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Implementation of fuel stations

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Executive Summary

The LNG Blue Corridors project's aim is to establish LNG as a real alternative for medium- and long-distance transport—first as a complementary fuel and later as an adequate substitute for diesel. For this aim the project contains a demonstration part with funding for part of the extra investment cost for the truck and funding for a share of the investment of filling stations. This deliverable gives a status on the implementation of the work with the filling stations.

The original plan was 14 stations along Europe. After some changes on locations and responsible companies, 12 stations are now in operation and 1 under construction. Some of the stations have been late in relation to the original plan, partly due to the fact that there were fewer trucks available then expected at the time of the application of the project, and the trucks available are not perfectly suitable for long distances.

Final stations in LNG Blue Corridors	Country	Location (city)	Company	Status
	Belgium	Antwerp	DRIVE	Open
	France	Nimes	GNVERT	Open
	France	Rungis	GNVERT	Open
	France	Lyon	GNVERT	Open
	Germany	Berlin	LIQVIS	Open
	Italy	Piacenza	ENI	Open
	Italy	Pontedera	ENI	Open
	Portugal	Carregado	DOUROGAS	Open
	Portugal	Elvas	DOUROGAS	Open
	Portugal	Sines	GALP	Under construction
	Portugal	Matosinhos	GALP	Open
	Spain	Barcelona	GAS NATURAL FENOSA	Open
	Sweden	Örebro	AGA	Open

Several of the technical specifications of the stations are the same or similar. All stations except the semi-mobile station in Nimes and the temporary station in Berlin are LNG/LCNG stations. The most

common storage volume for the LNG tank is 60 m^3, but they vary between 10 and 100 m^3. Most of the stations are equipped with a cryogenic pump. The nozzle used for the connection between the tank and the truck to be filled are the same for almost all stations in the project. The price of the station varies from 700.000 € to 1.800.000 €.

None of the companies offers a biomethane share in the LNG so far. All companies (that answered these questions) state that they have constructed the station in a way that minimizes the LNG boil off. All use a LNG boil off recovery technique except the Aga station in Örebro, Sweden, that uses a LIN cooling technique in order to minimize the boil off, and the Berlin station where boil off will not be an issue due to enough guaranteed withdrawal per day and therefore frequent refilling's of cold LNG.

On all stations it is possible to pay by credit cards. Several also provide their own company card (proprietary card). The information on the station regarding the filling is mostly given only in the language where the station is located, except for Drive (Belgium) and DOUROGAS (Portugal) where the information also is available in English.

This report also refers to other deliverables in the LNG Blue Corridors where there are, or will be, more specific reports regarding the discussed issue.

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1 Introduction

1.1 LNG Blue Corridors project

The LNG Blue Corridors project's aim is to establish LNG as a real alternative for medium- and long-distance transport—first as a complementary fuel and later as an adequate substitute for diesel. Up to now the common use of gas as fuel has been for heavy vehicles running on natural gas (NG) only for municipal use, such as urban buses and garbage collection trucks. In both types of application, engine performance and autonomy are good with present technologies, as they are well adapted to this alternative cleaner fuel.

However, analyzing the consumption data, the equivalence in autonomy of 1 liter of diesel oil is 5 liters of CNG (Compressed Natural Gas), compressed to 200 bar. Five times more volume of fuel prevents the use of CNG in heavy road transport, because its volume and weight would be too great for a long-distance truck. This opens the way for LNG (Liquefied Natural Gas), which is the way natural gas is transported by ship to any point of the globe. NG liquefies at 162º C below zero, and the cost in energy is only 5% of the original gas. This state of NG gives LNG the advantage of very high energy content. Only 1.8 liters of LNG are needed to meet the equivalent autonomy of using 1 liter of diesel oil. A 40-ton road tractor in Europe needs a tank of 400 to 500 liters for a 1.000 km trip; its equivalent volume with liquid gas would be 700 to 900 liters of LNG, a tank dimension that could easily be fitted to the side of the truck chassis. LNG therefore opens the way to the use of NG for medium- and long-distance road transport.

LNG has huge potential for contributing to achieving Europe's policy objectives, such as the Commission's targets for greenhouse gas reduction, air quality targets, while at the same time reducing dependency on crude oil and guaranteeing supply security. Natural gas heavy-duty vehicles already comply with Euro V emission standards and have enormous potential to reach future Euro VI emission standards, some without complex exhaust gas after-treatment technologies, which have increased procurement and maintenance costs.

Figure 1-1. Impression of the LNG Blue Corridors

To meet the objectives, a series of LNG refueling points have been defined along the four corridors covering the Atlantic area (green line), the Mediterranean region (red line) and connecting Europe's South with the North (blue line) and its West and East (yellow line) accordingly. In order to implement a sustainable transport network for Europe, the project has set the goal to build approximately 14 new LNG stations, both permanent and mobile, on critical locations along the Blue Corridors whilst building up a fleet of approximately 100 Heavy-Duty Vehicles powered by LNG.

This European project is financed by the Seventh Framework Programme (FP7), with the amount of 7.96 M€ (total investments amounting to 14.33 M€), involving 27 partners from 11 countries.

This document corresponds to the 13th deliverable within work package 3. It is a document describing the implementation of the filling stations. This document will be available at the project website: http://www.lngbluecorridors.eu/

1.2 Aim of this deliverable

One of the purposes of the EU-funded project LNG Blue Corridors was to start a market introduction of trucks running on liquefied natural gas, LNG. This part of the project included funding for part of the extra investment cost for the truck and funding for a share of the investment of filling stations. This deliverable gives a status on the implementation of the work with the filling stations.

On the map below it is depicted where all 13 stations will be deployed:

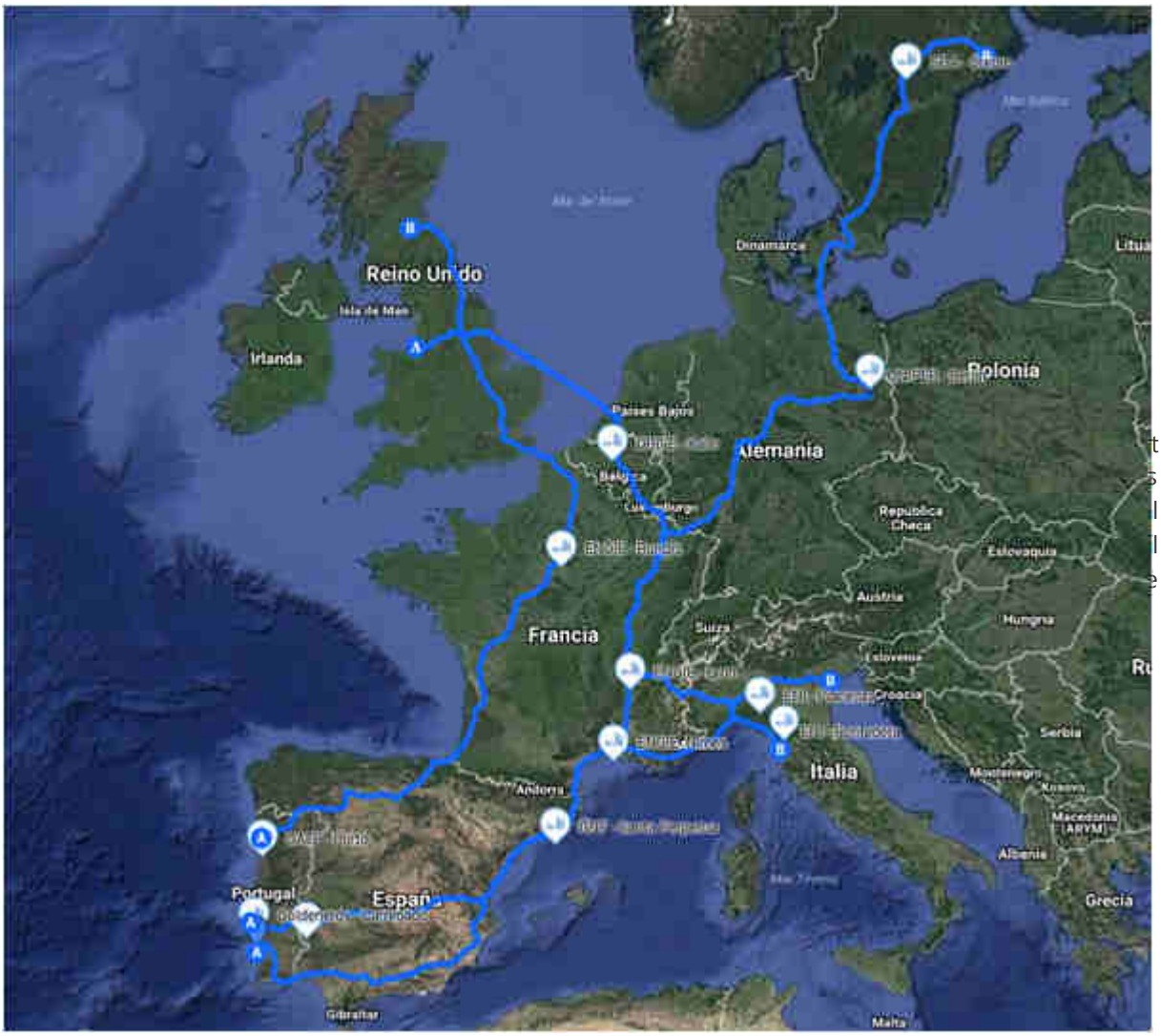

Figure 1-2 The four corridors in LNG Blue Corridors

Figure 1-3 The DOUROGAS filling station in Corregado, Portugal

2 Data collection methodology

The information of the fuel stations, or filling stations, has been gathered for this deliverable and for deliverables in work package 5, Demonstration, in co-operation.

The two questionnaires used to gather information are found in Annex 1.

The questionnaires were sent to all partners with a responsibility to build a station with funding from LNG Blue Corridors. There are several more partners in the project who owns and/or operates LNG filling stations, but those stations are not investigated in this report.

The response from the partners was good, all partners answered the questionnaires. However, some partners did not answer all questions in the questionnaires since it could contain sensitive information. Two areas are specifically worth mentioning were the response is a little scarce: first, when a partner is going to build more than one station, the information regarding the second stations is in most case a little less detailed. Second, issues related to stations under construction or at early operative stages whose results were not provided.

From the questionnaires, the data is presented on an aggregated level. First, as mentioned earlier, as a short description of every station with a map showing the location. And later in areas believed to be of interest for a public report.

The collected data related to safety is handled by deliverable 3.12 Security and Safety implementation and all issues regarding regulation and standardization is handled by WP 4.

3 The filling stations in LNG Blue Corridors

In the application to the EU Commission, 14 stations was originally included and allocated along four corridors.

The stations where allocated to specific companies and a preliminary location was set in most cases. During the first two years of the project there has been changes to the original allocations. BOC Linde in UK early stated that their interest in building a filling station had decreased and their funding was very early allocated to another partner and instead built in Belgium, after necessary decisions within the project and after necessary changes in the agreement with the EU Commission. The funding for the station in Sines, Portugal was changed. Two partners of the project showed interest in this funding, so it was agreed to be divided into two halves, one half funding a station in Sines for another company, Galp, and one half funding for a station in Elvas, Portugal.

Two countries with no existing infrastructure of filling stations, Slovenia and Germany, did extensive market investigations. ENOS, the Slovenian representative, had to conclude that the timing was not right since the planned filling station would be too isolated to give the trucking companies the security of supply they need. Therefore this funding was reallocated. It was transformed into funding for more trucks. On the other hand, after some discussions, the German station was finally built just outside Berlin by the company LIQVIS.

Finally, 13 facilities will be built for project purposes.

Figure 3-1 Johan Weimenhög, Aga, Lennart Pilskog NGVA and Maria Malmkvist, Swedish Gas Association at the inauguration of Agas filling station in Örebro, 2014.

The changes during the project can be followed in the table below.

Table 3-1 Changes in station funding and location during the first two years of the project

Original location	Original company	Moved to: (new location)	New company	Comments
UK	BOC Linde Group →	Reallocated to budget for trucks		Reallocated to budget for trucks
Sines, Portugal	CLOUD →	Sines, Portugal	GALP	50 % of the original Sines funding
	↘	Elvas, Portugal	DOUROGAS	50 % of the original Sines funding
Piacenza, Italy	ENI			
Pontedera, Italy	ENI			
Antwerp, Belgium	DRIVE			
Berlin, Germany	ERDGAS	Berlin	LIQVIS	
Matosinhos, Portugal	GALP			
Corregado, Portugal	DOUROGAS			
Jesenice, Slovenia	ENOS LNG →	Reallocated to budget for trucks		
Malaga, Spain	GNF →	Barcelona, Spain		
Nimes, France	GNVERT			
Le Mans, France	GNVERT →	Rungis, France		
Lyon, France	GNVERT			
Örebro, Sweden	AGA			

The final filling stations in the LNG Blue Corridors project are listed in the table below and each of the stations is described in the chapters 4.1 to 4.13, from the north to the south.

Table 3-2 Final stations in LNG Blue Corridors in October2015

Final stations in LNG Blue Corridors	Country	Location (city)	Company
	Belgium	Antwerp	DRIVE
	France	Nimes	GNVERT
	France	Rungis	GNVERT
	France	Lyon	GNVERT
	Germany	Berlin	LIQVIS
	Italy	Piacenza	ENI
	Italy	Pontedera	ENI
	Portugal	Carregado	DOUROGAS
	Portugal	Elvas	DOUROGAS
	Portugal	Sines	GALP
	Portugal	Matosinhos	GALP
	Spain	Barcelona	GAS NATURAL FENOSA
	Sweden	Örebro	AGA

The stations were finally allocated to the corridors as follows (see also Figure 1.2 and the project website http://lngbc.eu/).

South-North corridor
SoNor Blue – stretching from Sweden in the north through Germany, Belgium, France, Spain to Portugal
LNG BC stations – Örebro (Sweden), Berlin (Germany), Lyon (France), Nimes (France), Barcelona (Spain), Elvas and Carregado (Portugal)

Mediterranean corridor
MED Blue – From the south west of Portugal following the coast to Italy
LNG BC stations – Sines (Portugal), Barcelona (Spain), Nimes (France) and Piacenza (Italy)

Atlantic corridor
Atl Blue – From the north of Portugal through Spain, France, Belgium and over to United Kingdom
LNG BC stations – Porto (Portugal), Rungis (France), Antwerp (Belgium)

West-East corridor
WE Blue – From United Kingdom over France to Italy
LNG BC stations – Rungis (France), Lyon (France) and Pontedera (Italy)

3.1 Örebro, Sweden

3.1.1 A short description

The filling station in Örebro, Sweden is built and operated by Aga, a member of the Linde Group. Aga is the leading company in Sweden on industrial gases and has a long experience in working with gas as a transport fuel. Aga has two LNG filling stations before, one located in Stockholm (Älvsjö) and one south of Stockholm (Järna) along highway E4.

Figure 3-2 The AGA filling station in Örebro

The LNG filling station in Örebro is located at a Circle K filling station offering other liquid fuels such as diesel and petrol. The filling station is a LNG and an L-CNG station, offering both LNG and CNG. It is possible to pay with credit cards and Circle K card.

The station does not require an operator on site to do the filling.

In order to minimize boil off the Örebro station, as the only one of the project stations, uses LIN cooling. This technique has generally been working with very good result. In the case that the LIN cooling would stop working for some reason there is still possible to fill CNG and thereby reduce the pressure and in worse case there is a cold torch for gas release through safety vents.

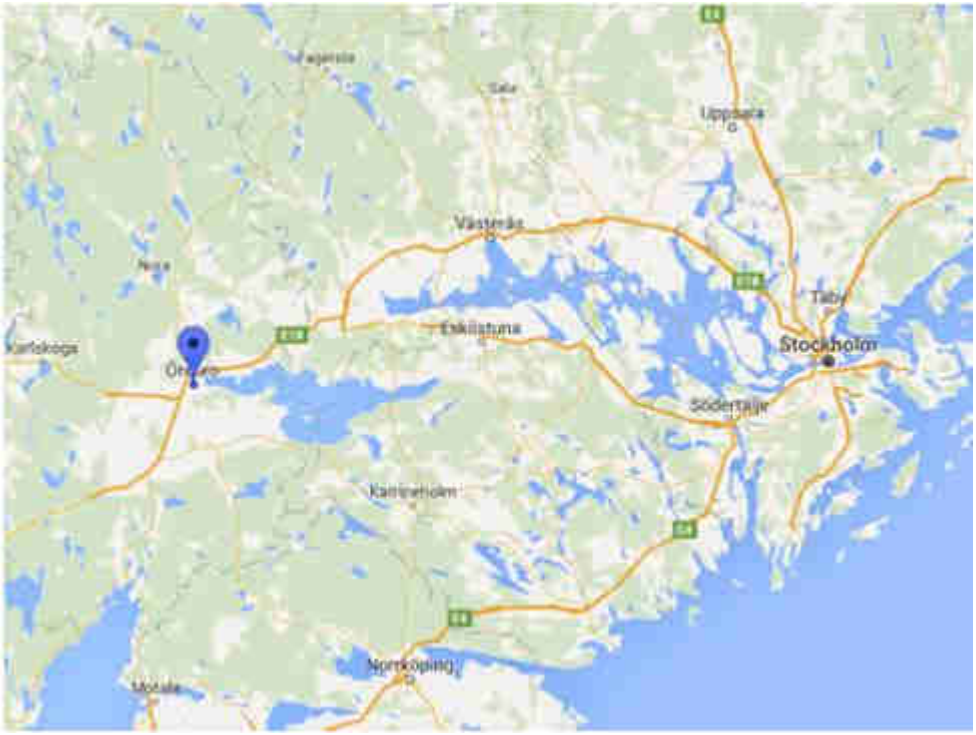

Figure 3-3 Map showing the location for the filling station in Örebro, Sweden

The filling station in Örebro is located near highway E20 and E18.

The filling station has been in operation since 2014.

3.2 Antwerp, Belgium

3.2.1 A short description

Figure 3-4 The DRIVE filling station in Antwerp.

The filling station in Antwerp, Belgium is built and operated by DRIVE, a company providing gas to vehicles in Belgium including CNG, LPG and LNG.

Redarding the payment method Total, DKV, UTA, Romac Fuel Card, Visa, Mastercard o Maestro cards are accepted. Enabling key is needed to refuel. This is given when signing a contract with the company and thereby assuring that the drivers are trained.

The LNG filling station in Antwerp is located in the port of Antwerp

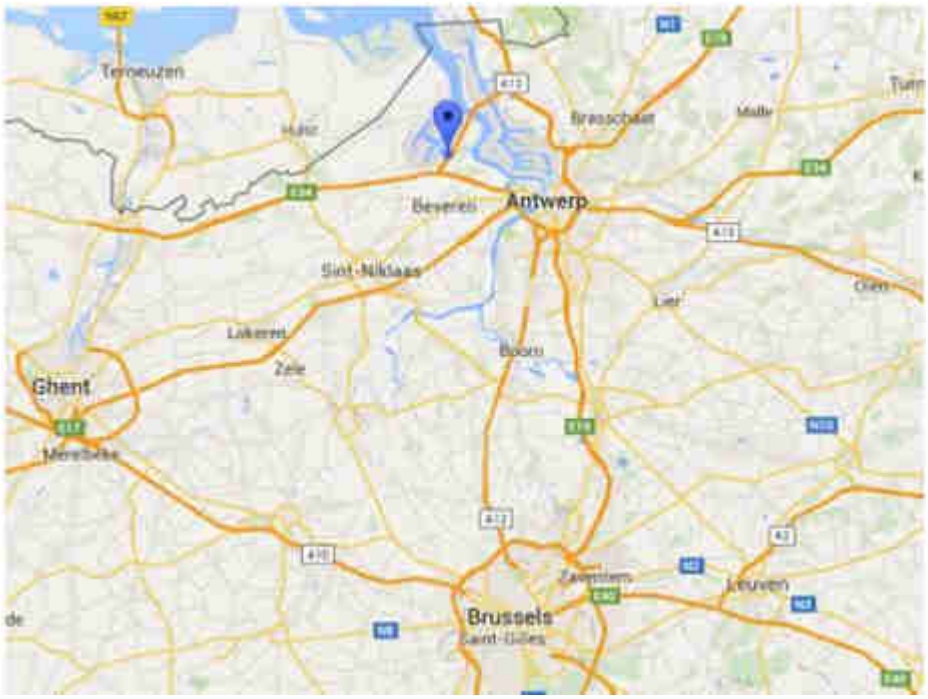

Figure 3-5 Map showing the location for the filling station in Antwerp, Belgium

The filling station is a LNG and an L-CNG station, offering both LNG and CNG. It is possible to pay with credit cards and several other cards. The filling stations do not offer any other fuels. The LNG filling station does not require an operator on site to do the filling.

The filling station has been in operation since 2014.

The filling station in the port of Antwerp has one dispenser for LNG filling, a cryogenic pump and a dispensing pressure at 8 bars.

In order to avoid emissions from boil off the boil off gas from the Antwerp station is injected to the gas grid of the next door company.

3.3 Berlin, Germany

3.3.1 A short description

After several discussions and negotiations with companies and fleet operators willing to invest in Germany, the LNG BC project finally have a LNG station in Berlin. The station is operated by LIQVIS and it is situated at Ludwig Meyer GmbH & Co in the area of Grünheide Freienbrink. It is a temporary mobile LNG station that has been in operation for the project since February 2017 and will stay operation for up to 12 months. In the second phase it is planned to install a permanent LNG fuelling station with a modular system on a plot in the same area. The capacity of the permanent station will be up to 30T.

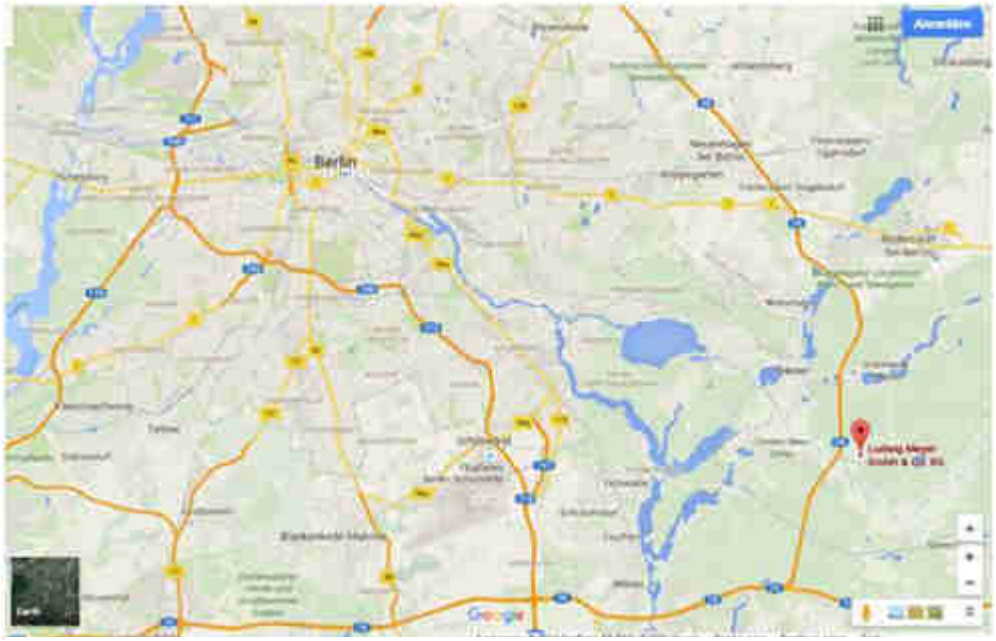

Figure 3-6 Map showing the location for the filling station in Berlin, Germany

At the temporary station in Berlin there are no boil-off recovery systems since boil off is no issue due to enough guaranteed withdrawal per day and therefore frequent refilling's of cold LNG. The only equipment to reduce BOG is an external HEX for saturating the LNG from the storage tank to the required 7-8 bar for IVECO and SCANIA trucks.

3.4 Nimes, France

3.4.1 A short description

The filling station in Nimes, France is built and operated by GNVERT, a company owned by Engie, former GDF Suez. GNVERT is responsible for the market of transportation fuels within Engie, and has a large number of CNG filling stations.

The LNG filling station in Nimes will start as a semi-mobile station providing only LNG and then a more permanent LNG and L-CNG station providing both LNG and CNG.

Figure 3-7 The semi-mobile filling station in Nimes, France

The French facilities (especially Lyon and Nimes) play a significant role within this corridor. The current distance between LNG stations, are in most cases, difficult to be covered by LNG trucks, assuming autonomy of 800 km on average. Thanks to both stations, it will be easier to cross France by driving a LNG truck to get to both the north part of France and Italy.

There is no other fuel offered at the filling station. It is possible to pay with credit cards or a special badge. An appointment before refueling is needed.

The semi-mobile filling station is in operation since mid-2016.

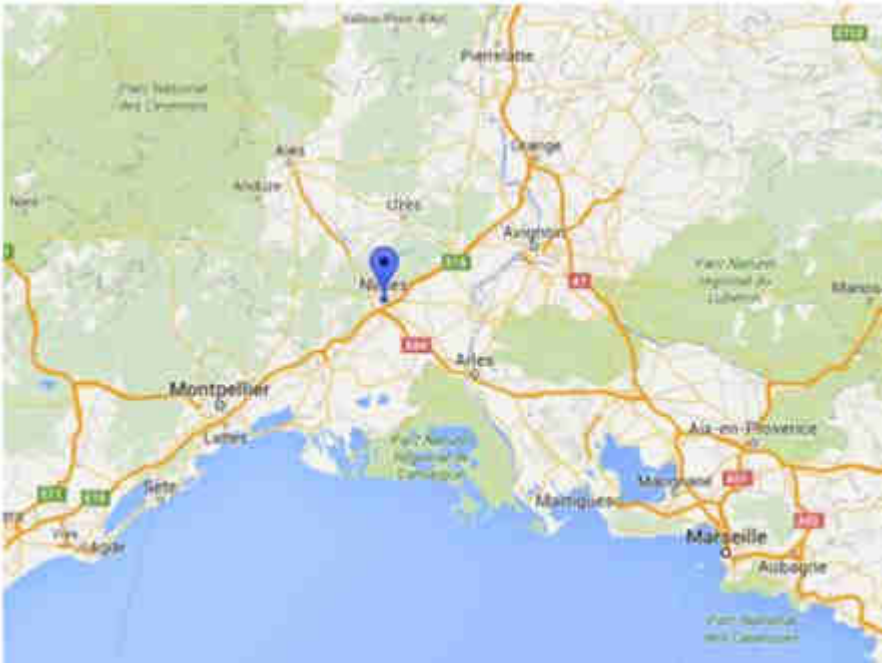

Figure 3-8 Map showing the approximate location for the filling station in Nimes, France.

The permanent filling station in Nimes will have a cryogenic pump and will have a stated dispenser pressure on 8 bars.

In most of the cases, there are a buffer to recover boil-off gas both from the tank and the trucks. There is also a CNG compressor to recover BOG in the CNG dispensing. When a truck needs to vent its tank (< 10% of refueling), the BOG is recovered directly in the CNG part and thereby it is avoided to have the warm gas flowing back into the LNG tank. BOG recovery from the tank does not happen in normal situations. When the station is running well, there is no need to recover BOG from the tank because there are enough offloading operations to decrease the pressure regularly.

3.5 Rungis, France

3.5.1 A short description

The filling station in Rungis, France is built and operated by GNVERT, a company owned by Engie, former GDF Suez. GNVERT is responsible for the market of transportation fuels within Engie, and has a large number of CNG filling stations.

Figure 3-9 The filling station in Rungis, France

The Rungis station is located relatively close to the main leaving highway of the city, namely the A.6. In turn, there are many important roads that surround Paris that are really close to the station. The Rungis area is a well-known logistic location frequented by trucks and is a crossing point for those who transport goods to the south.

There is no other fuel offered at the filling station but there is a filling station for petrol and diesel located nearby. The filling station is a LNG and L-CNG station, offering both LNG and CNG. The LNG filling station does not require an operator on site to do the filling.

It is possible to pay with credit cards or a special badge. The filling station is in operation since mid-2015.

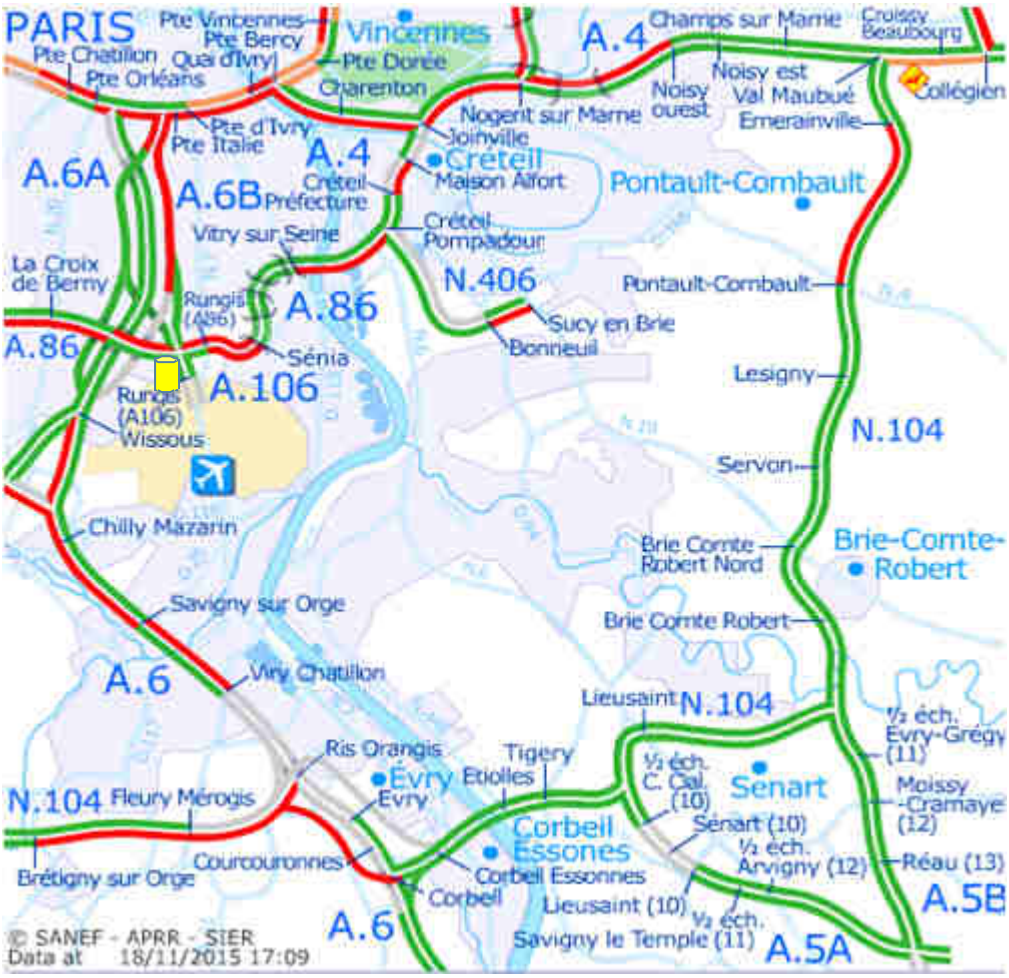

Figure 3-10 Map showing the approximate location for the filling station in Rungis, France.

The roads marked in red and green correspond to the high and medium rate of vehicles per road, respectively. The station is marked by a yellow dot.

The filling station in Rungis has a cryogenic pump and has a stated dispenser pressure on 8 bars.

In most of the cases, there are a buffer to recover boil-off gas both from the tank and the trucks. There is also a CNG compressor to recover BOG in the CNG dispensing. When a truck needs to vent its tank (< 10% of refueling), the BOG is recovered directly in the CNG part and thereby it is avoided to have the warm gas back into the LNG tank. BOG recovery from the tank does not happen in normal situations. When the station is running well, there is no need to recover BOG from the tank because there are enough off-loading operations to decrease the pressure regularly.

3.6 Lyon, France

3.6.1 A short description

The filling station in Lyon, France is built and operated by GNVERT, a company owned by Engie, former GDF Suez. GNVERT is responsible for the market of transportation fuels within Engie, and has a large number of CNG filling stations.

The LNG filling station is located in Lyon a part of Lyon, close to highway E15.

Figure 3-11 Map showing the approximate location for the filling station in Mions, France.

There is no other fuel offered at the filling station. The filling station is a LNG and L-CNG station, offering both LNG and CNG. The LNG filling station does not require an operator on site to do the filling.

It is possible to pay with credit cards or a special badge. The filling station is in operation since late 2015.

The filling station in Lyon will not have a cryogenic pump and will have a stated dispenser pressure on 8 bars.

In most of the cases, there are a buffer to recover boil-off gas both from the tank and the trucks. There is also a CNG compressor to recover BOG in the CNG dispensing. When a truck needs to vent its tank (< 10% of refueling), the BOG is recovered directly in the CNG part and thereby it is avoided to have the warm gas back into the LNG tank. BOG recovery from the tank does not happen in normal situations. When the station is running well, there is no need to recover BOG from the tank because there are enough off-loading operations to decrease the pressure regularly.

3.7 Barcelona, Spain

3.7.1 A short description

The filling station located north of Barcelona is built by Gas Natural Fenosa and operated by the company Transportes Mariné. Gas Natural Fenosa is a multinational energy services group whose activities include generation, supplying, distributing, commercialization of natural gas and electricity business, operating in more than 30 countries.

Figure 3-12 The GNF station north of Barcelona

Figure 3-13 Map showing the approximate location for the filling station – dot yellow - north of Barcelona, Spain

It is strategically well situated, close to highways which are passed by more than 100,000 vehicles daily on average, of which nearly 8 % are Heavy-Duty vehicles. It is also important to mention that the logistics factors when it is time to transport LNG are a quite important variable, mainly in terms of costs. In the Barcelona station case, its proximity to the LNG Terminal located in the Barcelona port (35 km away from the station), makes it be a really good region to build the facility.

The filling station is a LNG and a L-CNG station, offering both LNG and CNG. It is possible to pay with credit cards and Gas Natural Fenosa Card. The filling station also offers diesel. The LNG filling station does not require an operator on site to do the filling.
The filling station is in operation since December 2014.

The filling station north of Barcelona has one dispenser for LNG, a cryogenic pump and a dispensing pressure from 8 to 16 bar.

There is no specific protocol to avoid boil-off. All GNF stations always deliver CNG as well, so the BOG is stored and compressed for further use. The logistics is also managed carefully in order to minimize the LNG to be contained too much time inside the tank. Since the average frequency of the upcoming trucks is known, the stations storage tanks refillings are adjusted accordingly.

3.8 Piacenza, Italy

The filling station in Piacenza is built by Eni S.p.A and operated by the company Magic de Piccoli Marco E C. S.N.C. Eni is a global company working with oil and gas exploration, production and natural gas supply and sale.

The station is located at a motorway crossing point between the highway E70 between Lyon and Venice and A1 going down south through Italy. The location is also close to a site of a trucking partner.

Figure 3-14 Map showing the approximate location for the filling station in Piacenza, Italy

In the map above, the green lines represent those highways highly frequented; the blue lines mean a medium intensity of traffic.

As in the Spanish case, the LNG terminals' position plays a very important role when choosing the station location. The two LNG Italian facilities will be fed by the Barcelona and Fos Tonkin terminals.

The filling station is a LNG and an L-CNG station, offering both LNG and CNG. It is possible to pay with credit cards, fuel cards and cash. The filling station offers also other fuels; diesel and petrol.

The filling station has been in operation since 2014.

The filling station in Piacenza has one LNG dispenser and a cryogenic pump and a stated dispensing pressure varying from 8 to 18 bar (not adjustable).

In the case that the LNG at the storage tank level is becoming overly saturated, for example due to low turnover, the storage needs to be cooled down. Until 18 bar the station would not encounter venting from the storage tank but the maximum temperature threshold at storage tank level is around -120°C. When the temperature comes close to this limit the solution is cooling by mixing. A delivery truck loaded to about 50% will first pump saturated LNG from the station tank into the trailer and then pump the same quantity back into the station. This allows for efficient cooling without adding LNG stock into the station storage. This applies typically only in the very early startup phase of the station.

At high turnover stations there is absolutely no problem with the LNG getting to hot, to the contrary there is sometimes difficult to get above the -138°C required by the Iveco trucks.

3.9 Pontedera, Italy

3.9.1 A short description

The filling station in Piacenza is also built by Eni S.p.A. Eni is a global company working with oil and gas exploration, production and natural gas supply and sale.

Figure 3-15 Filling station in Pontedera, Italy

The station is located near a logistic center.

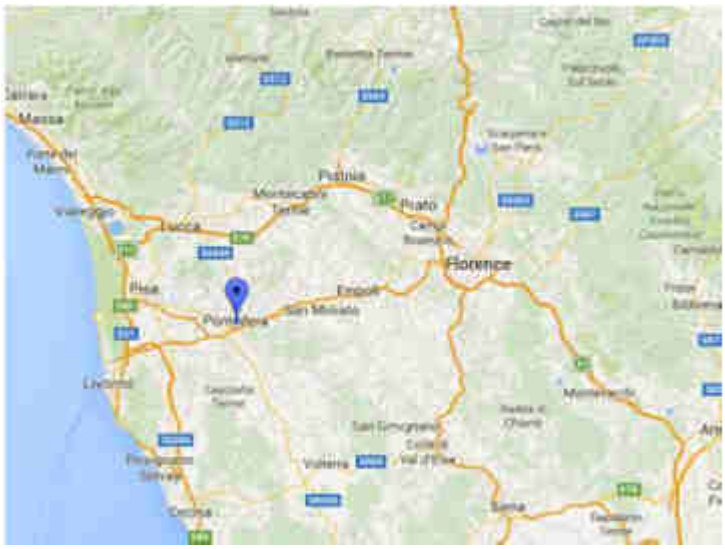

Figure 3-16 Map showing the approximate location for the filling station in Pontedera, Italy

The filling station is a LNG and an L-CNG station, offering both LNG and CNG. It is possible to pay with credit cards, fuel cards and cash. The filling stations offers also other fuels; diesel and petrol.

The LNG filling station does require an operator on site to do the filling and therefore has limited opening hours.

Regarding the payment method: BP Plus cards for clients, possibility to pay with Bancomat, Maestro, V Pay, American Express, Mastercard, Visa, DKV, other cards.

The filling station started to be operative in October 2016.

The filling station in Pontedera has one dispensers, operating without cryogenic pump and a stated dispensing pressure of 8 bar (variable).

In the case that the LNG at the storage tank level is becoming overly saturated, for example due to low turnover, the storage needs to be cooled down. Until 18 bar the station would not encounter venting from the storage tank but the maximum temperature threshold at storage tank level is around -120°C. When the temperature comes close to this limit the solution is cooling by mixing. A delivery truck loaded to about 50% will first pump saturated LNG from the station tank into the trailer and then pump the same quantity back into the station. This allows for efficient cooling without adding LNG stock into the station storage. This applies typically only in the very early startup phase of the station.

At Pontedera they try to do full trailer deliveries but it is close to the thermal limit. The next delivery is determined more by temperature than by stock, and stock is slowly increasing. At about a stable 600-800 kg/day for 6 out of 7 days of LNG sales the temperature balancing becomes easier.

3.10 Matosinhos, Portugal

3.10.1 A short description

The filling station in Matosinhos, Portugal is built and operated by Petrogal, Galp Energia. Galp Energia is a global company working with oil and gas exploration and production and natural gas transportation and distribution.

Figure 3-17 The station in Matosinhos, Portugal

The LNG filling station in Matosinhos is a LNG and L-CNG station, offering both LNG and CNG. The filling station is in operation.

The station in Matosinhos close to Porto is located at a motorway crossing and also close to sites of freight transporters. It is situated next to highway E81, close to highway E1.

Figure 3-18 Map showing the approximate location for the filling station in Matosinhos, Portugal

Boil-off is a problem in Matosinhos due to the fact that there are still low LNG consumption. The tank pressure had to be increased to 13 bar to avoid the venting. Other aspects that helps to prevent venting is that there is a regular and substantial consumption of CNG that uses the boil-off gas.

3.11 Sines, Portugal

3.11.1 A short description

The filling station in Sines, Portugal is built and by Petrogal, Galp Energia. Galp Energia is a global company working with oil and gas exploration, production and natural gas transportation and distribution.

The filling station in Sines is planned to be in operation in late 2017. The delay is due to the fact that the re-building of the station took more time then expected regarding the legal part, and the authorizations from the Sines Council..

The station in Sines is located at the service center of Sines at a motorway crossing and also close to sites of freight transporters.

Figure 3-19 Map showing the approximate location for the filling station in Sines, Portugal

The filling station is a LNG and L-CNG station, offering both LNG and CNG. The station will have boil off recovery and will be equipped with a BOG compressor.

3.12 Carregado, Portugal

3.12.1 A short description

The filling station in Corregado, Lisbon, Portugal is built and operated by DOUROGAS, a large Energy company working with electricity and natural gas.

This station, located in Carregado – Portugal, offers both LNG and L-CNG. It provides 1 LNG dispenser with 2 hoses (high and low pressure). So, the dispenser pressure is 13 bar for LNG (adjustable)

This particular filling station is active since August 2014 .

3-20 The Goldenergy filling station in Corregado, Portugal

The filling station is situated next to N1 and not far from the crossing of highway A10 and E1 in Carregado, north of Lisbon. Thereby, the station is close to the main routes used to enter and leave the country and close to the capital, Lisbon, and all the facilities needed. The fuel is paid by credit card or special DOUROGAS cards.

Figure 3-21 Map showing the approximate location for the filling station in Corregado, Portugal

The filling station is a LNG and L-CNG station, offering both LNG and CNG. It is stated to have a dispenser pressure on 13 bar.

The boil off that is generated goes to a boil-off tank. That tank is connected to a compressor which increases the pressure up to 250 bar and the gas is then injected to the CNG storage. If the station is used with regularity there is no gas release, but if not, after seven days there will be a release of methane to the atmosphere.

All the drivers have a coach session regarding safety procedures and good practices, independently of the number of drivers in each company.

3.13 Elvas. Portugal

3.13.1 A short description

The filling station in Elvas, Portugal is built and operated by DOUROGAS, a large Energy company working with electricity and natural gas.

Elvas is located east of Lisbon, close to the boarder to Spain, and the highway A6/E90 passes by Elvas. This way, the station has a strategic location, close to Spain and trucks' main routes.

Figure 3-22 Map showing the approximate location for the filling station in Elvas, Portugal

The filling station will be a LNG and an L-CNG station providing both LNG and CNG and is planned to be in operation in early 2016. The fuel is paid by credit card or special DOUROGAS Fuel cards.

The dispensing pressure of the station is stated to be 13 bar for LNG (adjustable).

The boil off that is generated goes to a boil-off tank. That tank is connected to a compressor which increases the pressure up to 250 bar and the gas is then injected to the CNG storage. If the station is used with regularity there is no gas release, but if not, after seven days there will be a release of methane to the atmosphere.

4 Location and facilities

This chapter concludes information from all stations regarding the subject location of filling stations and facilities on the station.

The stated reason for all partners in choosing the location of a filling station is the closeness to either a highway or a logistic center or trucking partner.

Other fuels are available at the same filling station in Örebro (Sweden), Piacenza and Pontedera (Italy) and Barcelona (Spain). The stations in France have no other fuel on the filling stations but there is no regulation that limits this possibility. The situation is different in Belgium and Portugal, where the partners states that there are limitations in the regulation, which prevents the possibility to provide more fuels than LNG on a filling station. On the sites of Eni and Galp the drivers are offered other facilities on the site, such as car wash or a shop or restaurant.

No other country than Italy requires an operator in site to assist in the filling procedure. They are also the only country with limitations in the opening hours.

Figure 4-1 Filling at Gas Natural Fenosa (GNF) station

All companies allow the usual credit cards for payment. Most of the companies offer their own fuel card as well. Half of them accept other companies fuel cards, but only company fuel cards from specific companies, for example the company providing the diesel on site. Only the stations in Italy accept cash payment.

The information on the stations is only in the language of the country except for Drive (Belgium) and DOUROGAS (Portugal) where there is also information available in English.

5 Environmental aspects - Venting prevention and bio methane share

This chapter concludes information from all stations regarding environmental aspects,

None of the partner companies has a biomethane share in their LNG at filling stations funded by this project at the time of writing this report. Two other partners within LNG Blue Corridors have a biomethane share, FordonsGas Sverige AB in Sweden and Gasrec in United Kingdom.

Another very important environmental aspect along the whole LNG chain is to keep the LNG as cold as possible to prevent boil off and possible venting of methane and when it occurs and then handle the boil off in a proper way.

Since LNG is very cold, approx. -140°C to -163°C, it is important to keep it cold. When warmed up the LNG is converted to gas (boil off) and the pressure increases in the systems. If not taken care of, this gaseous methane will be vented to the atmosphere for safety reasons. The tank is double walled with isolation of perlite in most cases. All partners (that answered this question) state that they have boil off recovery and that the L-CNG station is connected to the LNG boil off except at the Aga station in Örebro, Sweden and the LIQVIS station in Berlin, Germany. Aga is instead working with LIN-cooling (nitrogen) to keep down the temperature of the LNG and in that way prevent venting. At the Berlin station boil off will not be an issue due to enough guaranteed withdrawal per day and therefore frequent refilling's of cold LNG. The GNVERT semi-mobile station in Nimes does not have a boil off recovery but the permanent station in Nimes will have. The boiled off CNG is in most cases taken care of with a small compressor and sold as CNG.

Figure 5-1 Nozzle in the front and vent back hose in the rear. From Aga filling station in Örebro

All partners have a vent back connection on the LNG hose/nozzle, most use the Macrotech 1/2" bayonet vent back hose/nozzle. All partners use Carter-like nozzles.

Table 5-1 LNG boil off and venting reduction[1]

	ENI Piacenza	ENI Ponte-dera	DRIVE Antwerp	GNVERT Nimes	GNVERT Rungis	GNVERT Lyon	AGA Örebro	GALP Mato-sinhos	GALP Sines	DOURO GAS Carre-gados	DOURO GAS Elvas	GNF Barce-lona	LIQVIS[3] Berlin
Boil off recovery	Y	Y	-	Y [1]	Y	Y	N[2]	Y	Y	Y	Y	Y	N
L-CNG tank is connected to LNG boil off	Y	Y	Y	Y	Y	Y	N[2]	Y	Y	Y	Y	Y	N
Venting reduction technologies	BOG Comp-ressor	BOG Comp-ressor	BOG Comp-ressor	BOG Comp-ressor [1]	BOG Comp-ressor	BOG Comp-ressor	LIN cooling	BOG Comp-ressor	BOG Comp-ressor	BOG Comp-pessor	BOG Comp-pessor	BOG Comp-ressor	N

[1] No boil off recovering at the semi mobile station at Nimes but there will be at the permanent station
[2] The station in Örebro is built with LIN-cooling, active cooling with nitrogen as a boil off reduction and venting preventive technology
[3] At the Berlin station boil off will not be an issue due to enough guaranteed withdrawal per day and therefore frequent refilling's of cold LNG.

6 Fuel volume and economics

This chapter concludes information from all stations regarding the volume of LNG at the filling stations and economic information.

Information regarding these issues has been the most difficult information for the partner companies to provide. Partly because this is sensitive information to share and partly because some of the information is based on calculations and predictions on a future market situation. The answering rate is at the most half of the partner companies.

The investment for the filling station is varying from around 700.000 € to 1.800.000 €.

Figure 6-1 Filling at the DRIVE station in Antwerp

The fuel turnover was investigated in deliverable 5.6 LNG station details. In order to be able to estimate the turnover at each station, partners were asked to consider:

- The number of trucks that will use the station
- The models of trucks that will frequent the station (mono- vs. dual-fuel)
- Average daily mileage and fuel consumption (kg/100km)
- Estimated number of trucks outside of local fleets that will visit the station
- Amount of L-CNG sold (if applicable), considering passenger cars, local bus fleets etc.
- The number of trucks and expected fuel turnover considered during the design process

There is a very wide range of LNG fuel turnover among the different stations, between approximately 1 and 75 tons per week. There are several factors that can explain this variation. The number of trucks understandably has the greatest impact on the fuel turnover, and indeed there is a general trend toward higher fuel turnover when more vehicles frequent the station. However, the number of mono-fuel compared to dual-fuel trucks also impacts predicted turnover. For a given number of trucks, stations that serve a higher percentage of mono-fuel trucks will have higher fuel turnover than a station with more dual-fuel trucks. Actually, the monofuel trucks consumption is more than the double

compared to dual-fuel trucks, therefore the difference in amount of Natural Gas delivered is meaningful.

Additionally the consumption of LNG HDV's much depends on the type of vehicles used at each station. On average, this gas consumption is around 28 Kg per 100 Km. However, logically this figures varies if dual fuel trucks are used like in the case of Antwerp station. On Volvo dual fuel trucks and other dual engines solutions, the gas consumption is much lower, around 11 Kg/100 Km.

The chart below shows the relation between LNG trucks participation and the total Natural Gas consumption at each station in operation.

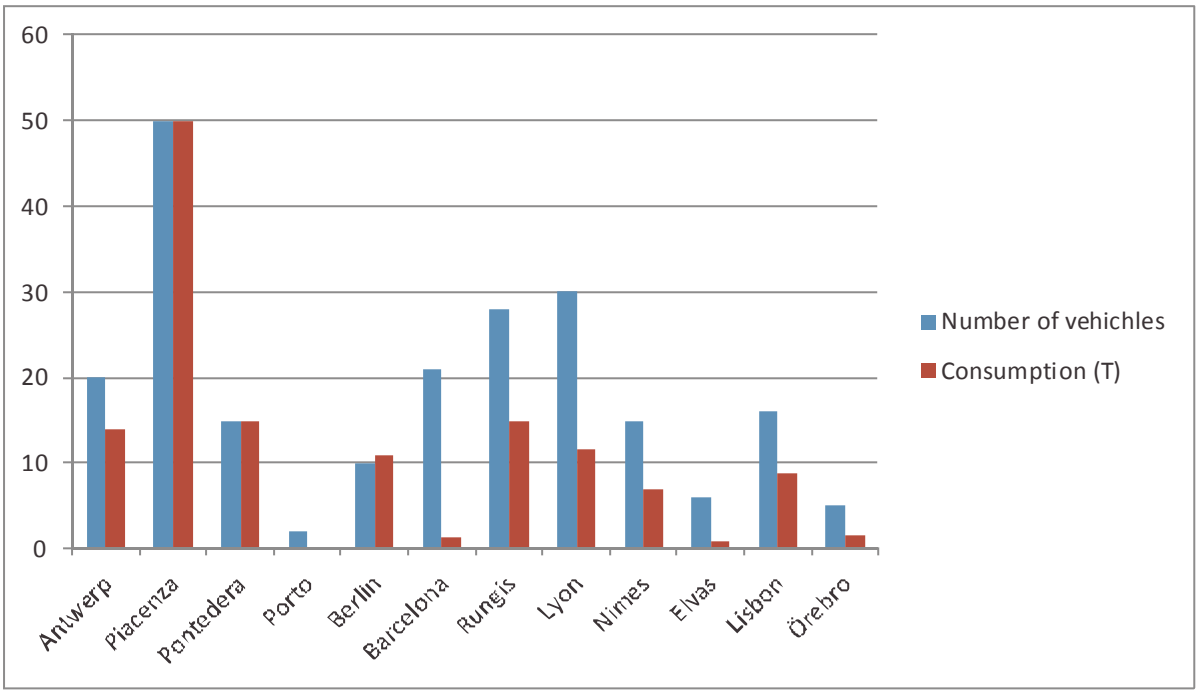

Figure 6.2. Relation between LNG trucks and the Natural Gas consumption at each station

The graphic displays a reasonable and quite coherent result: the number of trucks and the gas consumption at the stations and is closely related.

It is interesting also to compare the price for LNG with the price for diesel. In order to do so they have to be in the same unit in order to be comparable. In the table below the prices in the different countries has been recalculated to a price without VAT expressed in €/kWh, in order to get a price delta. The price delta is expressed as percentage of the diesel price.

Note that while the price for LNG that the customer finally pay is very likely the same or close to the price stated, this is not the case for the diesel where it is common to have rather large discounts. Also take into account that some LNG engine technology are not as efficient as diesel which might mean a slightly higher fuel cost.

Table 6-1 LNG and diesel price

Country	Company	Price LNG (€/kg) incl. VAT	Price diesel (€/l) incl. VAT	VAT (%)	Price delta (% of diesel price)[1)]
Belgium	DRIVE	0,97	1,14	21	38
France	GNVERT	1,2	1,22	26	29
Germany	LIQVIS	1,02	1,07	0,19	31
Italy	ENI[2)]	0,97	1,35	22	49
Portugal	DOUROGAS/GALP[3)]	1,05	1,19	0,23	36
Spain	GNF	0,74	1,12	21	52
Sweden	AGA	1,50	1,43	25	22

1) The Price delta has been calculated by calculating a price for LNG and diesel without VAT with a comparable unit, in this case by calculating the price in €/kWh.
The following factors has been used:
1 l diesel = 9.8 kWh
1 kg LNG = 13.5 kWh
The delta cost is expressed as the delta between the difference of the price of diesel in €/kWh and the price for LNG in €/kWh and as a percentage of the diesel price. The price for LNG in Belgium is for example 38 % lower than the price for diesel (without taking into account the presumed discount for diesel)
2) The price in the table is before the excise duty rebate is withdrawn.
3) The price is calculated as an average between the LNG prices collected from the two companies.
4) Prices can vary quite a lot depending on individual client contracts.
5) The prices are collected between May and July 2017 but the prices are average values from up to one years' time.

Table 6-2 LNG stations consumption

Participant	*DRIVE (Antwerp)*	*ENI (Piacenza)*	*ENI (Pontedera)*	*GALP (Porto)*	*GALP (Sines)*	*LIQVIS (Berlin)*	*GNF (Barcelona)*	*GNVERT (Rungis)*	*GNVERT (Lyon)*	*GNVERT (Nimes)*	*DOUROGAS (Elvas)*	*DOUROGAS (Lisbon)*	*SGA (Örebro)*
Which truck models will frequent station	Volvo FM / Iveco Stralis NP, Scania G340	Iveco Stralis, Scania	Iveco Stralis	Iveco Stralis	Iveco Stralis	Iveco	Iveco Stralis	Iveco Stralis, Scania,Volvo	Iveco Stralis, Scania,Volvo	Iveco Stralis, Scania,Volvo	Iveco Stralis 330HP, Iveco Stralis NP 400HP, Scania NLG 340HP	Iveco Stralis 330HP, Iveco Stralis NP 400HP, Scania NLG 340HP	Volvo Scania
Estimated % mono-fuel traffic	70%	Close to 100%	Close to 100%	95%	95%	100 %	100%	More than 90%	More than 90%	More than 90%	95%	95%	50%
Average fuel LNG consumption kg/100km	25	24	24	28	25	23-30	25	29	29	29	29	29	28
Estimated total # trucks	20	50	15	2	8	10	21	28	30	15	6	16	5
Average km per truck per week?	2500	2100	2100	2200	2500	n.a.	2325	2000	2500	Between 1600-3100	320	1923	2700
kg LNG/week	14000	50000	15000	200	5000	11000	1300	15000	11700	7000	783	8874	1250-1750
kg CNG/week	2000	25000	10000	1300	residual	0	3700	15000	1300	0	117	1326	2750
Total gas kg/week	16000	75000	15000	1500	5000	11000	6000	30000	13000	7000	900	10200	4000-4500
Max design capacity: kg/week	30000	50000	50000	n.a	n.a	30000	18250	100000	100000	30000	30000	100000	15000
Max design capacity: trucks/day	50	Close to max with served fueling, second dispenser planned	Not defined	n.a	n.a	30	52	1 dispenser = 48 LNG trucks during 8 hours (second dispenser during 2017))	48 LNG trucks during 8 hours	48 LNG trucks during 8 hours	48	72	51
Comments					Estimated figures	Figures for the temporary station							

7 Technical specifications of the stations

The technical specifications for the filling stations are very similar. All stations are both LNG and L-CNG stations except GNVERT semi-mobile non-permanent station in Nimes and LIQVIS station in Berlin. Most of the stations have the same size of the LNG tank, around 60 m^3 but it varies from 10-100 m^3. All stations, except the semi-mobile non-permanent station in Nimes and the temporary station in Berlin, are in general as described in the picture below from deliverable 3.1.1 Report on state of LNG and LCNG filling stations technologies in Europe.

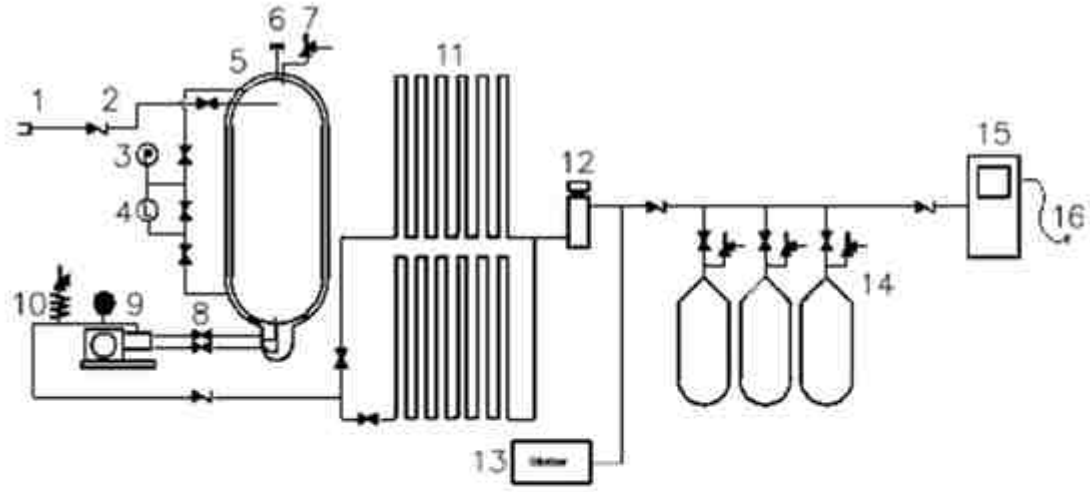

Figure 7-1 Example of flow diagram of an L-CNG Station with High pressure LNG pump

The tank manufacturers are different: Cryo, Chart, VRV SpA and Indox have been used. All have have one dispenser for LNG but the ENI station in Piacenza, Italy and the GNVERT in Rungis have planned two dispensers to increase the fuelling capacity. The manufacturers used for the dispenser are Cetil/Indox, Cryostar, Vanzetti and Ham.

They all use a cryogenic pump except at the GNVERT station at Lyon, France and the ENI station in Pontedrea, Italy. The manufacturers used for the pump, which is a submerged pump in most cases, are Cryostar and Vanzetti.

Many of the partners gives a range for the dispensing pressure, but only two companies states clearly that it is possible to adjust the pressure when filling the truck, GALP and DOUROGAS.

When filling the station with LNG from the thermo trailer, all states top and bottom filling. The hose/nozzle used between the thermo truck and the tank varies. The different kinds stated are Aga, Gasso (Enagas 2"type), Airhose, Vanzetti DN40 and Indox. Probably they are all threaded coupling, but their compability with each other is unclear.

For a summary of technical specifications, see table below. Please see also deliverable 3.1 European LNG/L-CNG technology and 3.4 Guidelines for setting up and operation of stations.

Table -1 Technical specifications of the stations

Participant	*DRIVE (Antwerp)*	*ENI (Piacenza)*	*ENI (Pontedera)*	*GALP (Porto)*	*GALP (Sines)*	*LIQVIS (Berlin)*	*GNF (Barcelona)*	*GNVERT (Rungis)*	*GNVERT (Lyon)*	*GNVERT (Nimes)*	*Dourogas (Elvas)*	*Dourogas (Lisbon)*	*SGA (Örebro)*
Total LNG storage capacity	70m³ tank	60m³	100m³	60m	80 m³	45 m³	60m³	60	60	Temporary movable station: 20 Fixed station: 60 m3	10m³	60m³	61m³
Expected gas source	Zeebrugge	Barcelona Fos Tonkin	Barcelona Fos Tonkin	TGNL de Sines	TGNL de Sines	Zeebrugge	Barcelona	For the long term: Montoir de bretagne, Zeebrugge	For the long term : Montoir de Bretagne, Fos Tonkin	Montoir de Bretagne, Fos Tonkin, Barcelona	TGNL de Sines	TGNL de Sines	Nynäshamn
Number of LNG dispensers?	1	1	1	1	1	1	1	1 (+1 later possible)	2 probably	1	1	1	1
Cryogenic Pump? (Y/N)	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
Max LNG flow rate:	65 kg/min	60 kg/min	60 kg/min	80 kg/min	80 kg/min	50 kg/min	50 kg/min	60 kg/min	60 kg/min	60 kg/min	50 kg/min	50 kg/min	60 kg/min
LNG dispensing pressure	7-10 bar	8 bar	8 bar, variable	8 & 16 bar	8 bar	8 bar	8-15 bar	8 bar	8 bar	8 bar	9-13 bar	9-13 bar	8 bar
LNG dispensing nozzle	Macrotech	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter	JC Carter
Vent-Back nozzle	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")	Y	Y	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")	Macrotech (1/2")
Number of L-CNG dispensers	1	1 + 1 planned	1	1	1	0	1 with double hose	1 + 1 during 2017	2 probably	1	1	1	1
L-CNG: Compressor Performance	700 Nm³/h	1350 Nm³/h	675 Nm³/h	415 Nm3/h	415 Nm3/h	-	700 Nm3/h	800 Nm3/h	800 Nm3/h	800 Nm3/h	400Nm3/h	400Nm3/h	700 Nm3
For L-CNG: Planned CNG storage	2400 liters	2400 liters	2400 liters	2560 liters	2560 liters°	-	2800 liters				1600 liters	2400 liters	2100 liters
Comments	In service	In service	In service	In service	Expected Q4 2017	Temporary station in service	In service	In service	In service	In service	In service	In service	In service

8 Conclusions

It has been important delays when building the project stations but finally almost all of the 13 facilities are operative. Despite of that, there some non-covered areas in Europe as can be seen in the map below.

The French facilities (especially Lyon and Nimes) now play a significant role in the project. The distance between LNG stations, was in most of case, difficult to be covered by LNG trucks with an assumed autonomy of 800 Km on average (we are aware that Iveco is already offering factory-made trucks with double LNG tank). Currently the distance between Sines and Barcelona can hardly be driven but it is now easier with the Elvas station, making the journey 150 km shorter.

A similar situation occurs when a truck goes from Barcelona to Antwerp. Between them, there was 1100 Km roughly which is a difficult distance to be covered by LNG trucks. In this case, thanks to the French station, it will be possible to travel to the BENELUX area, and consequently, many Portuguese and Spanish fleets could reach the northern European countries. France is in Europe, and especially in this project, a key connecting market. The three French LNG stations located in Nimes, Lyon and Rungis (Paris) are already allowing many fleets to easily get other markets.

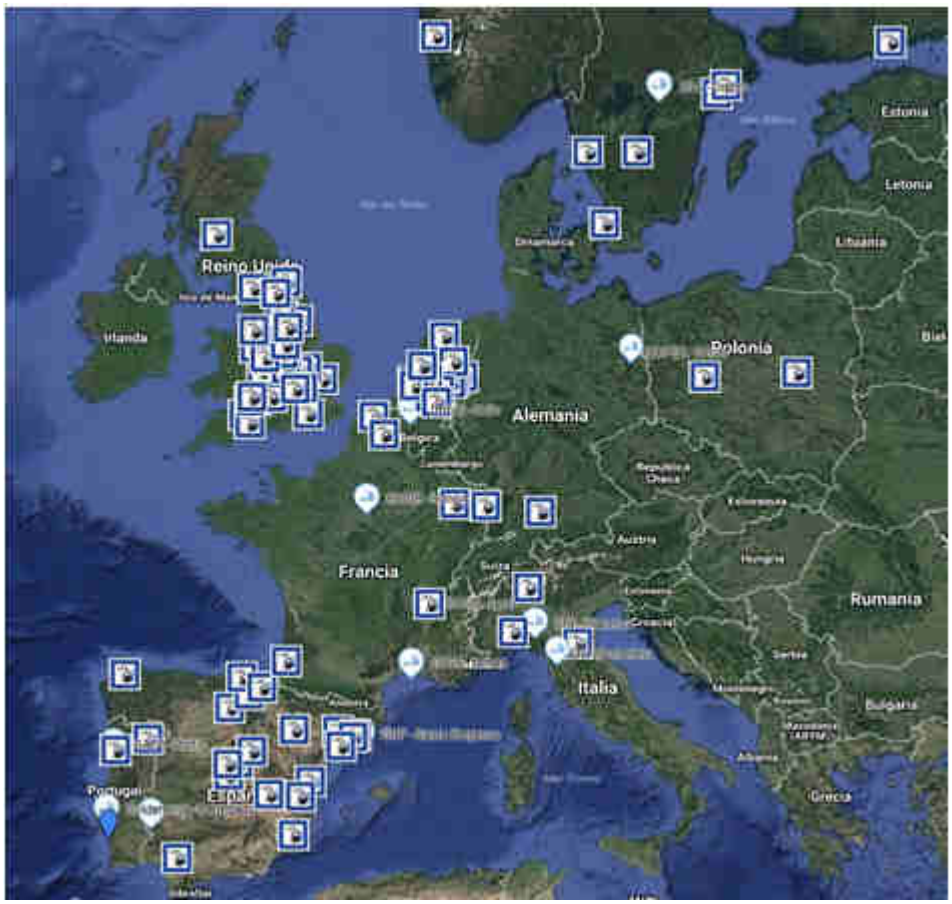

Figure 8-1 LNG Stations map

The biggest and major issue faced within this corridor was the absence of the German station. The Berlin station will now allow trucks to get Sweden and other European countries smoothly, by making the journey feasible since it was not possible to go through Germany with the LNG truck autonomy.

All in all, the distance between project stations is perfectly doable by a LNG truck, regardless the model. This is definitely a good news, and with almost all LNG Blue Corridors stations in operation, plus those LNG facilities that are currently being built, it will provide a LNG network more solid and with drivable distance between the stations.

The intention is to allow vehicles be able to do crossing-borders routes with no barriers.

On the other hand, regarding the dimensions and capacities, the results depicted in this document show that each partner's station(s) fall within a narrow range of technical specification. Each partner's fix station will have a single storage tank with a capacity between 60 and 100m^3, each station will operate with a cryogenic pump except the Lyon and Pontedera station, and each station will also deliver L-CNG. The storage capacity of each station is more than adequate to sustain the L-CNG equipment, and is therefore well matched to the CNG demand from each station.

It is interesting that these fueling stations are so closely grouped in LNG storage capacity and their general specifications. Boil-off is one of the most serious issues associated with LNG as a vehicle fuel and it is critical that it be minimized at all costs - venting methane directly into the atmosphere causes serious environmental impacts. Because the risk of boil-off is relevant only when LNG sits long enough to warm above its boiling point, the greatest tool for preventing boil-off of LNG is good management practices. Ensuring that fuel turnover is consistent and rapid enough that LNG never warms to this point is an ideal way to minimize these incidents; logically, the storage capacity should match the fuel demand. This is the reason why Dourogas has installed a LNG tank with a capacity of just 10 m3 at their station in Elvas. They have foreseen a low demand at the early operation period, an additional tank could be installed if it is needed.

An LNG station with L-CNG capability not only serves a wider range of customers, but also provides an effective boil-off reduction system. Boil-off gas from LNG, rather than being vented into the atmosphere, can be pressurized and stored for sale as CNG as occurs at the Rungis station.

9 Annex 1

9.1 Content Questionnaire 1

This questionnaire was sent out by WP5 and some of the results are also presented in deliverables from WP5.

Country:
Filled by:
Company name:
Date:

Location:	City: Precise Address:
Status:	Planning; Pending Approval; Approved; Construction;
Estimated timing for implementation	When will station be operational? (mm/yy)

Types of technology applied to fuel stations

LNG or LNG & L-CNG:
Require operator (Y/N):
Total Storage capacity (m3):
Dispensing Pressure(s) (bar) (indicate if adjustable)
If adjustable: how is it ensured that fuel is dispensed only at correct pressure?
Storage Pressure (bar):
Maximum dispensing rate LNG (kg/min):
Number of LNG dispensers:
Dispenser manufacturer:
Filling pressure selection & safety:
Cryogenic pump (Y/N):
Pump manufacturer:
Boil-off recovery (Y/N):
Number of L-CNG dispensers, hoses:
L-CNG dispenser manufacturer
L-CNG capacity (Nm3/h)
Pressurized gas storage capacity (storage bottle capacity) in liters
L-CNG station is connected to LNG tank boil off - (Y/N)
L-CNG Odorization (Y/N):
Vent-back hose system (Y/N)

LNG Gas specifications

Gas quality - Methane #

Biogas fraction (%)
Duty levied (EUR/Ton
)

Safety, security, and site access

Personal protective equipments used:
Hours of operation
Site surveillance (i.e. security cameras)?
How is access limited to qualified operators? (key card, passcode, etc.)
Can station be controlled or shut down remotely?
Who conducts training for refuelling operation?
Devices to ensure safe refueling (e.g. dead man's button, breakaway devices for hoses)
Fire protection: automatic fire extinguishers, etc.
Air compressor (Y/N) and gas used

Fuel supply operations

Payment methods:
Can other companies' fueling cards be used?
In what language are signs and instructions given?

Design solutions for methane slip-free refueling stations.

Venting reduction technologies:

Definition of filling hose needs from the point of view of the fuel stations

Hose and nozzle manufacturer (Parker/JC CARTER/Nanotechnologies...)
VENT BACK hose/nozzle manufacturer, type (e.g. Macrotech 1/2" bayonet)

Standardization of LNG tank working pressures and procedures

LNG tank capacity (T):
Tank maximum pressure (bar):
Safety valve calibration (bar):
Tank manufacturer :
Coupling between tank at station and the thermo trailer (manufacturer):
LNG Filling Procedures:
Other:

Regulation and standardization

Standards applied (e.g. ISO/TC 252 (draft), local standards...)
What agency enforces rules and inspects and grants permission for station operation?

Integration of L-CNG refueling stations into existing truck stop refueling stations on the long Distance Trans European Routes

Does the station include other fuels?
Is there regulation limitation to include other fuels with L-CNG or LNG in the same station?
Other:

Fuel Turnover

Estimated % dual-fuel traffic
Average mono-fuel consumption/100 km
Average dual-fuel consumption/100 km
Total LNG sold per week
% from which LNG
% from which CNG
Planned fuel turnover/week
Planned number of trucks/day
Maximum design capacity: fuel turnover/week
Maximum design capacity: number of trucks/day

9.2 Content Complementary Questionnaire 2

This complementary questionnaire was sent out by WP3.

STATION 1 REQUESTED INFORMATION

Country:
Filled by:
Company name:
Date:

1. Installation owner
2. Operator

3. Site

Emplacement: Reasons for sitting, strategy
Features of the emplacement around
Location coordinates
Emplacement of the previous and next station
Other services offered
Other fuel stations
Attended or unattended (Y/N). In case of unattended, how to proceed in case of an emergency?

4. Applicable regulations
5. Features and uses of gas

6.1. Facility description (Overview of facilities)

Fueling flows temperatures

6.2. Facility description (Special feautres of facilities components)

Storage – LNG
Vertical or Horizontal?
Net volume
Work temperature
Design pressure
Design temperature
Isolation description
Model
Year
Density
Included vaporizer to control inside pressure? (Y/N)
Storage – CNG
Pressures
Manufacturer
Model
Year
Recovering CNG inside noozle? (Y/N)
Offloading
Offloading occurrs by pressure difference (PPR) or by pump?
Safety equipment
Regasification
Vaporizer/s
Conditions
Capacity
Control
Set point (outlet temperature)
Heat exchanger (if needed)
How is regasification produced (by LNG Piston Pump or CNG compression inside CNG module)?
Manufacturer
Model
Odorization
Type of Odorizant
Capacity containment
Required concentration
High/low pressure of injection
Control
Vent recovering
System description (if vent recovering is possible)
Boil-off recovering
List of equipment
Metering (Y/N)
Vessel (Y/N)
’

Control
PLC
Signals
Alarms
Pipelines (LNG and CNG)
Isolation (materials and thickness)
Aerial or buried?
Pressure design
Safety equipment
Safety valves (Y/N)
Pressure relief valves
Temperature/pressure controls
Leakage detectors
Gas detectors
Fire detectors
Control strategy (in case of power failure)
ESD (Emergency Shut Down) (Y/N)
Electric System
Regulations that applies
Electrical ground connections (resistance)
Firefighting system
Number of fire extinguishers
Total capacity
Location
Regulations that applies

7. Set up

Detailed testing procedure
Certificates needed

8. Costs

CAPEX (Capital Expense in euros)
OPEX (Operating Expense in euros)

9. Prices

LNG price (orientative price in euros)
CNG price (orientative price in euros)