PROJECT LNG-HMA

CROATIA-ITALY

Creation of a Hub system for supply, storage and distribution of LNG in High/Middle Adriatic Sea

INDEX.

INTRODUCTION.

Today more than ever, methane gas is the most appropriate energy source to meet the energy needs of the EU and at the same time to lead the transition phase towards the Carbon Free strategy and CO2 reduction emissions.

Currently in Europe the natural gas market is essentially an oligopoly vertically integrated; supplies are regulated by long-term supply contracts with key producing countries (Russia, North Africa and Northern Europe).

The European Union in connection with the Ukraine crisis of 2014/2015 has stepped up efforts to policies aimed at reducing dependence on the current electricity delivery system and distribution, promoting the diversification of supply through the development of LNG.

In addition, the international treaty "COP21-Paris 2015" relating to climate changes around our planet, has committed the European Union to intensify the implementation of the Road Map Europe Carbon Free 2050. In this context that the project proposal concerning the establishment of a procurement Hub system, storage and distribution of LNG in the Upper-Middle Adriatic.

This document below is the rationale and objectives of the project, the description of the various modules that constitute it, the relevant skills of Croatian regions and the same Italian promoter, planned investments and economic and financial sustainability of the project.

1. GROUNDS OF THE PROJECT.

1.1 The Energy Policy of European Union.

The EU Energy Policy puts renewable energy at the centre of all initiatives aimed at ensuring the Sustainable Communities, secure and competitive. The Roadmap (Roadmap 2050) indicates that to achieve the **goal of 80% reduction** in emissions by 2050, energy production in Europe will be practically zero carbon emissions.

The **"Strategy 2050 Italian Carbon Free"**, beating the targets set at Community level, provides for an economy based on intelligent network management, the energetic rehabilitation of buildings, electric mobility with strengthening the public transport share, on energy production from renewable and endogenous sources.

In the transition from the current situation to that at **"zero carbon emissions"**, there will be a transition period, during which the goal is to make more efficient the entire energy system.

Methane becomes all the more essential and strategic since it is able to accompany the transition scenario, both consumption and production, guiding producers towards efficient distributed generation actions, more suitable to the characteristics of the changing system. Moreover, it would significantly reduce CO2 emissions and other greenhouse gases contributing to more quickly achieve the goals set by the European directives on the climate.

1. GROUNDS OF THE PROJECT.

1.2 II The role of LNG in the reorganization of Methane Gas supplies.

The LNG worldwide market has increased its market share up to represent 35% of global demand over the past decade.

Considering the strategic function of methane as a proper fossil fuel during the energy transition, the system requires the organization of the demand of LNG supply, storage and distribution in order to cover the additional demand for natural gas.

It is important to underline the fact that currently the supply of natural gas for the areas affected by the project is guaranteed by the pipeline network that caters Europe from producer countries (Russia - North Africa - North Europe). This dependence on pipeline networks created over the past twenty years some critical situations (see Ukraine case) that has determined resolutions by the European Union aimed at the differentiation and diversification of supply, by assigning to LNG a fundamental and decisive role.

1. GROUNDS OF THE PROJECT.

1.3 Benefits of the Methane Gas supply in Liquid state (LNG). 1/2

The construction of a supply hub and LNG storage, in contrast to the methane distribution projects through the pipeline, presents the following main benefits:

- the construction work in 18 months (authorization time excluded), against a minimum of 60 months for the pipeline;
- lower land use and restructuring costs;
- less investment: approximately 15-20% of the cost of a backbone pipeline;
- supply infrastructure and modular storage allowing different investment stages;
- price competitiveness in the growing LNG market without binding to a single supply contract. There will be a
- more flexibility in purchasing and supply costs;
- allows the opening of a LNG distribution network for road industry and more generally of freight transport by sea and rail;
- opens the way for a gradual conversion of the energy system, capable of overcoming the current unbalanced and centralized production model, electricity and heat transmission and distribution - which disperses in transport to 20% of energy produced - in favour of a decentralized system of production, distribution and consumption;
- it even offers energy benefits for the possibility of recovering cold from the gasification process and the heat from the distributed power generation processes.

1.3 Benefits of the Methane Gas supply in Liquid state (LNG). 2/2

In addition, the construction of a supply hub and LNG storage, unlike the methane distribution projects through the methane pipeline, would share the cost between public and private, reducing government intervention in the total investment for the methane. In particular;

- the implementation of supply and storage key infrastructures would be financed by a public-private partnership;
- the construction of regasification infrastructures and enhancement of the cooling energy would happen through private capitals.

Last but not least to overlook the positive impact at work, as regards procurement and subcontracting as part of the civil works and transport during the construction phase of the entire infrastructure of the LNG supply chain, there will be the involvement of businesses in the Upper Adriatic. Once operating, the system will provide stable and continuous employment in the management and maintenance of networks and logistic equipment.

1.4 The Market of Methane gas in the Upper-middle Adriatic region.

The current natural gas demand for the area of intervention on the High Adriatic sea **(Veneto - Friuli Venezia Giulia - Slovenia - Croatia)** is estimated at about 15-17 billion per year as the average of the last five years.

Europe Carbon Free 2050 transition is estimated assuming a methane needs in the intervention area of question between 22 and 24 billion per year. This estimate also considers the gradual replacement of other fossil fuels in industrial uses, for the production of electricity (industry cargo-passenger transport) and the application of European directives on energy efficiency of the current system.

For this profile of demand and the vision proposed by the auditing guidelines of the Northern Adriatic, the most simple and flexible way to meet the increased needs of methane is the methane gas supply of LNG by sea.

1.5 Strategic positioning of the Upper-Middle Adriatic Region.

The Northern Adriatic, among the macro regions in Europe, is more favourably positioned to receive LNG by sea thanks to its geographical position in relation to the charges for transportation. LNG may represent the long-awaited answer, to the demand for natural gas in those areas of Balkan regions that still not have methane gas.

Industrial and port areas already settled on the High Adriatic are in fact an elective place for the LNG supply and storage facilities. With this solution the potential of the LNG in civil and industrial sectors shall be exploited, as a vector to 3-energy-generation plants; that means with the recovery of refrigeration energy by the process of vaporization of the LNG (which produces cold).

This solution would minimize infrastructure investment and therefore the intangibles, helping the transition to the decarbonisation phase of the macro region economy, quickly and without the commitment of substantial economic resources.

LNG may represent the long-awaited answer, to the demand for natural gas in those areas of Balkan regions that still not have methane gas.

1. GROUNDS OF THE PROJECT.

1.6 Supply promotion and distribution of LPG and Bio-methane for road transport.

The European Directive 2003/30/EC has promoted and coordinated an integrated project for the entire territory for the supply and distribution of LNG for road transport.

More and more European countries have embarked on the path of LNG for shipping within 12 miles, for the road transport and this trend will spread across Europe shortly. Having signed the Kyoto Treaty, and recently the Paris agreement, Europe has developed over the years numerous links to renewable energy sources, that are part of the continental energy strategy The environmental fallout of this fuel is therefore a fundamental element in this logic. After the construction of biogas plants for the production of electricity from organic matrices across Europe, today the new European directives indicate in the production of biomethane as the new frontier for energy efficiency, that respects the strategic directives of the Carbon Free 2050.

Today it's up to the LNG fuel to enter their organic share in the fossil one with employment impacts, as well as environmental with conversion of sites used for landfill, in creating a virtuous chain in synergy with agriculture due to compost organic waste.

1. GROUNDS OF THE PROJECT.

1.7. State of the HV Electricity Network and related plants in the Upper-Middle Adriatic.

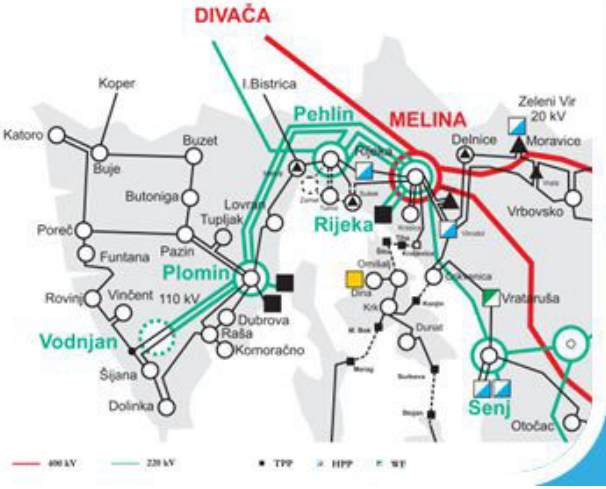
The network in the project area presents the following critical factors:

- Rigid power plants (conventional thermal power, hydro-river power);
- Large bands of fluctuations in withdrawals and significant changes in summer and winter due to tourists;
- Network design for linear electric rods and not for meshing grids.

The most significant part of the system is TS Melina with two 400/220 kV transformers of 400 MVA each and two 220/110 kV transformers of 150 MVA. An power line of 400 kV connects Melina with Slovenia, part of Zagreb and Dalmatia. TS Melina takes part in exchanges between Central Europe, Croatia, Slovenia and Italy.

Taking into account also the increase provided for the generation from non-programmable renewable sources (sun, wind), it is clear the need to develop an element of flexibility in the area can provide a stabilization of the service of Melina node, crucial point of HV whole area network.

Transformer stations:	400/220/110 kV Melina (2x400 + 2x150 MVA) 220/110 kV TE Plomin (3x150 MVA5) 220/110/35 kV Pehlin (2x150 MVA + 3x40 MVA)
Thermal power stations:	Rijeka (oil, 320 MW) Plomin 2 (coal, 210 MW) Plomin 1 (coal, 120 MW)
Hydroelectric power stations:	Rijeka (36 MW) Vinodol (84 MW) Senj (216 MW) Sklope (22,5 MW)
Wind farms:	Vrataruša (42 MW).



2. THE PROJECT.

2.1 Goals.

Candidate Croatia as a Driver Region, in the context of the Adriatic basin, for the construction of a new energy model to lead the transition of the planned Road Map Europe Carbon Free. In particular expected to:

- implement the "model of distributed generation" (produce where you consume);
- manage the transition Carbon Free harmonizing between renewable and fossil energy sources;
- reduce costs in all segments of the supply chain by increasing the efficiency and productivity of the energy;
- expand its sources of supply by strengthening the security of the energy system;
- creating new economic and social models less vertical and more inclusive, ensuring economic growth and employment;
- aggregate the world of scientific research multiregional for the design and implementation of a research and development program that supports the new energy model;
- Encourage economic, social and cultural development of the Adriatic regions.

2.2 Project Modules.

On the base of the abovementioned grounds, The project has four basic forms of realization:

M1 - LNG supply Hub;

M2 - LNG supply and distribution Hub for the transport sector;

M3 - Biomethane gas production;

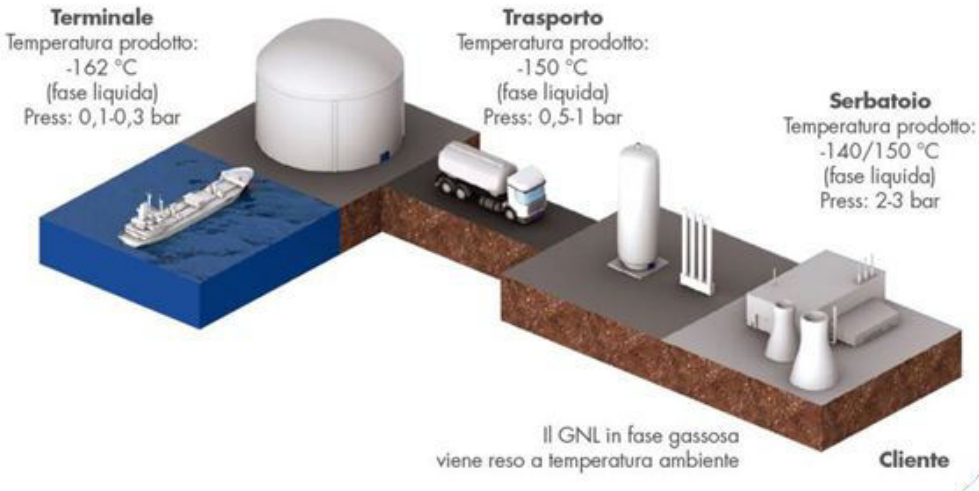
M4 - Rijeka thermal power station Conversion.

2. THE PROJECT.

2.3 M1 – LNG supply hub. 1/2

The project involves the construction of a supply and storage hub, which consists of two terminals (for obvious security reasons) to be allocated in strategic areas in the island of KRK with an overall and modular capacity between 80,000 - 160,000 m^3 of LNG. It will be able to satisfy, in annual rotation, a storage capacity stretched to cover an inner average demand for coastal regions in the Upper/medium Adriatic sea, of over 2,500,000 m^3 of LNG equal to about 1.500 Mln m^3 of methane gas.

This procurement Hub and storage must be able to ensure the landing of large LNG tank ships (at least 150 000 m^3 of LNG), which are the lonely ones that will produce the best economic conditions for the supply in a market that will become increasingly competitive.



2.3 M1 – LNG supply hub.

To have a sustainable distribution ecologically and energetically (not on rubber wheel) and a proper coverage area of the Upper Adriatic, the two units are not enough for supply and storage use. So, it is necessary to build eight other coastal deposits with an average total capacity of approximately 60,000 m3 of LNG, primarily located in the port areas of Rovigo (Italy), Pula, Split, Ploče (Croatia).

The procurement of medium coastal deposits is seaborne, and this implies the acquisition of small LNG units with a capacity between 1,000 and 10,000 m^3 of LNG.

One might expect an upgrade of the current project in case of an eventual increase in natural gas demand, in building other coastal deposits located one on the coast of Montenegro and one on the coasts or near to Bosnia and Herzegovina.

2.4 M2 - LNG supply and distribution Hub for the transportation sector.

As part of the regional macro project, the Veneto Region and the Region of Friuli through their operating entity, will take care of the organization and infrastructure management of supply and distribution of LNG for the freight/persons transport sector (road-sea-rail).

This intervention involves the construction of:

- supply depot and storage between 10 to 12,000 m^3;
- a promotion and the development of a network of LNG distributors to the road haulage service and to navigation.

In the same infrastructure will be provided the planned module for the production of Bio-methane (M3) described here below.

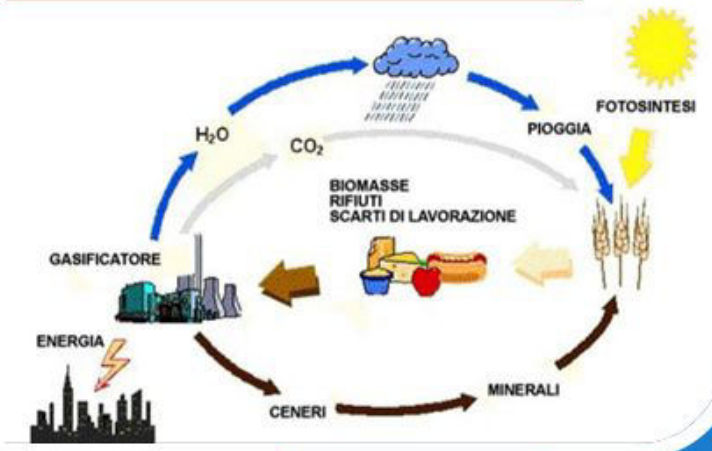
2.5 M3 - Biomethane production. 1/3

The project involves the construction of 8 production plants (4 in Italy and 4 in Croatia) of biomethane with a production capacity of 3,500 m^3 each of Liquid Biomethane.

Biomethane is produced from fermentation in anaerobic environment of organic agricultural matrix, by products from the food industry or the organic fraction of the waste (MSW).

The anaerobic fermentation in a controlled environment artificially manages a process that would occur in nature in a longer time through the decomposition of the organic substance. The process, managed in a proper way, avoids the release of CO2 and methane as well as other compounds that are harmful to the environment. The proposed initiative reduces CO2 release into the environment in an equivalent manner to the benefit of a wood with a 9,600 hectares extension.

Schema bio energetico



2.5 M3 - Biomethane production. 2/3

The process to arrive at Bio LNG production to be mixed with LNG of fossil origin, takes place in 3 steps:

S1 - Biogas production; S2 - Biogas treatment; S3 - Biogas liquefaction.

- **S1** - The first step consists in the construction of a plant for the production of biogas. This is a system of a biomass loading system of anaerobic digesters which generates biogas, collected to the accumulation storages. The plant for the production of biogas will have to ensure minimum **500/600 m^3/h** of biogas with a content of 60-65% of methane up to a maximum, required by law to **1,500 m^3/h.**
- **S2** - The second step is the treatment of the biogas. produced from the digesters through the **purifying and upgrading process.** In the purifying process the moisture is removed and the mixture of methane and CO2 is 4cleaned by the presence of fermentation waste products. With the upgrading is removed the carbon dioxide that is present in the mixture and can be recovered as a technical gas for industrial use.

2.5 M3 - Biomethane production. 3/3

- S3 - In the third step the pure methane to 95-97% is sent to the **liquefaction** process, consisting in the removal of contaminants and in multistage cooling the natural gas through cryogenic process. After being purified, the gas flows in a multi-stage heat exchanger in which it will be gradually cooled to a temperature from time to time, in function of the lower stage. Then it flows through a pressure valve as a liquid natural gas at atmospheric pressure and free of contaminants, which will be transferred to a waste storage tank by a cryogenic pump. Once stored is ready to be mixed with the fossil product to be distributed by the virtual pipe line to the various users. This process allows the insertion of the biological product and the fossil one by mixing process, in order to meet the demands of the legislation of 2018 on biofuels.

Organic LNG production

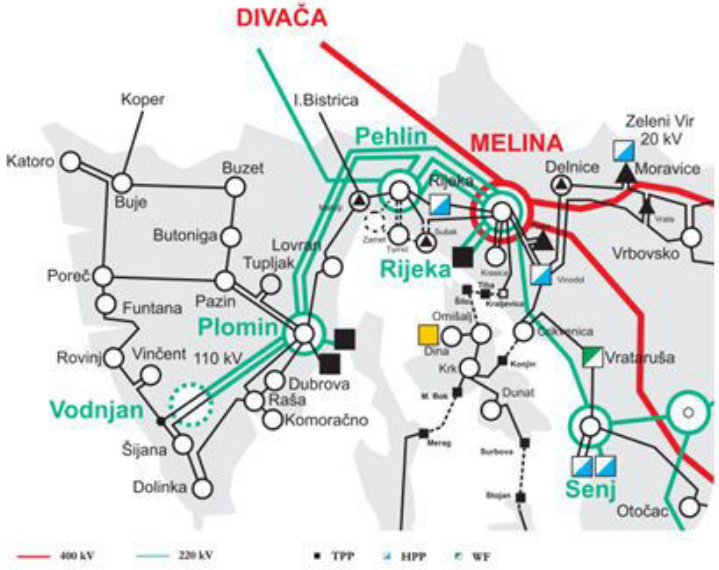
Mixing of LNG gas with fossil LNG (10-90%)

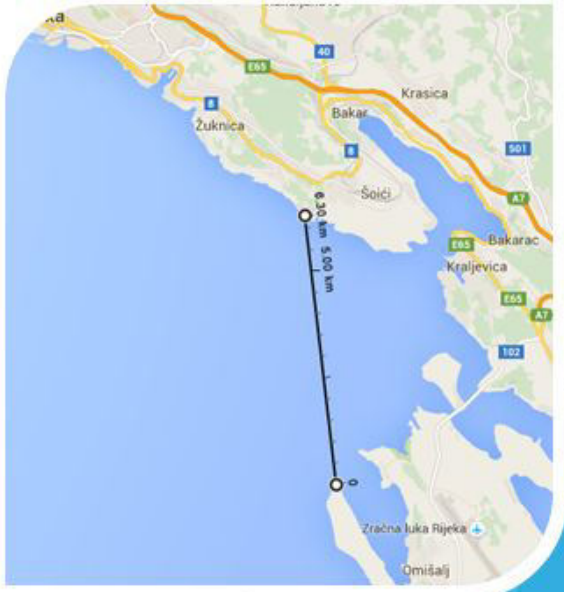
Distribution of green methane in liquid and gassous form

2.6 M4 - Rijeka thermal power station Conversion. 1/2

The thermal power plant of Rijeka is connected to Melina node, the primary Croatian node, by two transmission lines of 220 kV and is located in the area adjacent to that of the LNG terminal (about 4 miles - 6.3 km as the crow flies). This unit is powered diesel and is in operation since 1978 with a nominal capacity of 320 MW.

Because of the high production costs, high emissions and operating rigidity, in recent years the plant has been used only for backup to the network.





2.6 M4 - Rijeka thermal power station Conversion. 1/2

A development of a flexible element capable of providing a service of the stabilization of Melina node, crucial point of the whole HV country network, shall ensure to reconfigure the production facilities, without changing the installed capacity, but with a new architecture able to increase efficiency and reduce emissions.

- Natural gas power plant as technological choice to increase efficiency and reduce emissions
- Fractionation on more units of production capacity and by-pass between individual units
- Using the available "cold" produced from the LNG plant to increase efficiency and production
- Utility recovery, HV system of the existing power plant

L'ipotesi di impianto di riconversione della centrale elettrica prevede:

- ✓ **Capacity:** from 1 unit of 320 MWe to 3 units of 110 - 130 MWe
- ✓ **Operating in terms of maximum flexibility:**
  Winter 1 GT at minimum load (warm reserve) cold reserve for 2 units
  Summer 1 GT at minimum load, 2 GT warm reserve
- ✓ **Ramp-up to full load in 3-5 minutes from warm reserve:**
  Winter: Base load at 50-70 MWe, + 50-70 MWe in 3 Min
  Summer: Base load at 150-200 MWe + 150-120 MWe in 3 Min
- ✓ **Efficiency:** minimum 55%