VIRTUAL GAS GRID

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ABSTRACT

Due to the maturity of the LNG business and the new gas markets, innovative solutions are more and more demanded nowadays. The virtual gas pipeline offers an alternative to supply and receive gas in small quantities in a sustainable way, either to monetize small gas fields or remaining capacities in existing pipelines. The project covers the whole LNG small scale chain: liquefaction, distribution and regasification, involving the collaboration of three countries Bolivia, Paraguay and Uruguay. The use of modular solutions, for the LNG exporting and importing facilities, as well as the 'tailor made' barges design to allow LNG distribution in inland waterways with navigation restrictions will be the key of the success of this pioneer project. The purpose of this poster is to describe the technical solutions implemented as well as to highlight the main issues and difficulties found during the design process.

1. INTRODUCTION

Due to the maturity of the LNG business and the new gas markets, innovative solutions are more and more demanded nowadays.

The virtual gas pipeline offers an alternative to supply and receive gas in small quantities in a sustainable way, either to monetize small gas fields or remaining capacities in existing pipelines.

The project covers the whole LNG small scale chain: liquefaction, distribution and regasification. The LNG distribution could be either by trucks or by barges. In this paper only the distribution by barge is considered as the LNG truck system is standard solution, successfully implemented since years ago.

The use of modular solutions, for the LNG exporting and importing facilities, as well as the “tailor made” barges design to allow LNG distribution in inland waterways with navigation restrictions will be the key of the success of this pioneer project.

The project could involve several countries or single one.

The purpose of this paper is to describe the technical solutions implemented as well as to highlight the main issues and difficulties found during the design process.

The three components of the chain to analyze are:

- Natural gas liquefaction plant;
- LNG distribution system;
- Regasification facilities.

The LNG liquefaction plant shall be established as a marine LNG loading export terminal.

The LNG regasification plants shall be established as marine LNG unloading import terminals.

LNG international standards shall be applied and followed for the design of the facilities (the most common are the American Standard NFPA 59A or the European Standard EN 1473).

The LNG virtual grid is shown in the sketch below.
2. PROJECT DESCRIPTION

2.1. LNG liquefaction plant

The liquefaction plant will be fed by either an existing natural gas pipeline or by a dedicated gas well. The gas volume available will be lower than 1mtpa.

2.1.1. Process description

The liquefaction process is shown in the block flow diagram below.

![Block flow diagram](image)

The feed gas shall be in a stable gas composition. The feed gas will be metered, its composition checked and then it will feed the LNG liquefaction train.

The LNG liquefaction train comprises a guard bed to remove any mercury that may be present in the feed gas, an acid gas removal unit to remove acid gases (CO2, H2S) from the feed gas, a molecular sieve unit to dehydrate the feed gas, a heavy hydrocarbons removal unit and liquefaction unit.
LNG produced by the LNG liquefaction train is transferred to the LNG storage tank and exported via a dedicated LNG marine loading facility.

A collection and compression system will be provided to recover boil-off gases during storage and loading activities for reinjection in the liquefaction cycle.

The liquefaction process could be either nitrogen expansion process or mixed refrigerant. The selection shall be done case by case according to the local conditions comparing mainly: capacity, efficiency, power consumption, safety, operability, etc.

The LNG specification will be fixed according to the consumers needs; however as general rule the following LNG specification is accepted:

<table>
<thead>
<tr>
<th>Composition (mol %)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>C4+</td>
<td>2.0 max %</td>
</tr>
<tr>
<td>C5+</td>
<td>0.1 max %</td>
</tr>
<tr>
<td>N2</td>
<td>1 % max</td>
</tr>
<tr>
<td>CO2</td>
<td>50 ppm max</td>
</tr>
<tr>
<td>Benzene (mg/Nm³)</td>
<td>4 ppm max</td>
</tr>
<tr>
<td>High Heating Value (HHV)</td>
<td>37–43 MJ/Sm³</td>
</tr>
<tr>
<td>Wobbe Index</td>
<td>48-53 MJ/Sm³</td>
</tr>
</tbody>
</table>

**2.1.2. Facilities description**

The LNG Liquefaction plant and export terminal facilities comprise the following main components:

- Feed gas metering
- LNG liquefaction train
- LNG storage tank (full containment type if storage capacity higher than 15000m³ if lower capacity pressurized vacuum perlite insulated vessels could be considered)
- LNG loading jetty with LNG transfer arms
2.2. LNG distribution by barge

2.2.1. LNG shipment

The LNG stored in the LNG tank at the LNG liquefaction plant and export terminal will be loaded into the LNG carrier barges at the LNG export terminal jetty in order to ship to the LNG import and regasification terminals.

According to the project conditions the LNG barges could be a single unit or grouped in a barge trains consisting in two or more barges and one pusher (if not propelled barges) in order to increase the capacity.

The LNG barges or trains will be constantly rotating from the source to the consumers. There will be dedicated barge or trains for each receiving country in order to keep independency and flexibility.

To guarantee the continuous supply the LNG barges shall have a maximum occupancy rate of 75-80%. It is also important to consider that according to the IMO rules, the barges shall be inspected every 2.5 years on site and every 5 years within a dry dock.

2.2.2. LNG barge main characteristics

LNG barge type comparison and selection according to the river conditions: draught, size constrains, volume, etc.
The main parameters to select are:

- LNG containment system
- Propulsion system: self-propelled or non-propelled (pusher)
- Convoy arrangement: according to the volume, length, beam and draught in order to define the number and characteristics of the LNG tanks and number of barges per train.
- BOG management system
- Cargo handling

2.3. LNG import & regasification terminals

2.3.1. Process description

The liquefaction process is shown in the block flow diagram below.
The LNG will be supplied by LNG barge trains through the waterway.

The LNG from the barges will be unloaded at a receiving jetty and sent to the LNG storage vessels.

It is assumed that the storage capacity of each LNG receiving terminal is lower than 10000m³; therefore the LNG will store into pressurized vacuum perlite insulated vessels.

LNG will be pressurized from the storage vessels by LNG pumps up to the consumer pressure level and sent to the vaporizers. The type of vaporizer will be selected according to the local conditions, as general rule ambient air vaporizers are the preferable solution due to the low operation cost.

Once regasified, the natural gas will be sent to the consumers through the metering station.

### 2.3.2. Facility description

The LNG import terminal and regasification facilities comprise the following main components:

- The LNG unloading jetty,
- The LNG process facilities
  - LNG storage, as pressurized vacuum perlite insulated vessels,
  - The LNG pressurisation and vaporisation,
  - The boil-off gas handling system
  - The fiscal metering and connection to the natural gas grid/consumers
- Utilities comprising
  - Power generation
  - Instrument air and nitrogen generator
- Buildings comprising
  - Administration/ control building
  - Warehouse/ workshop
- Infrastructure comprising
  - Roads and drainage
  - Marine facilities

### 3. CONCLUSIONS

The objective is supply natural gas to remote areas without access to the grid as well as to monetize remote gas fields.

Once the chain is sized and the main parameters selected, further studies shall be done in order to describe the main components and to provide a cost estimation to define the technical and financial feasibility.

The feasibility of the project will depend on:

- Optimised chain
- Gas price (molecule)
- Chain cost, (total USD/mmbtu): liquefaction, distribution and regasification