issues and political barriers had to be carefully managed as local communities and authorities were not familiar with projects of this size and needed adjusting to such an intrusion in their habitat and normal life.

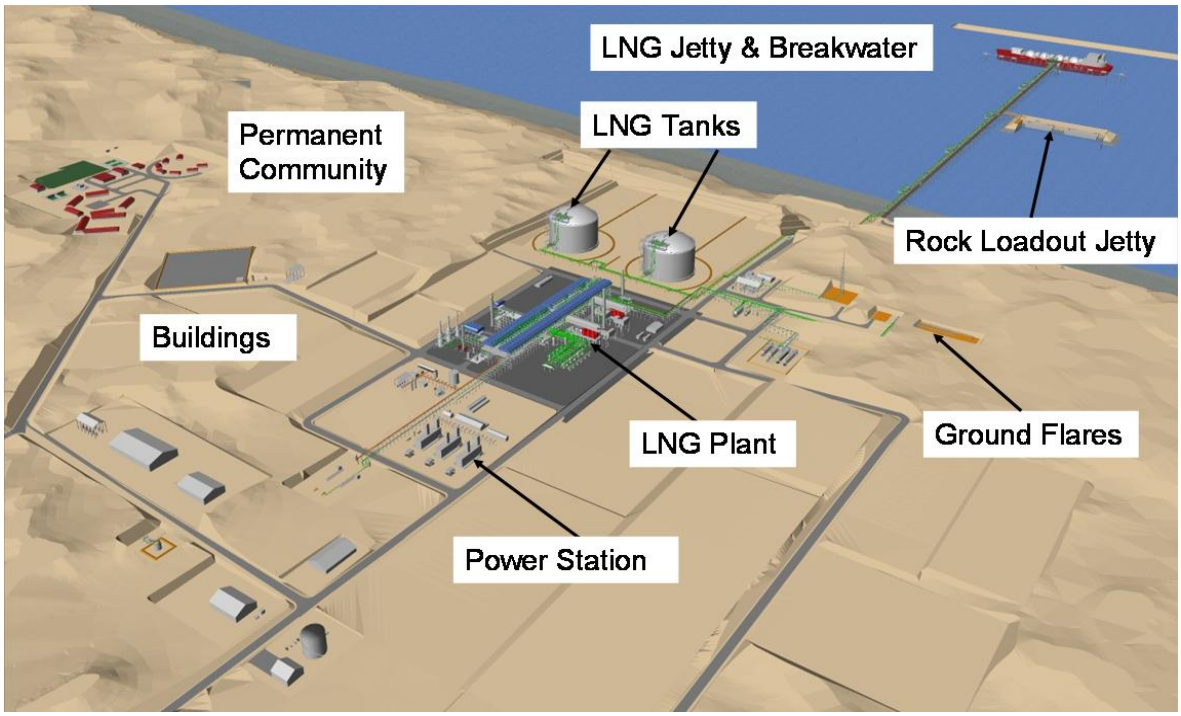
4.2 ***Liquefaction Plant***

LNG Plant site occupies 520 ha of desert land in the Peruvian coast 170 km south of Lima, at 135 m average altitude. It lies just off the Pan-American Highway, in between the towns of Cañete (30,000 inhabitants) and Chincha (over 100,000 inhabitants). The site is 40 km north of Pisco port where most equipment and materials for the project were unloaded during construction time. Climate is very mild with temperatures never exceeding 28 °C neither dropping below 12 °C, and practically no rain year round - though humidity is always well over 80%. Besides the highway no other infrastructure

was available at the site. The zone is highly seismic requiring special design conditions for installations.

Feed gas supplying the Plant is very lean and dry (well above hydrocarbon and water dew points) with C3 (+) content below mol. 0.02 %: as a consequence of that no NGL fractionation is performed at the site. The plant is self-sufficient as it generates all the electricity it requires and produces all the water, nitrogen and compressed air that are needed, as well as taking care of liquid effluents and solid wastes. A permanent community with housing and recreation facilities for all members of the operational staff is part of the project.

The current project consists of the installation of a single liquefaction train, though provisions for expansion –space and tie-ins- have been taken care of.



LNG Plant and marine Terminal 3D schematics

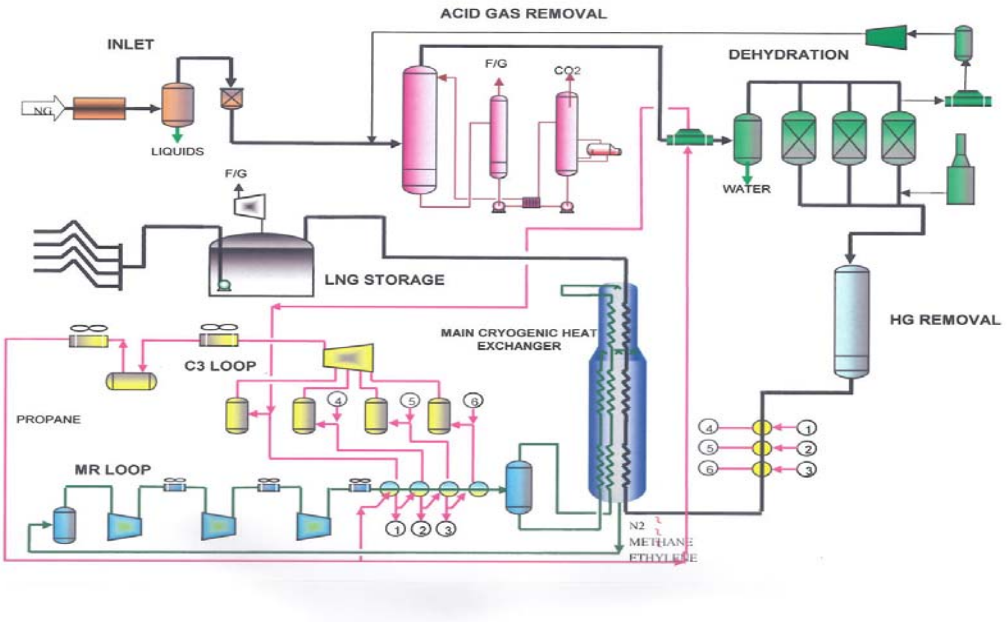
The gas entering the plant is first knocked out and filtered for any condensates or particulate it may bring from pipeline, and then it is purified by extracting acid components with a BASF-patented absorption method using an aqueous solution of an activated Methyl Di-ethanol Amine circulating counter-current to feedgas in the Acid gas Removal tower (the heaviest equipment in the LNG Plant at 400 ton weight). After being cooled down for water condensation the feedgas is passed through silica-gel molecular sieve Dryers to remove the rest of the water. Finally, and before entering the refrigeration zone, the feedgas goes through additional filtering and a Hg-removal Unit as precautionary measures.

A.P.C.I.'s propane pre-cooled mixed refrigerant process is the selected liquefaction technology for PERU LNG Plant. Two G.E. frame-7 gas turbines drive the Nuovo Pignone Propane (one casing, four stages) and Mixed Refrigerant (three stages in 3

casings) compressors, in a split configuration with the high pressure M.R. compressor installed in line with the propane compressor. Two SIEMENS 17 MW electric motors are used to start the gas turbines and provide additional power in driving the refrigerant compressors. Ambient air is the final heat sink for the Process through air-cooled fin fans. No scrub column exists as the natural gas does not contain hydrocarbons higher than ethane.

In the propane cycle the natural gas is cooled down to -34 C at 3 propane vaporizers. Another 4 propane vaporizers are used to condense the Mixed Refrigerant. After vaporizing the propane enters the 4-stage compressor via 4 suction drums. Then it condenses at the air coolers located on top of the Plant main rack; finally the propane is further sub-cooled to improve cycle efficiency, before expanding in its way to the vaporizers to repeat again the cycle.

In the M.R. cycle very low temperature refrigeration is provided by a mixture of nitrogen, methane and ethylene, with some ethane and propane as well. Partially condensed high pressure M.R. is fed to the main cryogenic heat exchanger (MCHE) via a vapor-liquid separator. Inside the MCHE, containing hundreds of spirally-wounded aluminum pipes working at high pressure, feedgas liquefaction and sub-cooling to -162 C is done as the liquid M.R. vaporizes in the upper part while the light M.R. retrieves further heat from the natural gas at the lower part of the MCHE. After being gathered in suction drums vaporized M.R. is compressed at the 3-stages 3-bodies M.R. compressor; inter-stage cooling is done to improve cycle efficiency.



Process Diagram

Two ground flares have been installed, for warm and cold end parts of the plant, as well as an elevated flare for LNG tank and loading boil-off. There are low, high and very high pressure fuel gas systems supplied by compressed boil-off (2 compressors), dryers regeneration gas (1 compressor) and feedgas as necessary. Two heaters for hot oil and one for drying gas have also been installed.

Once cooled down and liquefied the gas is stored at -162 °C in 2 large single-containment LNG tanks of 130,000 m3 holding capacity each. Single containment was selected by PERU LNG as the site remoteness and enough space being available to accommodate a different secondary containment were features that facilitated to comply with regulations and represented a safe design of installations. The LNG loading line slopes down 140 m from the tanks to the beach and then it extends for another 1.3 km up to the loading arms; PERU LNG adopted a special piping design for this line and incorporated quick opening valves and a surge drum at the loading platform.

Utilities, buildings and other offsite installations were also part of the process plant project. Most important of them were as follow:

-Power is provided by three (2+1) turbo-generators driven by 32 MW G.E. aero-derivatives LM-2500

-Make-up refrigerant is stored in 2 bullets for propane and 2 refrigerated containers for ethylene

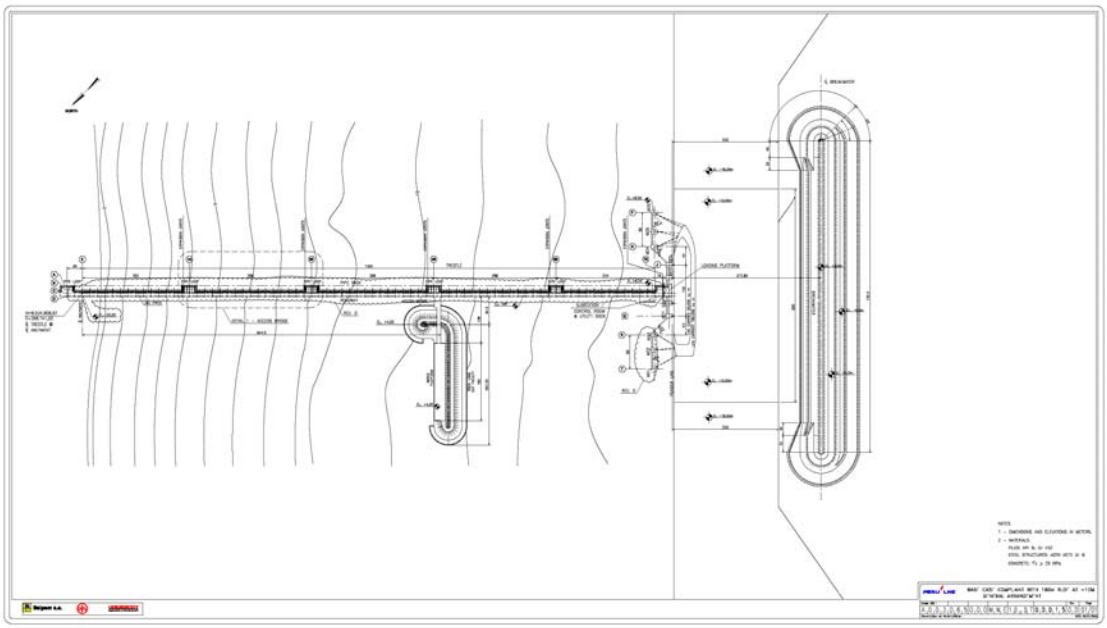
-Sea water is desalinated for plant service and firewater. Desalinated water is further treated to get potable drinkable water and de-ionized to obtain process de-mineralized water

-Three (2+1) compressors and dryers are installed to produce service and dried instrument air

-A skid-mounted package generates all nitrogen required by the plant to a 160 m3 storage tank

-Buildings installed: Central and secondary control rooms, electrical distribution Substations, Warehouse, maintenance Workshop, H&S / Medical center, Administration building and a permanent Community for 130 employees.

4.3 ***Marine Terminal***



Marine works schematics

The Marine Terminal has been designed to handle LNG tankers ranging from 90,000 up to 175,000 m3. It consists of following components:

- A 1.3 km long jetty into the Pacific Ocean
- The loading platform and ships dock
- 4 breasting and 6 mooring dolphins
- A 3.6 km dredged navigation channel 18 m deep
- A massive 800 m long breakwater protecting the whole harbor
- A tug boat dock, with a 200 m long breakwater
- Mooring, Navigation aids and ancillary equipment.

The 1.3 km long trestle consists of a 2-lane road and a steel rack containing the LNG, Boil-off and other pipes running all the way to the loading platform. Both, road and rack are supported by an extra strong steel structure that is anchored to the sea bottom by 550 steel piles that were driven into the soil down to the rock substratum. The mooring and breasting dolphins required 50 additional very deep piles.

The main breakwater is located 1,600 m from the shore at more than 15 m of water depth, and stands up to 11 m over the lowest (at spring tide) water level in order to guarantee protection to the docked LNG tankers against the incoming ocean waves -up to the 100-year return design level. A nearby quarry supplied the 2 million tons of rocks that were dumped into the sea bottom to build the core of the breakwater. On top of that 10,000 specially designed concrete blocks were placed as breakwater revetment.

5. **Project Implementation.-**

5.1 ***PERU LNG Project goals***

At the decision that the Plant size was to be between 4.2 to 4.5 Million ton/annum Team management set the Mission for the project as being: To design and build a processing Plant –including gas supply Pipeline and LNG offtake Terminal- that produced LNG at a rate above contracted sales (not less than 4.2 MTA net of LNG) in an efficient manner (total fuel consumption + losses under 9%) with a high availability (above 94% yearly), and ensuring that it would be doing all that in a safe manner for workers and free of pollution impacts to the environment.

The Mission was to be reached having in mind at all times a goal of optimizing capital expenditures for the project. Once Final Investment Decision was taken on December-2006 PERU LNG was committed to complete the project implementation phase within approved Budget and by the planned Schedule. As for financing the objective was to have 40% of investment on Equity and obtain 60% in project Finance.

Dolphin jacket being manufactured by local company SIMA

Finally, but very importantly, an additional objective for the project was adopted for benefiting Peru as a nation and Peruvian nationals through investment in the country, by creating sufficient jobs for local population and business opportunities for national companies, in accordance with approved EIA and Investment Agreement requirements. These advantages can be summarized as follows:

-Creation of 12,000 direct jobs plus an estimate of 30,000 indirect in the country, during construction (at peak time)

-Contracts awarded and goods purchased from Peruvian companies for more than US$1 billion

-A net contribution of 0.6% growth to the nation GDP

-Job training for thousands of Peruvian nationals in the fields of civil engineering, pipe and structural welding, electrical and instrumentation, etc.

-Significant catalyst for new gas exploration, with 18 licenses awarded in 2007 alone

-Promoting expansion in the gas production and transportation businesses with several programs being launched for new infrastructure systems.

It was also envisioned a more far-reaching profit for this country during commercial operations, with an estimated US$ 7.8 billion in royalties and taxes to the Government throughout the life of the Plant only from PERU LNG project. Even higher income for Peruvian state is expected to be derived from Upstream gas production and gas Transportation activities linked to the liquefaction project gas supply.

5.2 ***Organization and initial Progress***

As for project implementation initial EPC contract strategy and contractor selection activities were performed in 2004 and 2005 as well as a Bid request for Site Preparation works at Pampa Melchorita. But it was not until PERU LNG signed off the Gas Supply and LNG Sales Agreements, in January and June 2005 correspondingly, that project implementation took off. At that time several activities were launched, namely:

1) Project management organization was established with project managers and other positions being selected and hired

2) Plant site Preparation works – Phase I were awarded

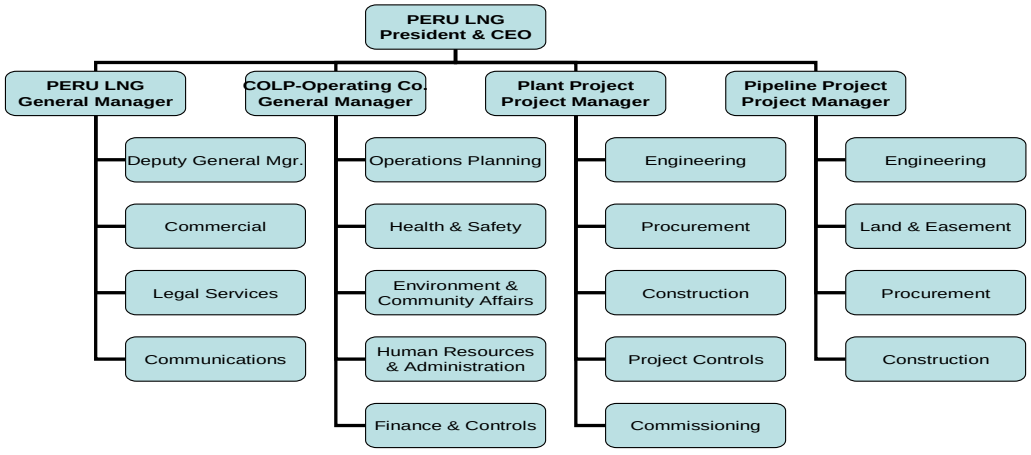
3) A Plant EPC Lump sum Turn key bid was requested from KBR

4) Bid packages were prepared for planned Early Awards as follows: Site preparation –Phase II (several local bidders), MCHE supply (Air Products) and Refrigeration compressors supply (G.E. – N. Pignone)

5) A Marine Terminal E.P.C. package was prepared for launching a Lump sum Turn key bid request (several international bidders)

6) A Pipeline Engineering Bid package was prepared and sent to several bidders.

PERU LNG Management Organisation, during Project Development



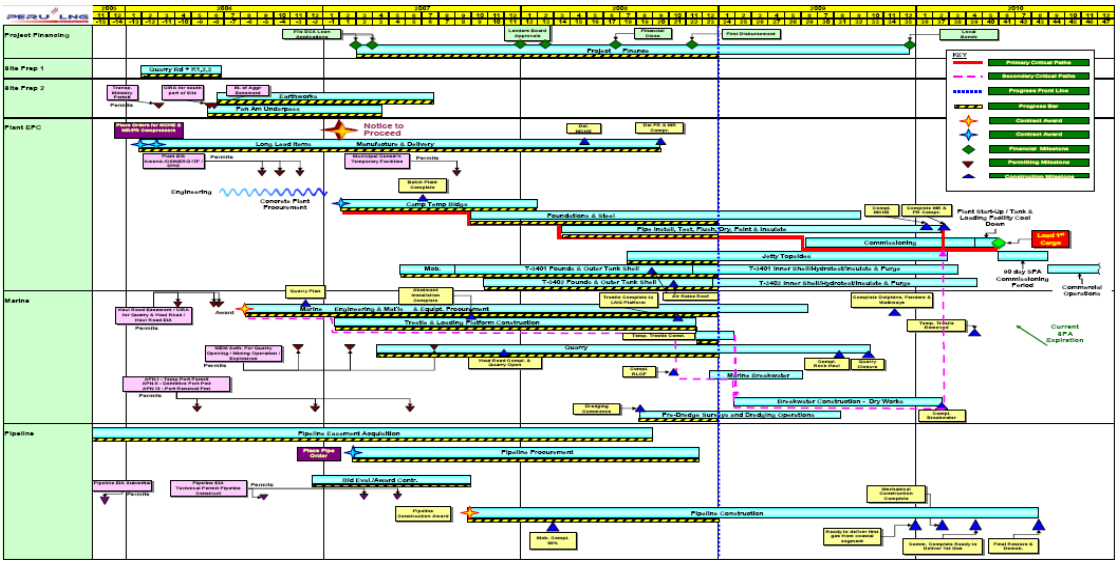
In August 2005 site preparation works began at Pampa Melchorita. In January 2006 PERU LNG awarded the manufacture and supply of the main cryogenic heat exchanger

(MCHE) to A.P.C.I. of USA, including liquefaction process license. In April 2006 a contract was also executed with G.E.-Nuovo Pignone (Italy) for the manufacture and supply of both propane and M.R. turbo-compressors. Both supplies were incorporated to the main EPC contract once this one was awarded.

Almost 2 years were consumed in the bidding process for the LNG Plant Engineering, Procurement, Construction and Commissioning (EPCC) contract, with lengthy negotiations being undertaken with KBR and Chicago Bridge & Iron (CB&I). Finally in December 2006 PERU LNG awarded the work to CB&I on lump sum basis, with Notice to Proceed issued in January 2007, for a price of US$ 1.6 billion (wholly including MCHE and Refrigeration compressors early awards). Contractor had 40 months EPCC execution time to First LNG Cargo.

On its part the Marine terminal EPC was awarded to CDB (Odebrecht/Saipem/Jan de Nul) consortium in August 2006, also on a L.S. basis, after careful evaluation of the 3 valid bids received. Work was planned to be complete by year end of 2009.

As for the Pipeline detailed Engineering was done in 2006 first half by G.I.E. (USA) while line pipe Supply was awarded to Welspun (India) and Ilva (Italy) in early 2007. Pipeline Construction contract was eventually given to Techint in October 2007 and construction started effectively in March 2008. In all 3 cases –Engineering, line pipe Supply and pipeline Construction- open bid competition was enforced and awards were done to the best proposal in terms of quality and price.



Project Schedule

5.3 ***Current status***.-

Currently –June 2009- work is proceeding in all fronts. Detailed Engineering is 100% complete in all three cases (Pipeline, LNG Plant and Marine projects). Materials and Equipment Procurement has been finalized for the Pipeline and Marine projects and it is almost complete for the LNG Plant with only some minor top-up orders and spare parts

outstanding to be supplied. As for Construction, at mid 2009 both the Pipeline and the LNG Plant were 2/3 complete while Marine works accumulated 85% progress. Commissioning activities have started in June-2009.

For the pipeline construction 2 full spreads were mobilized in order to comply with Date for Completion. After been manufactured, tested and inspected at the factories all line pipes were in Peru by fall 2008. Contractor installed 2 logistic centers, 4 base camps and 12 temporary camps along the pipeline route. In total 1,200 pieces of construction equipment were used. By early 2009 more than 4,000 people were working in the pipeline project, with peak number just over 5,000 by May 2009. Even though Pipeline construction rates fell significantly during summer months (June to April) due to rain, good planning ensured that no delays were incurred on the whole.

Pipeline construction during summer 2009 at the Andes

As for the LNG Plant a project Team was assembled by CB&I at its offices in London (U.K.) in order to perform Detailed Engineering activities as well as Procurement of Plant Materials and Equipment. Some components of the project were designed and procured out of offices in Chicago and Houston (USA). In total contractor CB&I have procured and installed following main equipment and Plant components:

-Process and pressure vessels: 44
-Heat exchangers (including MCHE): 19
-Air coolers: 228
-Pumps and Compressors (with drivers): 57
-Electrical units: 295
-Tanks (including those built on site): 16
-Valves: 3,610
-Instruments: 1,870
-Buildings (process and non-process): 24, plus the Permanent community.

Process area of LNG Plant under construction (May 2009)

Construction in Pampa Melchorita (both land and offshore) has encompassed following material quantities:

-8 million m^3 of excavated land onshore
-3.5 million m^3 of dredged soil from sea bottom
-2.5 million ton of rocks quarried, hauled and dumped at sea
-143,000 m^3 of concrete for foundations/supports, 81,000 m^3 for breakwater blocks and 17,000 m^3 for paving
-17,600 ton of primary and 11,100 ton of secondary structural steel
-6,700 ton of carbon and stainless steel in plates and 14,500 ton in piles
-120,230 m of piping in diameters up to 72", plus 29,000 fittings
-1,075 km of electrical and instrumentation cable
-30,400 m^2 of cryogenic insulation.

Accident prevention has been carefully and systematically considered from the outset of the project and was of paramount importance when selecting Contractors. Safety performance has been outstanding in all sections of the Project. By June-2009 there were more than 11,000 people working in construction activities, including 4,200 in the pipeline, 6,300 in the LNG Plant and 1,000 in the marine terminal. By then the project had cumulated 42.7 million manhours with only 10 lost-time accidents (LTA) and 1 fatality -a security guard who got killed in a car accident- since project inception.

Safety records, as of June 2009, have beaten all pre-established targets for the Project and they are as follow:

	Manhour (million)	LTI #	LTI rate	Recordable Injuries (#)	Rec.Inj. Rate
Pipeline (Land Ease. & Construction)	17.9	**8**	0.10	**16**	0.29
LNG Plant (Eng. & Construction)	19.2	**3**	0.03	**18**	0.20
Marine Terminal (Eng. and Constr.)	5.6	**0**	0.00	**10**	0.35

Construction work quality has been very good especially for the LNG plant construction where, for instance, pipe welding defects were fewer than 2% in LNG Plant piping erection when more than 150,000 films have been taken (100% X-ray).

PERU LNG Project management organization was growing as project progressed: At the peak of construction activities Owner task force consisted of more than 300 employees. Finally, in preparation for commissioning and operating the installed facilities, an organization was first defined for the commercial phase of the project and then populated with new and additional personnel. A careful blend of experienced people – both Peruvian and expatriates- and training for younger technicians was adopted. This organization is now in charge of commissioning activities for the gas Pipeline, the LNG Plant and the marine Terminal.

Marine works overview (June-09)

Delays in construction were experienced during early phases of work for both Marine terminal and Pipeline but have already been recovered by now. No significant delays have been incurred so far in the LNG Plant project. Though stoppages by some local communities in the sierra are making pipeline works progress difficult, in the whole it is expected that the original schedule be accomplished with First LNG cargo being loaded by the end of May-2010.

As for the Investment Budget (see Table hereunder) it is forecasted that it will remain at an actual cost of US$ 3.8 billion at project completion. Only 4 relevant deviations have occurred since it was approved 3 years ago, namely:

-An increase in Marine EPC contract (CDB) price driven mainly by a geotechnical problem that was only evident during construction

-An increase in Pipeline construction contract (Techint) price due to unexpected work stoppages caused by local communities along the ROW

-An increase in Staff and Third party services costs as a consequence of additional archeological and social work in relation to the pipeline project

-A decrease in Financing costs mainly due to lower than predicted interest rates during construction. The savings in Financing just offset the three previously mentioned increases in project costs.

Main EPC lump sum contract price by CB&I did experience several variations during work execution but it is expected to be completed as anticipated when it was awarded in December-2006, at US$ 1.6 billion budget.

LNG Plant E.P.C. (CB&I)	1.6
Marine Terminal (CDB)	0.3
Line pipe and Pipeline equipment Supply	0.3
Pipeline Construction (Techint)	0.4
Initial Studies and Project Management	0.2
Insurance, Land rights, Tax & Duties	0.2
Corporation expenses	0.2
Capitalized Operations	0.1
Financing Costs (including interest)	0.5
TOTAL	3.8 (see note)

Note.- Elements in this Budget do include some Contingency

Approved PERU LNG Project Budget, end-2006 (US$ billion)

5.4 ***Project finance***

A very complex financial package has been developed for this project in order to get 60% project finance –vs. 40% equity. A combination of multilateral organisms, export credit agencies, commercial banks and Peruvian local bonds market have been pulled together to raise US$ 2.2 billion, as follows:

a) Multilateral Organisms:

- Inter-American Development Bank (IDB): US$ 400 million with 14 year maturity and interest rate at 0.75% over LIBOR during construction and 1.0% thereafter. This amount doubles pre-existing per-project limit of US$ 200 million in IDB
- International Finance Corporation (IFC-World Bank): US$ 300 million with 14 years maturity and interest rate in line with IDB loan. This is the largest IFC loan in Latin America so far.

b) Commercial Banks (S.G., BBVA, Calyon, Sumitomo, ING, Mizuho and B. of Tokyo): US$ 400 million with 12 years maturity priced at 1.0% over LIBOR during construction and rising afterwards up to 1.37% maximum. This is a syndicated loan by 7 private banks under the umbrella –terms and conditions- of IDB.

c) Export Credit Agencies (ECA):

- U.S.A. Ex-Im: US$ 400 million facilitated through Societe Generale and BBVA, and tied to contract award to CB&I (a USA-based company) for the LNG plant construction

- Korean Ex-Im: US$ 300 million, with half of it as direct loan and rest guaranteed, and not tied to any specific award to Korean companies

- SACE (Italy): US$ 250 million, tied to the purchase by the project of Compressors and other equipment produced by G. E. and other in Italy

All ECA credits are similar in maturity and rates to multilateral loans.

d) Local Bonds: US$ 200 million to be placed in Peruvian market by selected bank Banco de Credito del Peru (BCP) during second part of 2009. Local rating agencies have already provided a AAA+ rating to the emission and Peruvian market regulators strongly support it.

Main cryogenic heat exchanger (Air Products) being transported to site

During construction phase all the debt is guaranteed by PERU LNG shareholders (HUNT, REPSOL, SK and Marubeni) pro-rata to their participation in the company. This mechanism lowered the risk profile of the project significantly and is one of the main drivers for the very low rates obtained by the project finance.

Financial close was reached on June 26th, 2008 at a very delicate moment in international finance market with the global financial crisis about to start. The closure culminated more than 2 years of very hard work by a dedicated team within PERU LNG and external advisers:

-Societe Generale (Financial),
-Skadden and al (Legal),
-Merlin (Technical),
-Gas Strategies (Commercial),
-J.G.P. (Environmental), and
-several other (Social, Administration, and so on).

5.5 ***Environmental and social compliance***

Besides designing projected installations in compliance with all requirements in the approved EIA the contractors were instructed to perform construction work in complete agreement with those requirements. In order to ensure that all necessary measures were adopted at all levels a significant organization was set in place: hundreds of local archeologists, social workers, environmental consultants and business development experts were hired by PERU LNG at different times during project implementation to perform surveillance work or to implement social programs.

With a strong commitment from top management (see paper presented at N. Orleans LNG by company's president S. Suellentrop) PERU LNG designed a complete set of programs within and beyond its EIA obligations in order to:

1st) mitigate any impact the project could provoke on the environment or in the people around the project

2nd) compensate for construction activities, and

3rd) invest on social programs.

In the first place a comprehensive Mitigation Program was established including:

-Pollution prevention Programs for all projects

-Environmental Management Plans for all contractors

-Pipeline specific programs: Erosion control, ROW Re-vegetation

-Monitoring programs for: Sea birds and Mammals, Coast line, Water and Air quality, Noise and vibrations

-Cultural Heritage program: Archeological search and Remains rescue in the Plant / Quarry sites and all along the pipeline route.

PERU LNG medical campaign in the Sierra

In parallel to that a Biodiversity action Plan was defined and implemented with activities such as following:

-Ecological field surveys
-Camelids management
-Biodiversity monitoring
-Bio-restoration management
-Environmental investments, and
-Several other.

Secondly, in order to compensate the people affected by the project activities PERU LNG established a Social Responsibility program with following activities:

- Monetary compensation for the Right of Way easement contracts
- Compensation of several kinds to fishermen that could be affected by restriction of sea area along Pampa Melchorita beach
-Training local people to participate in EIA and social Monitoring programs
-Local hiring for construction activities (all manual labor is local)
-Local purchasing (priority to local providers)
-Grievance and conflict resolution program
-Interaction and communication (5,000 engagements in 2008 for instance).

PERU LNG as part of its commitment to the communities in the area of influence and under the social frame defined within the company policies -considering areas of education, health, nutrition and capacity building- is supporting several Social Investment programs to help the communities improve their quality of life, for a total amount well over US$ 10 million. Some of these programs were:

-Allin Minkay (good team work, in quechua language), an agricultural improvement for more than 2,000 families in the Andean highlands
-Agro Progreso for 300 small agricultural families along the coast
-Local supply chain management, in collaboration with World Bank IFC
-Capacity building for local governments, also with World Bank IFC.

During project execution PERU LNG and its contractors have been frequently audited for environmental and social compliance by both project Lenders and Peruvian government Agencies, with only minor observations recorded and high recognition for standards applied.

6. **CAPEX Optimization**.-

6.1 ***Cost Reduction Methods***

As for any other new investment project in the world PERU LNG project economics are not driven merely by capital costs: All aspects of the project during its entire life must be taken into account. Fuel efficiency, plant reliability and safety/environmental costs are of paramount importance together with original CAPEX. In this chapter some of the cost reduction techniques that PERU LNG was implementing to reduce its capital investment and operating costs -taking into account the life cycle of the installations to be built- will be discussed.

In the first place a safe and proven design forms the basis for a sound liquefaction Plant in the long run so there must not be any short cuts or cost reduction considerations when performing front-end design work. A basic principle is not to venture into new or promising technologies when it comes to the core of the plant process, leaving cost reduction initiatives to less critical issues. Deriving experience from previous liquefaction projects PERU LNG project management team established very early in the project that one single train was the best possible option given the production level selected by the commercial team -4.4 MTA-. For that plant size there existed in the market a well proven technology that fitted that size, being the A.P.C.I.'s propane pre-cooled mixed refrigerant process that option.

Liquefaction Plant overview (June 2009)

Another area excluded from cost reduction considerations was Project specifications. Requirements for materials and equipment were set at the outset of the project at the highest quality level and never relaxed thereafter. Notwithstanding that the selected specifications were based on well known USA standards as NFPA, ASME, API and similar ones, so that no onerous non-standard requirements to be met by Vendors or Contractors existed. NFPA 59A, 2006 rev. was used as the main reference for safely

designing and building the LNG facility. The Pipeline project follows the well known ASME (ex-ANSI) B 31.8 standard.

Good planning ahead, optimizing design and establishing EPCC competition were the main tools used by the Project Management for getting the project CAPEX reduced; in addition to those strategies adequate handling of LNG plant Land acquisition and pipeline Right-of-Way proved very valuable. Previous experience by present paper's author in ATLANTIC LNG (Trinidad) project implementation –as published in B.I.D. Magazine- confirms the correctness of this approach. More details on these issues will be given in this chapter, finalizing with a discussion on PERU LNG project Cost estimates and a benchmarking exercise.

6.2 ***Project Planning***

Planning ahead is always good for any project, but planning ahead and being realistic at the same time is even better and that is especially true when it comes to huge integrated gas liquefaction projects. That is exactly what PERU LNG set to do: In the first place enough time and resources were allocated for the necessary Regulatory, Commercial and Shareholding Agreements to be defined, negotiated and eventually agreed.

Concurrently with the negotiations of those Agreements, the project EIA activities were undertaken in order to have available enough time as they always tend to be lengthier than planned; significant ecological, social, economical and archeological considerations were to be taken into account besides the usual environmental impacts.

Selection of the Plant site was done well in advance with a view to progress and complete EIA activities early enough as to be able to start Site Preparation works well ahead of Plant EPC award.

For the gas supply to the LNG plant from Malvinas there existed the possibility of using the forest section (210 km) of the existing pipeline -as that pipeline had spared capacity in that section- against building a new forest pipeline section. Negotiations with existing pipeline owner, TGP, were established quite early in the project while at the same time PERU LNG was undertaking environmental studies with a view to build its own pipeline through the forest region (gas supply for a potential 2nd liquefaction train was also part of the equation). These activities allowed the company to take a decision by early 2006 in base to optimal cost: pay TGP a fee for gas transportation through their pipeline in the forest region (210 km), and design PERU LNG own pipeline in the sierra and coastal areas (410 km) in a way that could be expanded by adding compression whenever train 2 was decided.

Enough time was also spared for EPC contracting. This proved to be particularly true as, for instance, the selection of the contractor for the Plant EPC resulted from activating a contingency solution requiring several months for its implementation.

Another example of Planning ahead that paid dividends was project Financing. After months of preparing and presenting memorandums, negotiating credit conditions and establishing legal terms PERU LNG reached financial close in June 2008, just 3 months prior to the global financial crisis exploded.

All these actions were planned in detail well ahead of their implementation by PERU LNG clearly avoiding overspending in project resources, time and cost.

6.3 ***Land acquisition Management***

A) Gas Pipeline

PERU LNG pipeline route selection considered basically three possibilities:

-A direct route with the shortest distance between initial point and Plant site. This alternative would have the advantage of being the most economic solution –assuming that terrain was similar- as total length was over 400 km

-A route parallel to the existing gas pipeline and within its Right of Way (ROW). This solution would simplify the process of Land easements with land owners that was predicted to be onerous and time consuming

-A route optimized for land easement, soil geotechnical conditions and total distance. Eventually PERU LNG decided for this last possibility.

Right of Way negotiation meeting between PERU LNG and local Community

Lessons learned during construction in 2003/04 -and operation thereafter- of another pipeline that runs close to PERU LNG pipeline were used in deciding Right of Way within that selected route. Three issues were of paramount importance for those activities, namely:

- Design against erosion: As unstable soils and landslides are frequent in the Andean region very comprehensive Geotechnical surveys were performed to collect enough data as to avoid problematic areas or to adopt protection measures when needed.
- Cultural heritage: As the pipeline generally follows the same paths than several pre-existing Inca trails through areas that are populated since pre-Hispanic times a search for archeological remains was implemented since the first route surveys

were done. Dozens of sites were identified and were either avoided, preserved or its contents recovered, always in agreement with and following the procedures of state organism Instituto Nacional de Cultura.

- Social considerations: Land in Peruvian Andes is owned by local Communities who are very adamant in preserving its characteristics intact for future generations. In that respect contacts were established with all of them early in the project in order to agree in adopting any necessary measures.

B) LNG Plant / Marine Terminal

On the LNG plant project PERU LNG criteria for site selection emphasized reducing investment costs for the project as a whole. In that respect special care was taken in order to minimize social or environmental impacts as well as for being capable of implementing cost-optimized solutions for the installations. Some of the parameters considered were as follow:

-Minimum distance to gas fields so as to reduce pipeline length, though close enough to a port suitable for unloading line pipe in large quantities as well as heavy plant equipment (up to 400 tons a piece).

-Soil being of easy excavation onshore / dredging offshore characteristics, while at the same time being geotechnically sound in order to optimize foundation costs.

-Adequate topography (as flat as possible) / bathymetry (sloping down quickly to reach -15 m water depth).

-Enough space to accommodate optimized design solutions like single containment LNG tanks, and to facilitate construction work (areas for materials lay-down, personnel accommodation, temporary facilities and workshops).

-Environmental and socially acceptable, distant 10 km at least from natural reserves and populated areas to avoid direct pollution impacts.

-Availability of skilled labor and adequate services in the area, as well as having easy access by road.

In addition to all that, and as described by project Manager S. Sharma (Hunt Oil) in a GASTECH-2009 paper, three other specific conditions had to be complied with in PERU LNG case, namely:

-Site elevation over 20 m to mitigate possible tsunami effects

-No archeological remains, very frequent in Southern Peru

-Stable ground characteristics with no presence of liquefactable soil or nearby geological faults, due to seismicity in the zone.

6.4 ***Design Optimization***

The time it took to complete the project EIA's and to finalize the commercial contracts was used by the project team to review and optimize the original LNG plant design. With the help of the original designer company PERU LNG undertook a comprehensive technical definition of the Plant installations and processes. All elements of the original design were reviewed and better defined, reducing project unknowns and technical risk. At the end of this process PERU LNG was ready to proceed with an Open Book strategy for the EPC bidding phase, if necessary.

Liquefaction Plant under construction, as seen from inlet (May-09)

Amongst the many areas covered during that time it is worth mentioning the following:

- Equipment supply: PERU LNG prepared requirements so as to allow suppliers to maximize their supply; and data sheets were prepared in such a way that suppliers could design most of the auxiliary equipment and instruments.
- LNG storage: Having been able to select a site for the LNG plant that was very isolated and quite big, it was first considered and then decided to install single containment tanks for the storage of LNG.
- Refrigerants compression: Compressor dynamic simulation and curve sensitivity analysis were performed. One of the many conclusions of those studies showed that increasing electrical helpers power from strictly required 6 Mw to available 17 Mw could help to produce additional quantities of LNG by using marginal refrigeration capacity in MCHE if refrigeration compressors proved they could handle additional quantities of refrigerants at the performance tests (as it was eventually the case).
- Installation layouts: Very detailed analysis were performed in order to optimize location and spacing of equipment as well as distances between plant sections, by taking into account land available at the site and the special process characteristics of the LNG Plant project.
- LNG loading lines: As the lines to the loading platform are over 3 km long and depart from 140 m elevation transient pipeline analysis were performed to verify design for water hammer effects and temperature induced tensions so as to adopt protection measures if needed.

While having to be capable of transporting well above 1,600 MMscfd –enough capacity for two liquefaction trains- design optimization for the pipeline project was done by optimizing pipeline route (see above chapter). The work performed during this phase on the pipeline project also contributed to PERU LNG deciding not to build a 210 km extension of the pipeline on the Amazonian jungle, as earlier described, using instead the extra capacity available in the existing pipeline.

6.5 ***Contractual Strategy***

In order to define its contractual strategy PERU LNG evaluated the world market status for project Engineering, Materials / Equipment Manufacturing and Construction work, as well as recent experiences with similar installations in the region. The analysis proved that the situation was different for Liquefaction plants, Marine Terminals and gas Pipelines. As a consequence of that a specific strategy was adopted for each of the project main installations.

In the first place it was decided to bid the Marine Terminal separately from the main EPC for the LNG Plant as several contractors were available and willing to bid on Lump Sum Turn Key (LSTK) basis for the marine works, and also because time to completion and risk profile were different in both cases. In that way EPC cost could be optimized for the Marine terminal by promoting technical as well as commercial competition amongst selected bidders. That proved the right thing to do as several bids were received for the marine works and allowed PERU LNG to finalize detailed contractual discussions with 2 of the bidders before final award was decided.

For the Gas Pipeline project implementation PERU LNG adopted a totally different approach after considering previous experience in a pipeline job through the Peruvian Andes in which project the EPC LSTK strategy that was adopted by the operator proved inappropriate in terms of social impact on communities, safety performance in construction and excessive maintenance costs during operation of the pipeline. In our case different packages were prepared for Design Engineering, line pipe Procurement and pipeline Construction so that these activities could be bid separately by pre-selected Service companies, line pipe manufacturers and pipelaying contractors – correspondingly. Strict competition was established amongst the selected companies in each group and PERU LNG project team was managing the whole process. In that way, for instance, 4 valid bids were received for pipeline Construction and negotiations with 2 of the bidders could be completed before final award.

At the time of launching PERU LNG project the Liquefaction Plant construction market was boiling with similar projects. Operators had trouble in finding contractors willing to bid for projects similar to this one. In previous decades it was very often the case of getting 3 valid LSTK bids for a liquefaction project EPC, but that situation changed dramatically after 2003. Preparing itself for that situation PERU LNG allocated enough time for adopting approaches different to LSTK, which was the standard strategy for liquefaction EPC contracting thus far.

After checking for LSTK competition PERU LNG decided to stay with a single contractor and adopted an Open Book strategy to get just 1 LSTK bid for the LNG Plant EPC. Although the bid then presented was technically correct it was unacceptable from a commercial /contractual point of view, and it was not considered any further. After careful evaluation a new contractor -CB&I- was selected and a new Open Book bidding process was initiated. By working closely with PERU LNG, CB&I was able to produce a fully agreed LSTK bid in little more than 1/2 year, including contractual documents ready to be signed.

PERU LNG pipeline string ready for lower-in (June 2009)

6.6 ***Capital Cost estimates and Benchmarking***

Early cost estimates for PERU LNG liquefaction Plant and Terminal were done in 2003 - once KBR completed the project FEED- and once again in 2004, indicating an EPC Lump sum price of US$ 1.0 billion. This figure was in line with estimates done for similar projects being developed at the time like the new Algerian liquefaction plants in Skikda and Arzew, as well as with the actual cost of Damietta Plant in Egypt which EPC was awarded in 2002 for US$ 0.9 billion. The Peruvian, Algerian and Egyptian LNG projects were very similar to each other: Greenfield, single train, same size, similar environment and identical liquefaction process and configuration.

One year later, in 2005, it was already evident in the LNG industry that the increase trend in materials and construction costs was even more pronounced than ever anticipated and so new estimates put the price of PERU LNG project at US$ 1.4 to 1.5 billion. Also in 2005 the new Algerian plant project estimate was updated to a figure in that range. A significant jump from original estimates in both cases, but then that was not the end of the story.

Taking into account the risks that contractors were taking in adopting a lump sum turn key strategy for projects EPC's at that special period of high prices for raw materials, long delivery periods for equipment and volatile exchange rates, by the end of the year 2005 the pre-selected contractor formally submitted to PERU LNG an EPC Bid with a price that was significantly higher than any previous estimate. This additional increase in EPC prices reflected the unrelenting pace of material and labor costs increase at the time, of course, but also a possible over-reaction to prices and cost escalation on the Contractor side.

Upon receiving the bid PERU LNG moved itself very quickly to plan B and pre-selected an alternate Contractor. In parallel to that an analysis of the LNG construction market, performed in March-2006, confirmed that costs have gone steadily up during the previous year but not as much as the bid suggested, concluding that the right price for a project of the size and type of PERU LNG at that time should be no more than US$ 2.0 billion.

Eventually in August-2006 PERU LNG awarded the marine Terminal EPC for US$ 0.3 billion, and in December-2006 a bid from CB&I for US$ 1.6 billion was awarded the EPC Contract of the Liquefaction plant, making the total price for the whole plant + terminal project to be US$ 1.9 billion, just below the US$ 2.0 billion target. (In any case the Plant EPC final price resulted almost double than originally estimated 3 years before).

As for the Algerian liquefaction plants on July 7, 2007 SONATRACH announced that it had awarded the EPC contract for the Skikda LNG project –a 4.5 MTA liquefaction train similar to Damietta, PERU LNG and Arzew projects- to KBR for a price of US$ 2.9 billion. On the Arzew project SAIPEM/CHIYODA publicly announced on July 18, 2008 that the LNG Plant EPC was awarded to them for Euros 2.8 billion (over US$ 4 billion). In this last case EPC price had jumped 300% in the 4 / 5 years lapse between 2004 and 2008, reflecting a further increase of project costs in 2007 and 2008.

7. **Final Comments**.-

7.1 ***Results***

PERU LNG project is approaching completion of its investment project with excellent results in all fronts. Planned goals are being reached as set at the launching of the project; and comparison with similar projects elsewhere is very satisfactory. In what follows we summarize main achievements.

1) Health and Safety.- In the first place people's safety was the main consideration for project management through all phases of the work, from FEED to Commissioning. Construction safety records -as shown earlier in this paper- have beaten all targets and compare very favorably with similar projects in Peru and elsewhere in the world, as LTI rate for the whole project remains currently at 0.06 (Project target 0.25) when more than 42 million man-hours had been cumulated for Pipeline, LNG Plant and Terminal works.

2) Investment Cost.- PERU LNG total investment for all three main installations and related activities, including pre-FEED expenses and project management and company administration, was approved in 2006 at US$ 3.3 billion as follows: LNG Plant 1.6 billion, Marine Terminal 0.3 billion, Pipeline 0.7 billion, Company Mgmt. and Other 0.7 billion. Three years later, with more than 2/3 of the project executed, total planned expenses for the whole project still stand at same total figure. Finance costs on the other hand have resulted in net savings of almost US$ 0.2 billion over initial estimate.

3) Project Schedule.- Loading first cargo date was established at Project launch to be at the end of May, 2010. Consequently project activities were planned for all work packages in order to reach that goal. Contractual schedules for all contractors were approved in a consistent manner so that an orderly commissioning of installations could be done and start-up could be implemented before that date. So far Time to Completion remains end of May, 2010 although PERU LNG had to implement Acceleration plans with all three main contractors (Marine EPC, Pipeline Construction and LNG Plant EPC) in order to recover minor delays.

4) Plant Capacity.- With all detailed engineering work finalized Plant Nominal capacity has resulted to be 4.45 MTA, well above the requested minimum. As for energy Efficiency final simulations done with delivered Main Cryogenic Heat Exchanger produced a Total gas consumed/Feed-gas rate result of exactly 8.0%, so 1% less than target. Finally advanced Reliability/Availability/Maintenance studies have shown that Plant average annual Availability would be 96.3%. In all cases pre-established goals have been exceeded.

5) Local Development.- From project inception in 2002 to commercial operation in 2010 PERU LNG would have invested a total of US$ 3.6 billion, including corporate and financing expenses (interest and commissions) during construction. It is by far the biggest single investment in Peru's history, and it is generating thousands of jobs in the country. Further to that, once in operation the project will increase 0.6% Peru's G.D.P., will generate US$ 1,700 million in exports and will produce a net income to Peruvian government of more than US$ 300 million, only in taxes, every year. That is also a project goal that will be realized.

7.2 ***Conclusions***

PERU LNG project was initiated in 2002 at a time when numerous LNG projects – whether greenfield or expansions- were also being started in several places around the world. LNG Plant E.P.C. was awarded to CB&I in January-2007 at the peak of the rocketing LNG industry CAPEX increase. Financing was finally arranged in June-2008 at the verge of the current economic crisis. Facing commercial uncertainties, high construction costs and credit difficulties PERU LNG nonetheless has been successful in overcoming all these challenges.

Thanks to an excellent performance by workers and managers of main Contractor CB&I we have reached an EPC unit cost for the LNG Plant well under 400 US$/ton for just one liquefaction train, a Time to Completion under 40 months for a grassroots plant, and an excellent Safety, Environmental and Social performance in a very difficult site. Those are the main successes of the project when PERU LNG is less than one year away from loading its first LNG cargo.

PERU LNG managed to make reality this Liquefaction Plant, capable of producing 4.5 million ton/year of LNG, by attaching itself to very well known principles of project management -like design optimization, anticipation in decision-making, competition in EPCs and all other contracts and strict planning schemes- as well as by receiving full support and knowledgeable collaboration from project stakeholders whether Company shareholders, Official institutions, Lending agencies, Gas suppliers, LNG off-taker, Project vendors and contractors, and above-all Peruvian construction workers.

References

-D. Jamieson, P. Johnson, P. Redding (ATLANTIC LNG): "*Targeting and achieving lower cost liquefaction plants*". LNG - 12

-C. Lopez Piñon (REPSOL): "*Natural gas liquefaction plant in Trinidad: Planning, Design and Construction*". B.I.P. Magazine, September 2001

-LNG Express: "*Algeria awards $2.9 billion contract*". July 15, 2007

-Saipem website: "*Saipem wins 2.8 billion euro contract in Algeria*". July 28, 2008

-G. Humphrey (CB&I): "*The rising costs of LNG projects, why?*". CWC - 2008

-S. Suellentrop (PERU LNG): "*Peru LNG challenges and achievements*". New Orleans LNG – 2009

-S. Sharma (HUNT OIL); D. Hill, P. Rano, G. Humphrey, M. Mayer (CB&I Lummus): "*PERU LNG: Executing Peru's largest industrial project*". GASTECH - 2009