DUNKERQUE LNG, IMPLEMENTATION OF CREATIVE SOLUTIONS FOR THE DEVELOPMENT OF A NEW MAJOR EUROPEAN LNG INFRASTRUCTURE

Authors:
Marc Girard, Dunkerque LNG / EDF group
Catherine Jouny, Dunkerque LNG / EDF group
Christophe Liaud, Dunkerque LNG / EDF group

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I – Background: Dunkerque LNG, a five-year development project

Dunkerque LNG SAS ("DKLNG"), a subsidiary created by EDF, the leading electricity producer in Europe with around 120 GW installed capacity worldwide, is a company in charge of the construction, commissioning and operation of a liquefied natural gas ("LNG") receiving terminal in Dunkirk seaport.

In 2005 the EDF group evaluated various potential sites for the location of a new LNG terminal in France. Of the sites studied, Dunkirk emerged as the most suitable due to (i) the quality of the port environment and its capacity to accommodate the largest LNG carriers such as Q-max (short access time, safest conditions and significant slots), (ii) the location of the port providing good access to French and European gas transmission system and (iii) local skills in terms of the development and operation of large industrial facilities.

Following a public consultation process held in 2007, and the receipt of tenders for construction in 2009, the viability of the project was confirmed: this terminal could offer a competitive tariff comparable to other terminals in France and Northwest Europe provided a minimum 10 bcma (out of 13 bcma) re-gasification capacity is sold on a long term basis, regarding the economies of scale.

Thus an active search for partners to purchase re-gasification capacity besides EDF, or invest as shareholders in DKLNG, was initiated in 2009 among all the major gas players in Europe.

II – Aims: to secure a competitive, flexible gas supply for the EDF group

EDF considers gas to be an essential component of its electricity generation activity, particularly its role in supplying the Group's combined cycle gas turbine or in extending the offering to end customers.

II.1 Description of EDF end-users

In 2010 the EDF Group gas sales totalled more than 130 TWh.
In France the EDF pursued a marketing strategy designed to develop the loyalty of the most attractive customers and to increase the value of its customer portfolio. In 2010 EDF's natural gas sales to its end users in France totalled around 21.4 TWh (which represents a market share of 4% i.e. around 600,000 customers).
In Italy, the United Kingdom and Belgium, the development of sales is based on a more aggressive approach with downstream customer portfolios composed of:

- in Italy: around 600,000 customers, 4.5 Gm^3 (around 50 TWh), market share not available
- in the United Kingdom: around 1.7 million customers, 30.4 TWh, or 4% market share
- in Belgium: around 520,000 customers, 25.6TWh, or around14%market share

With 35 GW installed capacity worldwide, the EDF group is a major player in fossil-fired power generation.
In the EDF group's energy mix, gas power plants are used to supplement nuclear power plants (mainly in France), which supply the base load and meet daily recurrent demand. Their use allows the EDF group to adapt rapidly to fluctuations in energy demand and meet requirements during periods of high demand, which are increasingly frequent and extensive: since electricity cannot be stored, EDF adapts its generation capacity in real time to match consumption.
The EDF group already has CCGs in Europe (Italy, Belgium, Holland, the United Kingdom) and brought its first CCGs in France on line in 2011. In 2011 the installed capacities of EDF group's electrical power plants in France, the United Kingdom, Belgium and Italy amounted to around 11.8 GW (combustion turbines, co-generation power plants, combined cycle gas power plants) and the developments planned for the gas industry in this zone area amounted to more than 5 GW of additional installed power (EDISON excepted).

More generally, the role of natural gas in electricity generation has been growing sharply for more than ten years, and this trend could accelerate, especially with the withdrawal by 2015 of fuel oil and coal from production resources in Europe because of new emissions standards. The energy efficiency of combined cycle gas power plants, the low investment costs associated with the use of this technology, and the relatively short construction times make this industry a technology that supports transition to low carbon technologies. In fact in the medium term, combined cycle gas power plants ("CCG") will no doubt be the only technology available and rapidly deployable to achieve the CO_2 emissions reduction goals. For example EDF has been developing the first next-generation combined cycle gas turbine (CCGT) featuring GE Energy's FlexEfficiency 50 technology. This combined cycle gas turbine, due to begin production in 2015, will have an installed capacity of 510 MW providing electricity. This new technology will achieve 61% efficiency with average 10% lower CO_2 emissions than those of a traditional CCGT and reach maximum load in less than 30 minutes. In the longer term, the operational flexibility of this technology will offset the intermittent electricity generation from renewable energy sources.

II.2 Difficulties in ensuring competitive, flexible gas supply

The distance of supply sources combined with the decline in North Sea production, the low liquidity of the short-term markets, the still limited gas transport capacities (LNG chain and gas pipeline) and the liberalization of European gas markets have pushed EDF not only to diversify its supply sources to have access to competitive offers, but also to have access to logistical infrastructures over the entire natural gas chain (storage facilities, import pipelines, LNG terminals, production assets, etc.) to ensure delivery and flexibility of use and to limit exposure to the volatile and not very liquid wholesale market.

In this context, Dunkerque LNG, as an arm of EDF's strategy, is developing one of the tools that will allow the EDF group to access natural gas under competitive conditions compared to those of its challengers, mainly the former gas monopolies, and strengthen its position as a major European competitor in the natural gas market.

III – Method: development of a 13 bcma LNG receiving terminal on a green-field site to access natural gas under competitive conditions

The development by EDF's affiliate Dunkerque LNG on a green-field site in France of Dunkirk 13 bcma LNG receiving terminal project is entirely in line with this strategy.
At the same time, this context also gave rise in 2005 to more than 10 new regasification terminal projects, including four in France including the Dunkerque LNG project.

However, at a time when the gas industry is questioning its future model, how to ensure security of supply and the options for dealing with uncertain demand, the decision to build a terminal involves significant risks. On top of this, the economic and financial crisis has also challenged most of these projects which, when not abandoned, have been suspended or postponed for two years.

But creative solutions and long-term vision have meant that the Dunkirk terminal is the only project that has been decided in Europe, strongly supported as it is by solid industrial players, EDF and its two partners Total and Fluxys G. This success of this project depends on three major pillars:

III.1 Environmental, social and local acceptability

Prior to any industrial development it was essential to secure local acceptability; several factors have helped secure strong local acceptability of the project allowing Dunkerque LNG to obtain smoothly all the environmental permits and operation authorisations.

- First of all, the industrial Port of Dunkirk (Grand Port Martime de Dunkerque, GPMD), an established industrial port preparing to accept LNG, was chosen not only as a co-promoter of the project but also as a co-owner for the implementation of the maritime platform and facilities.
  GPMD has significant experience with large industrial facilities that are subject to stringent safety requirements (13 existing industrial facilities where dangerous substances are present in large quantities in the port area), it is only 90 minutes by sea from the Pas-de-Calais Straits and Channel sea lanes, it is the third largest port in France (47.5 Mt of traffic and 7,000 ships in 2011), it is the leading French port for importing copper, coal and ore and has a long history of energy imports (crude oil, petroleum and chemical products, liquid gases).

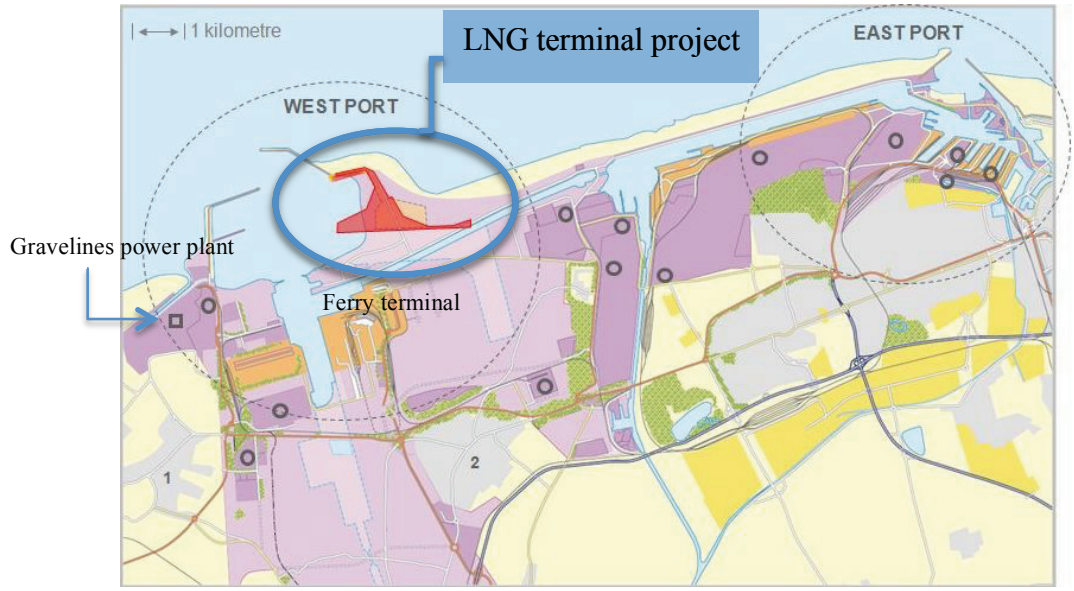

Figure 1

The port of Dunkirk has committed to undertaking the work required for site preparation such as (i) dredging to allow docking and the construction of an LNG tanker unloading station, (ii) levelling of the 50 hectare site for the construction of onshore terminal facilities and (iii) maritime works to protect the site against coastal erosion. A 50-year period leasing convention was signed between Dunkerque LNG and the Port of Dunkirk to ensure its return on investment.

- Secondly, the presence of EDF as a well-established industry in the area for 40 years, operating the most powerful nuclear generation plant in Europe with 5,500 MW without any major incidents ensures, through its safety experience, the recognized long-standing economic, social, and environmental commitment to the wider society.
  This is the best guarantee for local communities that the project is developed sustainably and carefully and taking into account local development, environmental contraints and social concerns.

- The chosen design for the terminal complies with the most stringent safety rules for preventing the occurrence of major accidents:

  - ❖ Implementation of EN 1473 general recommendations (gives guidelines for the design, construction and operation of all onshore stationary liquefied natural gas installations) such as fire zones, blow down, control spillage systems,

  - ❖ Safety distances considered in plant lay-out for the mitigation of accident escalation,

  - ❖ Compliance of the design with the recent French regulations taken from the Seveso European Directive on hazards analysis and Dunkerque LNG HSE policy.

- This site also complies with land and marine safety requirements: indeed no industrial facilities or housing enclosed in the hazardous area, the closest site is about 1 km away from the terminal (the ferry terminal), the EDF nuclear power plant (Gravelines) is 5 km away from the terminal and the closest houses are 2.5 km away (Figures 1,2).

Figure 2

- Additionally, the Dunkerque LNG receiving terminal project was strongly supported by the local and regional authorities who decided to take advantage of this industrial project to support local development.
  In the fourth quarter of 2007, under French law, Dunkerque LNG organized public meetings during which constructive dialogue took place, leading to a broad consensus among local political and economic stakeholders in favour of the project.
  In mid April 2008 the "*Commission Nationale de Débat Public*" (national institution responsible for public discussion) published its final report. Of the 3 different public debates on LNG terminals in France held at the same time, this was the only report which explicitly mentioned the acceptability of the project: "The acceptability of an LNG port then looks strong".
  On 3 July 2008, after work on ways to guarantee the acceptability of the terminal, Dunkerque LNG announced that it would continue the project with a new layout sparing most biodiversity sensitive areas and preserving 80% of biodiversity issues (figure 3), and released development of a set of major accompanying and compensatory measures to be implemented:

  ❖ Social support measures

  Examples: Training through a partnership with the local Jobcentre, prospecting of workforce, accommodation for people working on the construction site, creation of a "Nature Centre", and improvement of leisure by creating a new water spot.

  ❖ Economic support measures

  Examples: Information meetings for possible contractors, R&D, Collaboration with Dunkirk University (Development of Inncold: R&D expertise relative to cryogenic technique association), workforce prospecting, promotion of the freezing capacity existing in the Terminal for neighbouring companies (cooling networks), etc.

  ❖ Environmental compensatory measures

  Examples: reconstruction of dune ecosystem, identification of preservation areas, creation of a new feeding area for migrating species, etc.

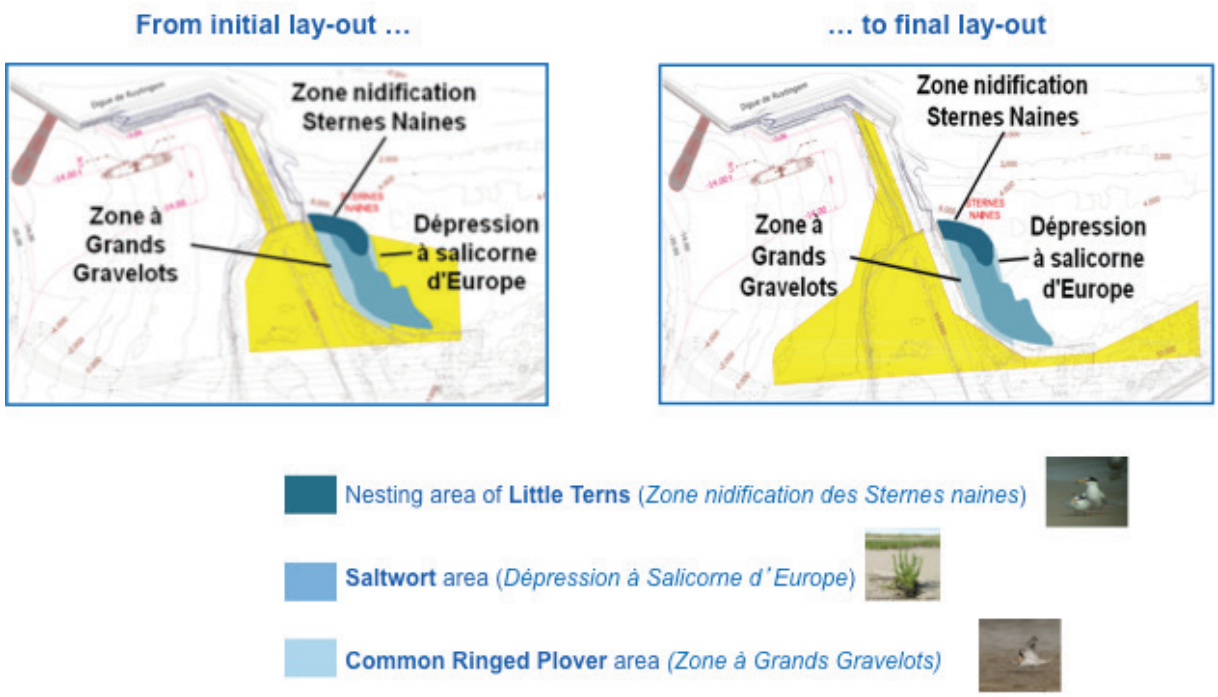

Figure 3

On this secure basis, Dunkerque LNG was more easily able to focus on the development of its commercial attractiveness.

III.2 Commercial attractiveness:

The specifics of Dunkirk make this port an ideal site for the development of an LNG terminal.
Indeed, the Clipon site, where the terminal is being constructed, is located on the sea front with short, direct access to the shipping lane (Figure 4):

- less than 30 minutes from port entrance to berth (+2½ hours from the Pilot Boarding Station including any high tide wait at beginning of operations),
- away from the main navigation channel (the berth is more than 700 m away from other ships using the port and therefore has little impact on the traffic),
- in case of emergency, vessels can leave the berth without tugs

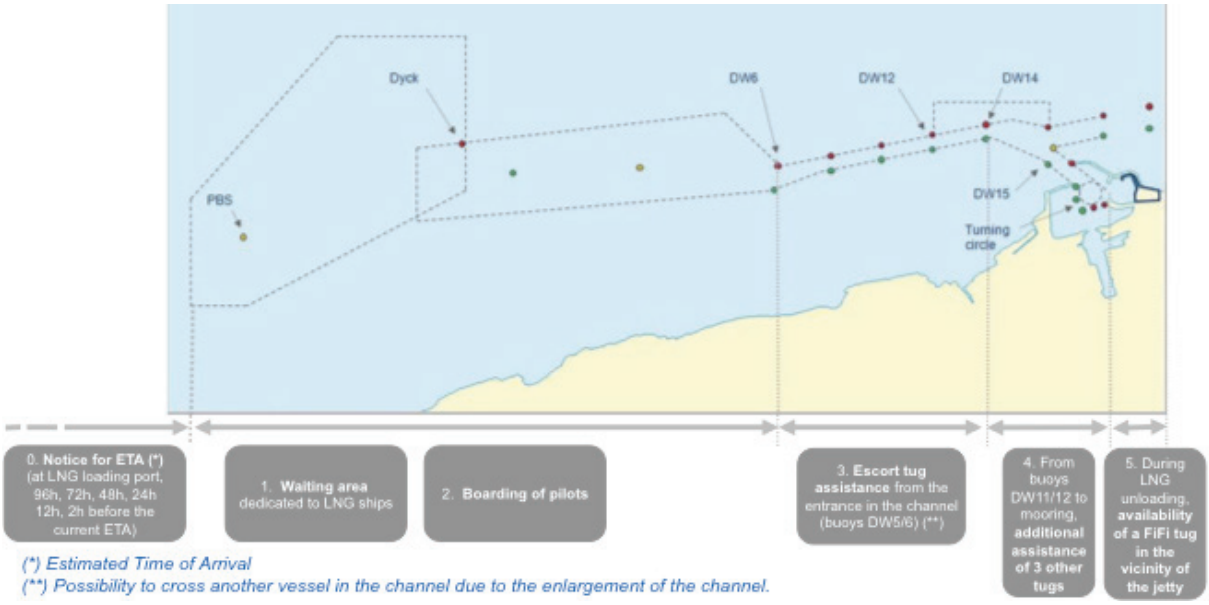

Figure 4

The Clipon site is capable of receiving up to Qmax vessels (267,000 m3) and constraints on vessel movements are compatible with efficient marine operations:

Wind:

- Limit: up to 25 knots for W/NW winds, up to 30 knots for other directions
- Annual restriction: 0.6% for wind faster than 30 knots (all directions)

Wave:

- Limit up to 2 meters
- Annual restriction: 3.3% (cumulative wave & wind)

Tide:

- Limit: no vessel movement around high tide (30 minutes) for vessels longer than 250 meters. This limit is likely to be removed as the pilots gain experience with LNG vessels

Fog:

- Limit: vessel movements prohibited if the visibility is less than 500 meters (or less than twice the length of the ship)

Night:

- No restriction, possibility of arriving 24 hours a day

Additionally, Dunkirk is a key crossing point for LNG exchanges in the Atlantic basin (figure 5).

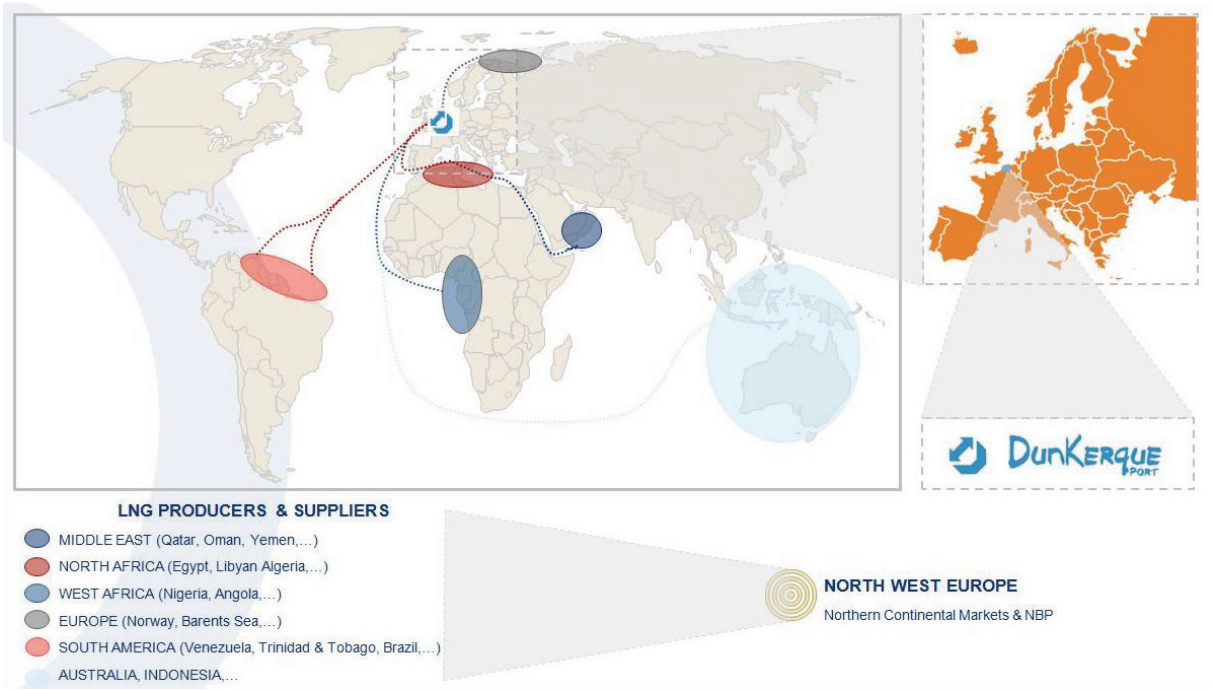

Figure 5

Lying on a main north-west European pipeline junction, Dunkerque LNG regasification terminal offers the best potential supply. Due to the direct connections to two major markets, France and Belgium, Dunkerque LNG terminal will make it possible to offer a new LNG gate for supplying gas to the whole of north-west Europe (France, Belgium, Germany, Luxembourg, the Netherlands).

That is why Dunkerque LNG is promoting the connection of the terminal to France but also the more complex connection to Belgium.

This second ambition was shared and supported by both French and Belgian Regulators and public gas transport operators GRTgaz and Fluxys. For the first time in France, GRTgaz would be able to export both non-odorised gas out of France and odorised gas to PEG Nord from the terminal (France is the only European country where gas is odorised from the interconnection points) (figure 6).

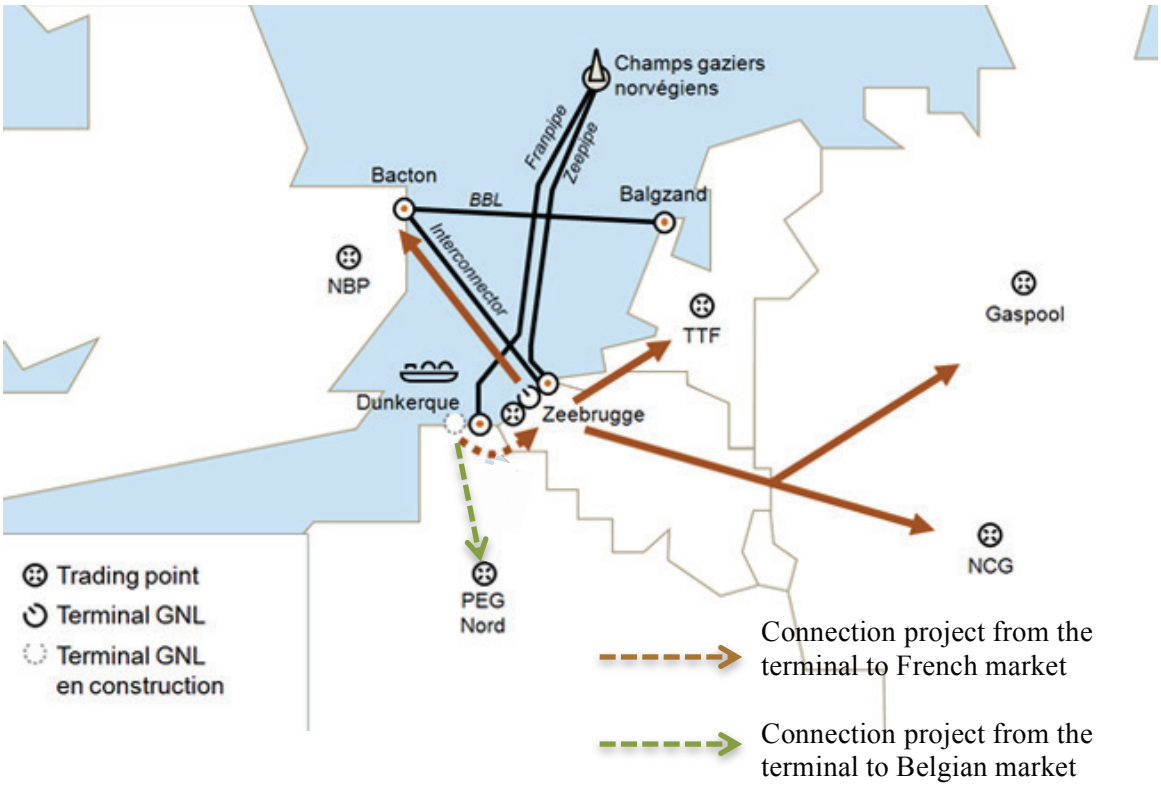

Figure 6

Thus Dunkirk terminal contributes to the dynamic integration of the European gas market:

- Entry of new gas suppliers on the wholesale markets, a factor in the development of competition (attractiveness)
- Creation of firm capacity between France and Belgium at marginal cost (opportunity later to use this ability in the direction Belgium to France)
- Possibility of entering into supply contracts other than historical contracts
- Laying a non-odorize gas pipeline from the terminal to the Fluxys network.

With zero CO_2 emissions and zero gas use, Dunkerque LNG is definitively an environment-friendly industrial infrastructure.
Indeed the heat needed to vaporize the gas will be provided by warm water from the nearly nuclear power plant. Gravelines nuclear power plant is a safe source of warm supply, indeed:

- 6 reactors, with a total power of 5,460 MW,
- The warm water represents about 5% of total send-out of warm water – 10 to 15m3/s),
- Each reactor unit will be able to supply all the water required for the re-gasification process, thereby ensuring considerable redundancy.

This technical solution has positive environmental and financial impacts:

- Reduction of the environmental impact of both the power plant (less warm water discharged into the sea) and the terminal (no CO2 emission, no submerged-combustion vaporizers saving 50,000 to 100,000 tons per annum),
- Open Rack Vaporisers instead of Submerged Combustion Vaporisers,
- No service gas except for flare spark (energy saving).

In addition, the terminal is designed to re-incorporate boil-off gas without needing to burn gas in a flare.

Competing with other operating terminals in Europe, which intend to develop extensions with certainty at a marginal and lower cost than the Greenfield Dunkerque LNG project, Dunkerque LNG needs crucially to be able to design and freely propose its own service. This would not be possible if the investment did not take place unless a third party access (TPA) exemption was granted. Thus after negotiations with the Regulatory Commission of Energy (CRE) and the European Commission, it was demonstrated and then agreed that the project would not be detrimental to competition or the effective functioning of the internal gas market, or the efficient functioning of the regulated system to which the infrastructure is connected: Dunkerque LNG terminal project enhances competition in gas supply and enhances security of supply in Europe.
Dunkerque LNG was then granted the benefit of a 20-year period exemption from regulated third party access and tariff regulation.

Lastly, in 2009 Dunkerque LNG offered the market an innovative, competitive 20-year period ship-or-pay flexible multi-user service to interested parties (including EDF).
This service offers firm, independent rights to customers of the terminal (berthing slots, capacity, send-out rates range). Due to the wide range of emission rates offered combined with a huge LNG storage capacity (570,000 m^3), the customers of the terminal will benefit from huge downstream and upstream flexibility, enabling them to optimize the supply portfolio on all world markets and to capture price changes in short-term markets in north-west Europe (figure 7).

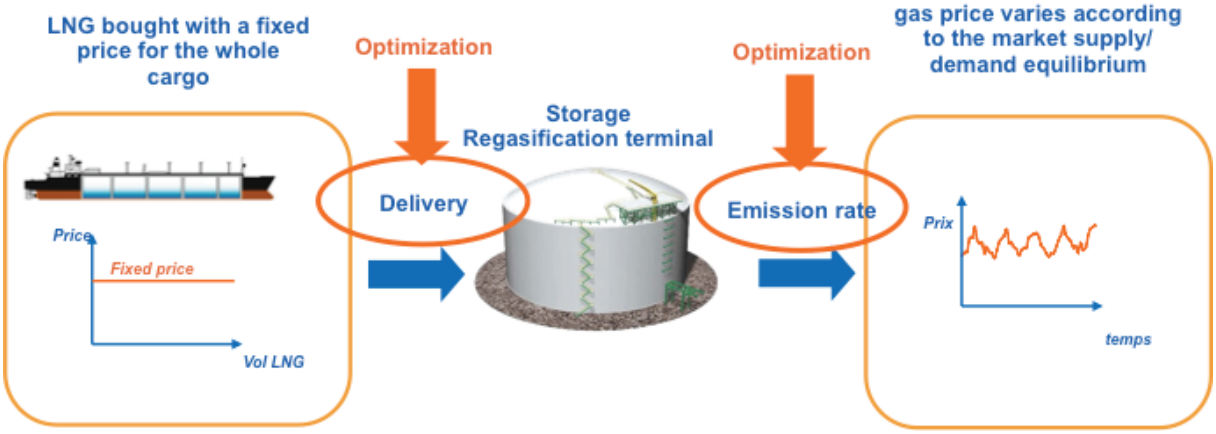

Figure 7

III.3 Challenging industrial strategy:

To achieve the strategic and commercial bases of the development of this new north west european LNG regasification terminal, and respond to present and forecast market appetite for the capacity, the terminal has been designed with a yearly throughput capacity of 13 Bcm, an LNG storage capacity of 570,000 m^3 (3 full 190,000 m^3 containment tanks), 1 berth and a huge range of emission rates (figure 8).

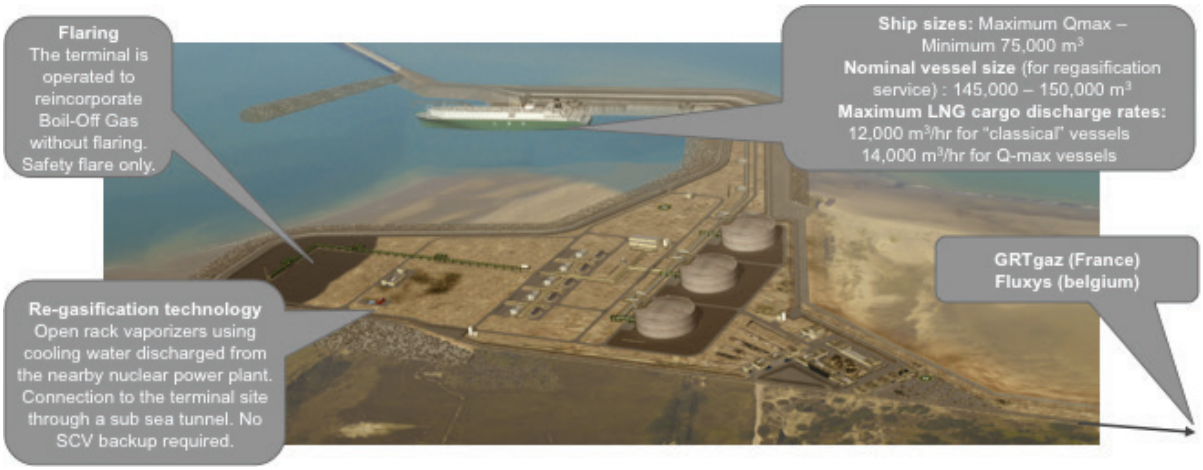

Figure 8

To undertake construction of the LNG terminal at a competitive price, a strategic choice has been made: split the contruction in 3 main tenders for EPC contracts, in order to ensure full competition for the three different kinds of works necessary of the terminal erection : tanks erection, process engineering and erection, and tunnel boring. Marine works (jetty) have not been separated from process, due to the importanct interfaces beween jetty and GNL pipes and arms.

In parallel the Engineering Department of EDF was chosen as the owners'engineer, to make sure of a proper and powerfull management of interfaces.

Following a European tender, work has been awarded to 3 EPC international skilled consortiums:

- Bessac-Razel-Soletanche will build the 5 km tunnel from the nuclear power station,
- Bouygues-Entrepose Project will build the 3 liquefied natural gas reservoirs,
- Techint-Sener LNG will be responsible for the unloading installations and the industrial processes linked to the re-gasification of LNG.

In addition, DKLNG has teamed with Fluxys, LNG receiving terminal and transmission network operator in Belgium through a long term partnership with its affiliate Fluxys G, which has materialized by implementing a JV in charge of start-up and operations of the LNG terminal (figure 9).
Thus Dunkerque LNG will benefit from 30 year terminal Fluxys experience.

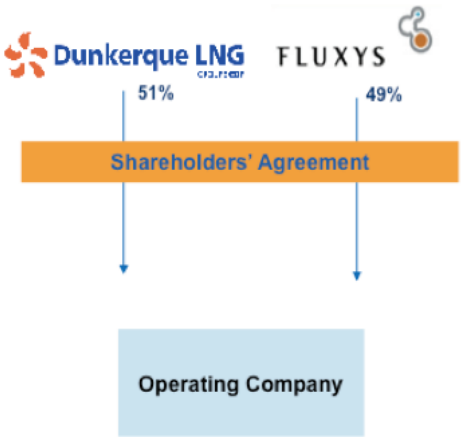

Figure 9

Results: The 13 bcma re-gasification terminal FID approved on 27 June 2011 for a start-up expected in November 2015

On the one hand, long-term commercial regasification agreements were signed by EDF and Total on 24 June 2011, bringing the total booked capacity up to 10 bcma for a twenty-year period.

On the other hand, on the same date Total and Fluxys G entered alongside EDF in Dunkerque LNG by acquiring 9.99% and 25% of the shares respectively.

Due to this fine, distinguished consortium of industrial partners, the Final Investment Decision was approved at the end of June 2011 on the basis of a 10 bcma sold capacity out of 13 bcma, shareholders taking the risk to market 3 bcma regasification capacity later.

The same date also saw the creation of the Joint Venture in charge of start-up and operations of Dunkirk LNG terminal between Dunkerque LNG and Fluxys.
6 months later, at the end of December 2011, GRTGaz, the French gas transmission systems operator, formally approved the investment for connecting the Terminal to the French grid. It will lay a 170 km pipeline from Northern France to the Paris area.
In May 2012, French and Belgium gas transmission systems operators GRTgas and Fluxys, will decide on the construction of the connection to Belgium. In order to make the proposed capacity available GRTgaz plans to lay a 26 km pipeline to the French-Belgian border. Fluxys, in turn, envisages building a 72 km pipeline from the border to the Zeebrugge area.
The facilities connecting French and Belgian markets are expected to come on stream at the end of 2015.

Summary: key factors in deciding a 1 billion euro re-gasification terminal in Europe

The location of the LNG receiving terminal in Dunkirk strongly connected to French and Belgian gas networks is ideal to serve as a **foundation and anchoring point for supplying north-western Europe**. The project is a **major strand in reinforcing European gas security of supply,** with no CO_2 emissions and a low environmental impact, **this new infrastructure will contribute to sustaining the future low carbon growth of Europe**. The 20-year 100% exemption together with a challenging EPC contractual strategy allow the terminal to provide **a competitive tariff** that is comparable with other terminals in France and Northwest Europe. The **innovative multi-users service** offers huge upstream and downstream flexibility that makes it possible to seize market opportunities and **meet growing demand in downstream flexibility** due to the expected increase of gas-fuelled power plant production.
By deciding to invest 1 billion euros now, EDF and its two industrial partners Total and Fluxys G will have a rare and powerful industrial tool.
Nevertheless, following the construction, the next challenge remains selling the 3 bcma available capacity and starting commercial operations in 2015, after 4 years' work or 6 million working hours!