

An Overview of the Pipeline Networks of Europe

Introduction

This document provides an overview of the pipeline networks and infrastructure within the oil, gas, petrochemical and chemical industries across Europe.

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1 North West Continental Europe (Netherlands/Belgium/Northwest Germany)

1.1 Oil and Natural Gas:

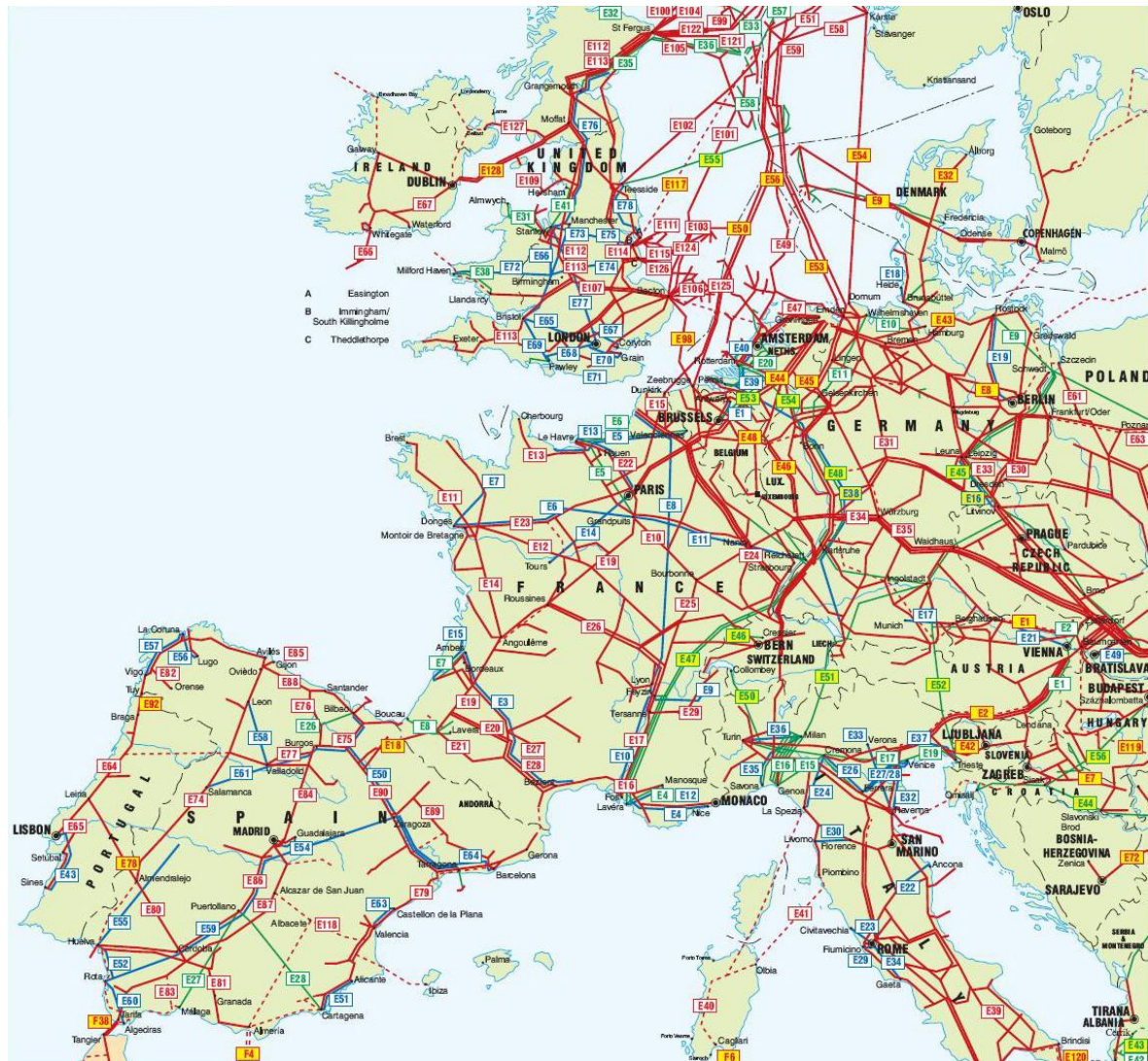


Fig.1 – European Oil and Gas Pipelines

http://www.theodora.com/pipelines/europe_oil_gas_and_products_pipelines.html

Please follow the above link for key and to enlarge map.

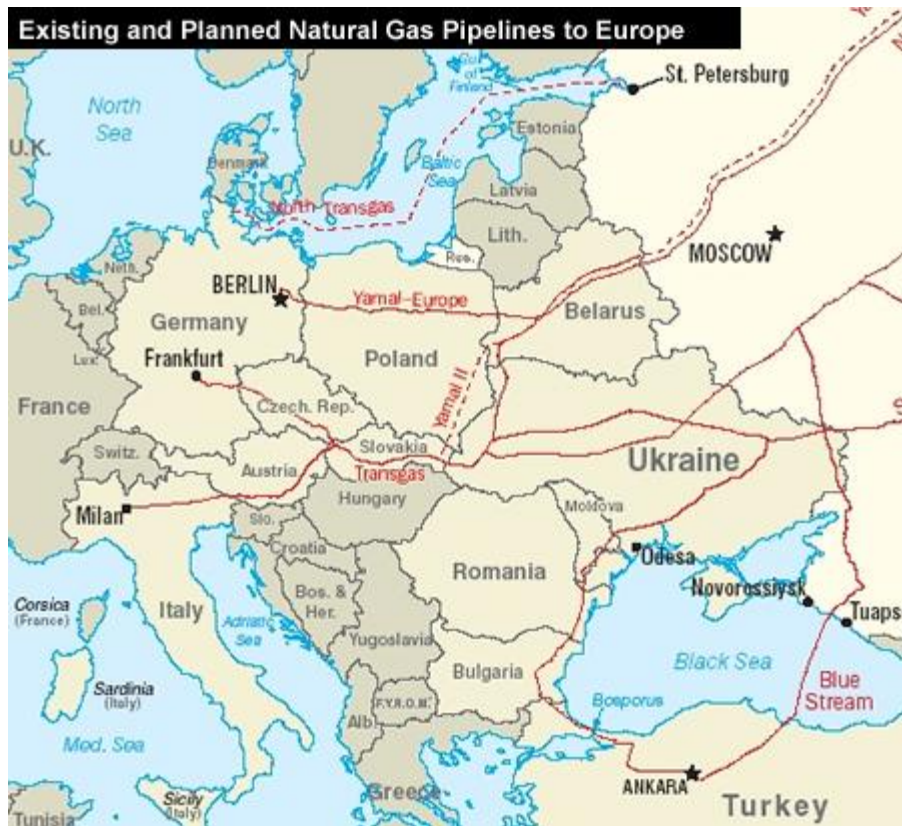


Fig.2 – Planned Natural Gas Pipelines

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1.2 Commentary

Oil and natural gas extraction in the North Sea's inhospitable climate and great depths requires sophisticated offshore technology. Consequently, the region is a relatively high-cost producer, but its political stability and proximity to major European consumer markets have allowed it to play an important role in supplying North European countries with oil and natural gas.

The Netherlands – although partly producing themselves - import large quantities of oil and natural gas from Russia, Saudi-Arabia, the UK, Norway and Kuwait. One half of the crude oil is refined in the Rotterdam area while the other half is distributed via the extensive pipeline system. The Rotterdam-Ruhr Pipeline (RRP) provides a link to refineries in Venlo, Wesel, Gelsenkirchen, Godorf and Wesseling. In addition, Rotterdam is connected to Vlissingen, another Dutch sea port, and to Antwerp, Belgium, via the Rotterdam-Antwerp Pipeline (RAPL).

Rotterdam is also linked to the Central European Pipeline System (CEPS), the largest of the NATO Pipeline systems, which distributes fuels and lubricants and is designed to ensure that NATO's requirements for petroleum products and their distribution can be met at all times.

The German refineries are also supplied via the 240 mile, 300,000-bbl/d Nord-West Oelleitung (NWO) connecting Wilhelmshaven with Wesseling, near Cologne. The Norddeutsche Oelleitung (NDO) crude oil pipeline in northern Germany connects the oil terminal and refinery in Hamburg with the oil terminal in Wilhelmshaven. The 90-mile NDO has a capacity of 150,000 bbl/d.

Distrigas operates a LNG terminal in Zeebrugge, Belgium, to import LNG from Qatar (contracted amount: 2.75 billion m³ starting in 2007). Zeebrugge is also connected to Norwegian gas fields via the Seapipe subsea pipeline and to Bacton, England via the Interconnector pipeline.

Both the Dutch and the Belgian networks are important distribution systems for natural gas. Zeebrugge is connected to the Trans-European Natural Gas Pipeline (TENP), a joint venture of E.ON Ruhrgas and Italy's Eni S.p.A (formerly Snam S.p.A) which runs 600 miles from the German-Dutch border to Italy. This system supports a reverse flow operation, so it would be possible to use the TENP to transport Algerian or Libyan natural gas from Italy to Germany. Groningen is linked to Emden, which itself is supplied by Norwegian gas fields. Rysum/Emden are the starting points for the 440-mile Mitte-Deutschland-Anbindungs-Leitung (MIDAL) system operated by Wingas that runs the length of entire Germany from the North Sea coast via Rheden, Bad Hersfeld, Hanau and Ludwigshafen to Karlsruhe. With a capacity of 1.2 Bcf per day (Bcf/d), MIDAL allows Germany to import natural gas from Norway through receiving terminals in Emden and Dornum.

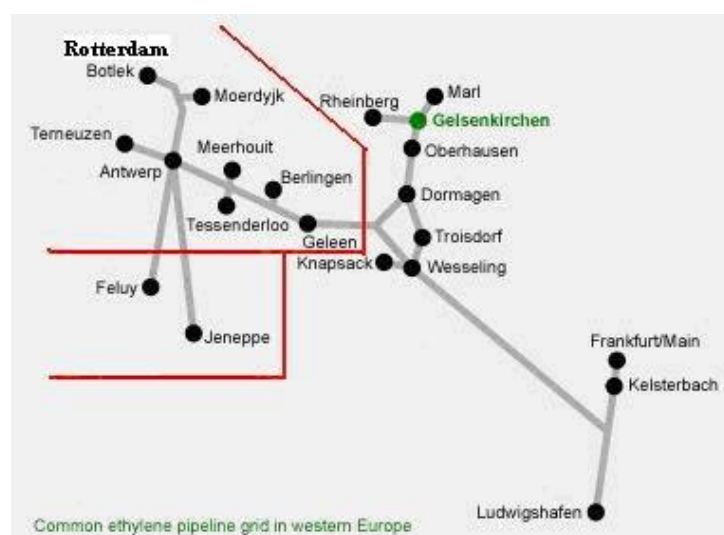


Fig.3 -The ARG pipeline system (Source: Infoseek, 2002)

Rotterdam refineries distribute their products mainly via pipelines to chemical sites located in the Netherlands, Belgium and Germany. The 495 km Äthylen Rohrleitungsgesellschaft (ARG) pipeline transports ethylene between producers and consumers at petrochemical sites in

Germany, Belgium and the Netherlands. It is an important facility for the European petrochemical industry, linking directly or indirectly almost half the ethylene production capacity in Europe and 90% of the capacity in Belgium, Germany and the Netherlands. ARG shareholders are Westgas GmbH & Co KG, Bayer AG, DSM Hydrocarbons B.V., Sasol Germany GmbH, BASF AG, and BP (in the name of Veba Oel Refining & Petrochemicals).



Fig.4 - Ethylene and Propylene Pipelines in Benelux and parts of Germany (Source: APPE, 2004)

Propylene pipelines connect important chemical sites in the Netherlands (Rotterdam, Moerdijk) and Belgium (Antwerp, Feluy, Geel, Beringen, Terneuzen). Dow operates its own propylene pipeline from Rotterdam to Woensdrecht, near Terneuzen. In Northwest Germany, there is only one propylene pipeline connecting Cologne, Gelsenkirchen and Marl (not correctly shown on the map). The resulting deficit of about 600,000 tpa propylene in the Ruhr area is currently imported from Rotterdam by both the Rhine waterway and railway. Construction works for new propylene pipelines connecting the major chemical sites in the

Ruhr area via Cologne, Geleen and Amsterdam to Rotterdam are scheduled for 2007 with completion in 2009.



Fig.5 - Proposed propylene pipelines (Source: Ministry of Economic Affairs and Energy of the State of North Rhine-Westphalia, 2006)

Associated with the construction of the above mentioned propylene pipelines from the Ruhr area to Rotterdam, are the following projects:

- A carbon monoxide pipeline between Dormagen and Krefeld-Uerdingen (Bayer AG)
- A hydrogen pipeline between Ratingen-Breitscheid and Düsseldorf-Stadtwald (Air Liquide)
- A natural gas pipeline between Mettmann-Metzkausen and Krefeld-Uerdingen (Wingas)
- A synthesis gas pipeline between Duisburg-Meiderich and Krefeld-Uerdingen (BOC).

Naphtha is pumped through the PALL (Pipeline Antwerp-Limbourg-Liège) between Antwerp and Geleen. DSM owns a naphtha pipeline connecting Geleen and Rotterdam. The Rhein-Main-Rohrleitungstransportgesellschaft m.b.H (RMR) operates a pipeline for transporting naphtha, gasoline, diesel, fuel oil and kerosene from the Dutch-German border at Venlo to Frankfurt and Ludwigshafen.

The Netherlands and Belgium offer also an extensive network for industrial gases such as oxygen, nitrogen and hydrogen. There are also links to French chemical sites e.g. Dunkerque. Low capacity pipelines transport carbon monoxide in both the Rotterdam and Antwerp areas.

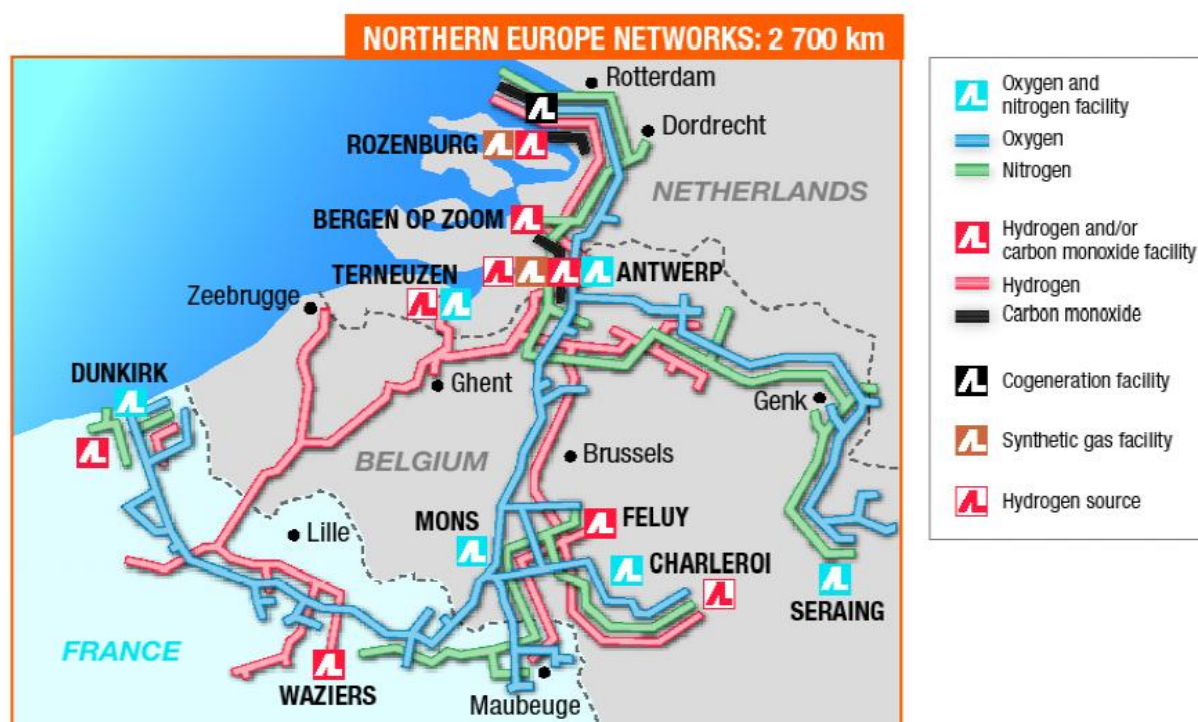


Fig.6 - Industrial Gas Pipelines in the Benelux Region (Source: Air Liquide, 2006)

In the Rhine-Ruhr area Air Liquide and Praxair (southern part of system) operate the 240 km hydrogen network shown in the map below and a 500 km pipeline system for the transport of oxygen and nitrogen.

The Rhine waterway is another link between Northwest Germany and the Netherlands, transporting both feedstock and finished products.

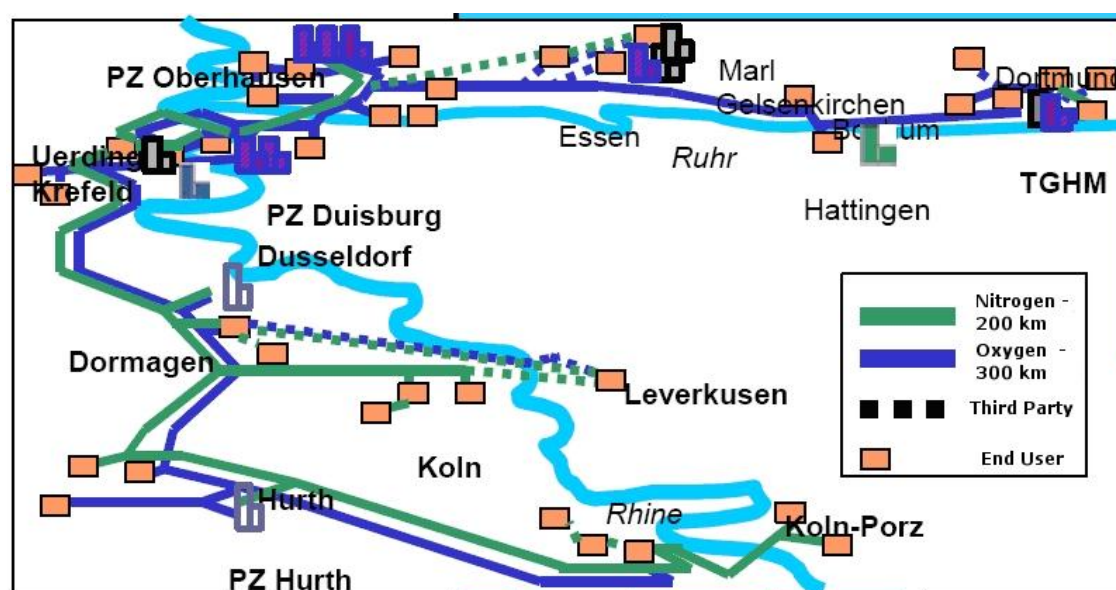


Fig.7 - Nitrogen and oxygen pipeline system in the Rhine-Ruhr area (Source: Spiritus Consulting, 2004)



Fig.8 - Hydrogen pipeline system in the Rhine-Ruhr area (Source: Air Liquide, 2005)

2 United Kingdom:

The UK is the largest producer of oil and natural gas in the EU. However, after years of being a net exporter of both fuels, the UK became a net importer of natural gas in 2004. Government estimates also predict that the country will become a net importer of oil by the end of the decade. Production from UK oil and natural gas fields peaked in the late 1990's and has declined steadily since, as the discovery of new reserves has not kept pace with the maturation of existing fields.

There is an extensive network of pipelines in the UK to carry oil extracted from North Sea platforms to coastal terminals in Scotland and northern England. BP operates the 110-mile, 36-inch Forties-Cruden Bay pipeline, linking fields in the Forties system to the oil terminal at Cruden Bay, Scotland. The company also operates a 110-mile, 36-inch pipeline connecting the Ninnian system to the Sullom Voe oil terminal on Shetland Island. Total operates a 150-mile, 24-inch pipeline linking the Bruce and Forties fields to Cruden Bay and a 130-mile, 30-inch pipeline connecting the Piper system with Flotta on Orkney Island. Shell and Esso jointly operate a 93-mile, 36-inch connection between the Cormorant oil field and Sullom Voe. Talisman Energy owns a 37-mile, 16-inch pipeline connection between its Beatrice field and the Nigg Bay oil terminal. There are also numerous, small pipelines that connect each North Sea oil platform to these major backbones. Finally, the UK does have a few onshore crude oil pipelines, including a 90-mile, underground pipeline operated by BP that links the Wytch Farm field to the refinery at Fawley and the nearby oil export terminal at Southampton.

The UK had 1.9 million bbl/d of refining capacity in 2006, according to OGC. ExxonMobil operates the single-largest refinery in the country, the 326,000-bbl/d Fawley facility in southern England. However, BP controls the largest total amount of refining capacity, with facilities in Grangemouth, Scotland (196,000 bbl/d) and Coryton, England (163,000 bbl/d). Other companies with significant refining capacity in the UK include Total (325,000 bbl/d), Shell (296,000 bbl/d), ConocoPhillips (221,000 bbl/d), and ChevronTexaco (210,000 bbl/d). According to DTI, refinery utilization in the UK was near 90 percent in 2004. The UK maintains an active international trade in refined petroleum products, exporting 36.1 million metric tons (mt) and importing 26.4 million mt in 2004.

As already mentioned, the UK will have to increase natural gas imports to supplement domestic production in the future. As supplies from UK gas fields are estimated to meet 60% of the country's gas needs at the end of the decade, the move from exporting of natural gas to importing it has resulted in several pipeline projects: Interconnector Pipeline from Zeebrugge (Belgium) to Bacton and the BBL pipeline from Balgzand to Bacton.

BG Group has a 25% shareholding in Interconnector (UK) Limited, which developed the pipeline that links the UK and Continental European gas transmission systems. All the capacity in the Interconnector has been sold on long-term contracts until 2018. Interconnector (UK) Limited manages and operates the asset for its shippers and shareholders. The pipeline, which runs from Bacton in England to Zeebrugge in Belgium, has been fully operational since October 1998. Up to 745 bcf (20 normal bcm) natural gas per year can be transported from the UK through the 230 km 40-inch diameter sub-sea pipeline to a reception terminal at Zeebrugge and then into the Continental European grid. In addition, the pipeline's Phase 1 reverse flow import capacity expansion from 317 bcf (8.5 normal bcm) to 615 bcf (16.5 normal bcm) became operational on 8 November 2005. The second phase, designed to boost the UK import capacity to 876 bcf (23.5 normal bcm), is expected to be available from December 2006. BG Group uses its own capacity for long-, medium and shorter-term sub-lets to third parties and also ships gas to take advantage of market price differentials between the ends of the pipeline. Interconnector (UK) Limited is contemplating a further expansion to increase import capacity by around 75 bcf (2 normal bcm) to around 24.2 bcf (25.5 normal bcm), which could be available before the end of 2007.

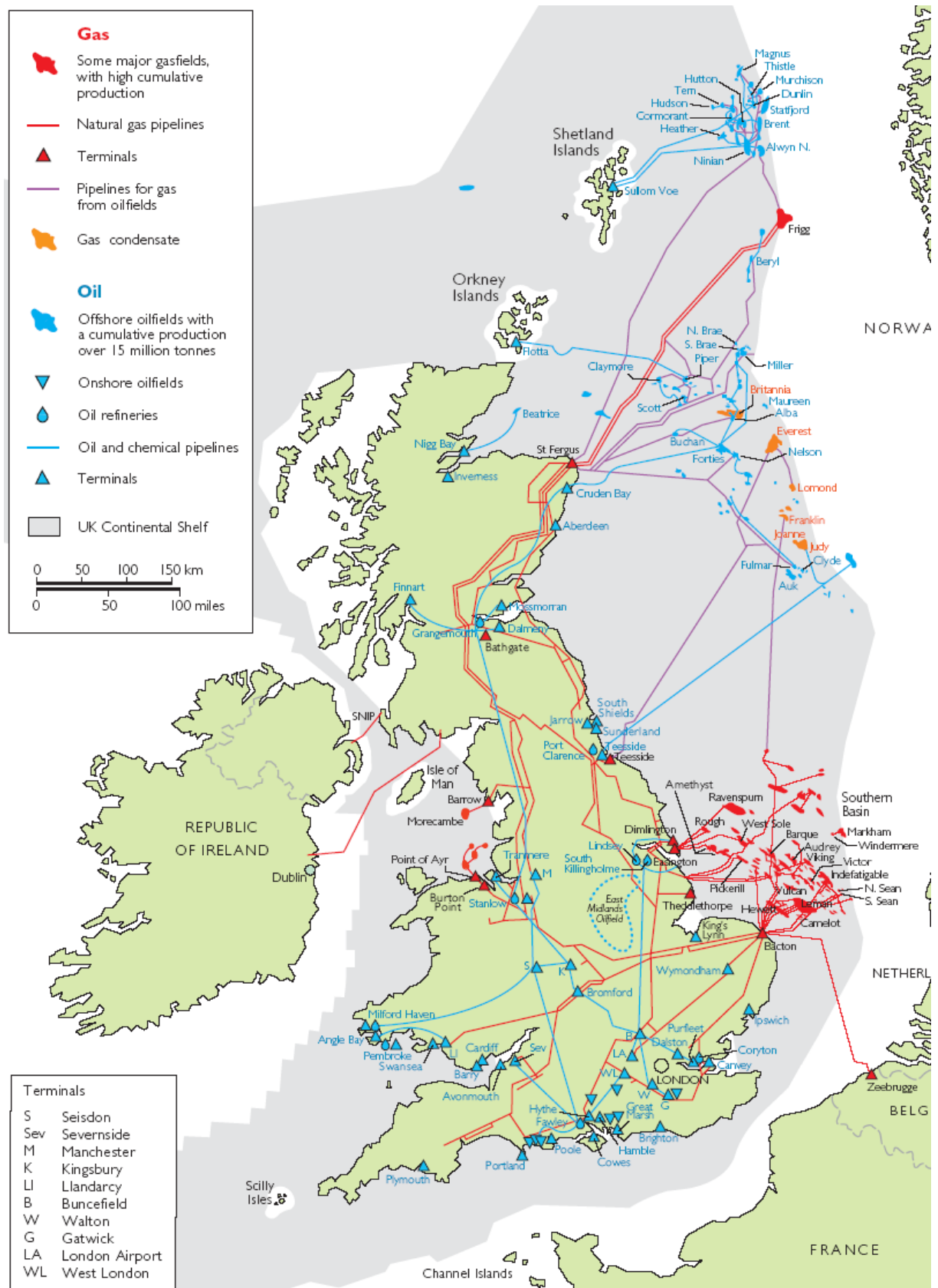


Fig.9 - Gas and Oil Production in the UK (Source: National Statistics, UK, 2002)

In July 2006 BBL company started the work on the construction of a 230-kilometre undersea gas pipeline which will link the Netherlands and the United Kingdom. This pipeline has been given the name BBL (Balgzand Bacton Line) and is being built by N.V. Nederlandse Gasunie under the authority of BBL Company. BBL Company is a partnership of three subsidiaries of N.V. Nederlandse Gasunie, E.ON Ruhrgas and Fluxys. The gas flow direction is from the Netherlands to the UK.

Currently, the UK has a single LNG import terminal, the NGT's Grain LNG on the Isle of Grain. The facility has a sendout capacity of 420 Bcf/d, which NGT plans to expand to 1.3 Bcf/d by the end of 2007. Algeria's Sonatrach and BP are the principle importers using the terminal.

ExxonMobil and Qatar Petroleum have received regulatory approval for the South Hook LNG receiving terminal in Milton Haven, Wales. The terminal will receive its LNG from the Qatargas II liquefaction project in Ras Laffin, Qatar, which is also a joint project between the two companies. The South Hook LNG project should come online by 2007, with an initial capacity of 1.0 Bcf/d and a maximum capacity of 2.1 Bcf/d by 2009.

Finally, BG has collaborated with Netherlands-based Petroplus and Malaysia-based Petronas to build an LNG receiving terminal in Milton Haven, on the site of an existing natural gas storage facility owned by Petroplus. Dragon received regulatory approval from Ofgem in early 2005, and the project should start receiving cargos by the end of 2008 at an initial sendout capacity of 580 Mmcf/d.

Most chemical sites are located near refineries and connected to offshore natural gas fields via pipelines. Interconnections between individual chemical sites are restricted to the onshore natural gas network operated by NGT and several ethylene pipelines. The latter connect Shell Chemicals at Stanlow, North West England, via Grangemouth to an ethylene facility at Mossmorran, Scotland, and to Wilton, Teesside, North East England. In 2001 BP Amoco's ethylene pipeline running from Grangemouth to Teesside, was extended by the Teesside to Saltend Ethylene Pipeline (TSEP) to reach its petrochemical facility in Saltend, near Kingston-upon-Hull, Yorkshire.

As most chemical sites in the UK are located at the coast, both the supply of feedstock and the delivery of products can easily be accomplished via sea routes.

3 Northern France (Seine Valley):

As France is an oil importing country with only minor oil production in the basin of Paris and in Aquitaine, the port of Le Havre is especially important as a transit point for crude oil and natural gas. The pipeline Le Havre-Grandpuits transports crude oil from Le Havre via Gargenville to a Total refinery in Grandpuits, south of Paris. The Antifer-Le Havre pipeline connects the oil fields in Aquitaine to Le Havre.

However, most of the oil is refined in Le Havre itself which accounts for about one third of the national oil refining capacity. Pipelines carrying finished products form two extensive networks starting from Le Havre: the Le Havre-Paris (LHP) network and the ODC network (NATO Pipelines in France, mainly for kerosene supply). These are both operated by Trapil which is owned by Total, Pisto SAS, Esso, Shell and BP.

Although chemical plants on the Le Havre site are well connected (i.e. the Port of Le Havre, the Le Havre area and the Port of Jerome-Gravenchon area), ethylene, propylene and industrial gas links to other sites do not exist.

Le Havre's coastal location on the Seine River facilitates transport of both raw materials and products.

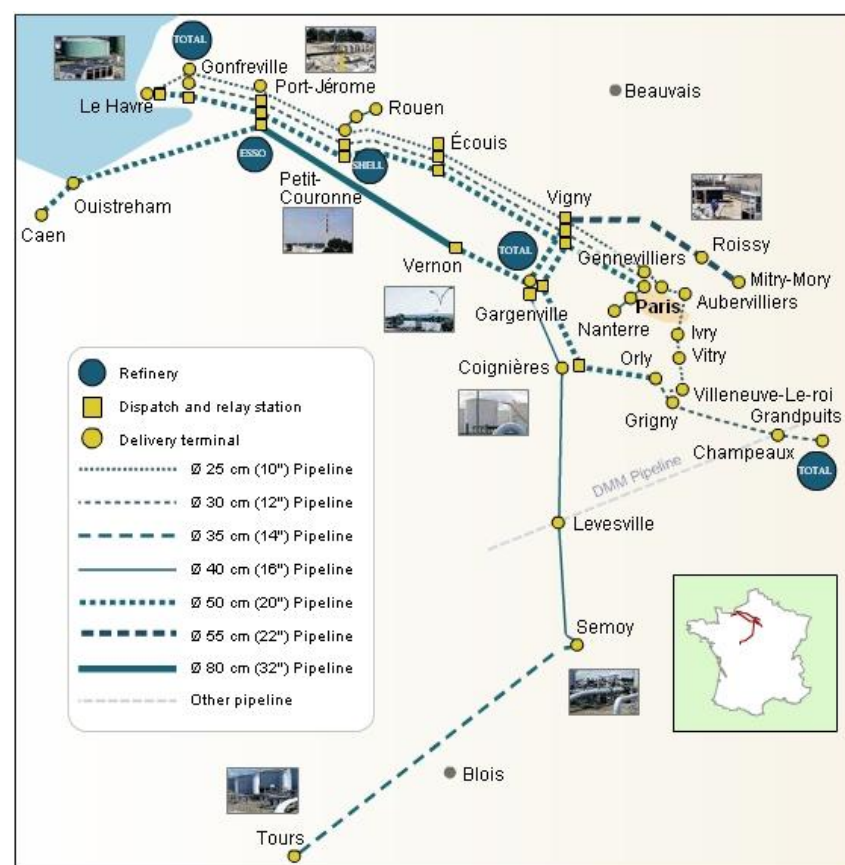


Fig.10 - The Le Havre-Paris (LHP) network for refinery products (Source: Trapil)

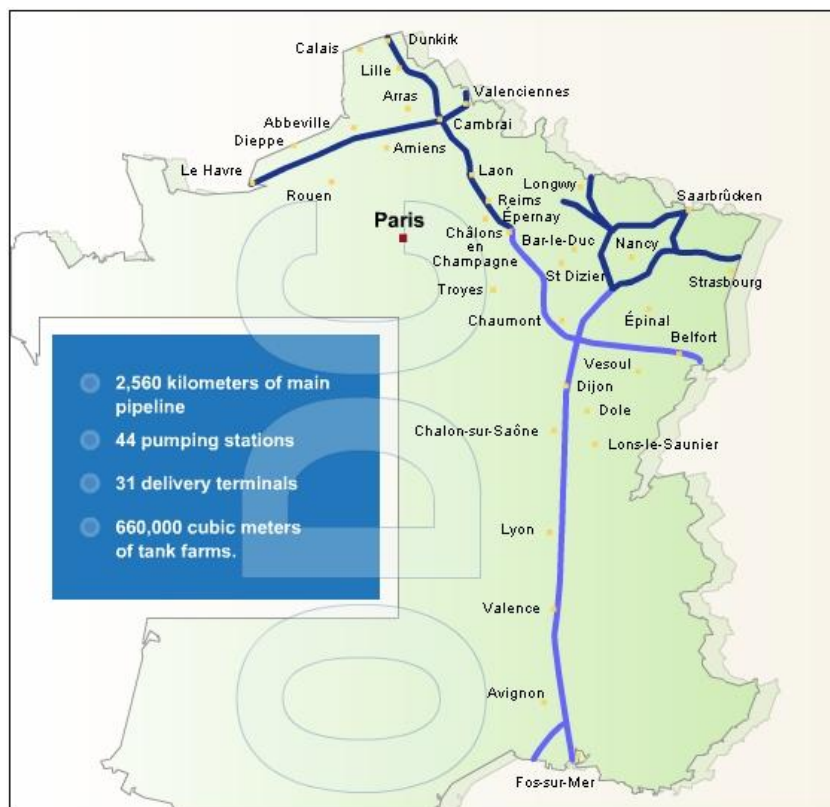


Fig.11 - ODC network - NATO Pipelines in France (Source: Trapil)

4 Southern and Eastern France/Southern Germany:

Marseille is not only the southern transit point for oil and natural gas in France but with four refineries also a major distribution channel for refinery products. The South European crude oil pipeline (SPSE) starts in Marseille and supplies the refineries at Karlsruhe. Karlsruhe is also connected to Trieste via the Deutsche Transalpine Ölleitung (TAL) pipeline which is the main source of crude oil for the refineries in Ingolstadt and Burghausen.

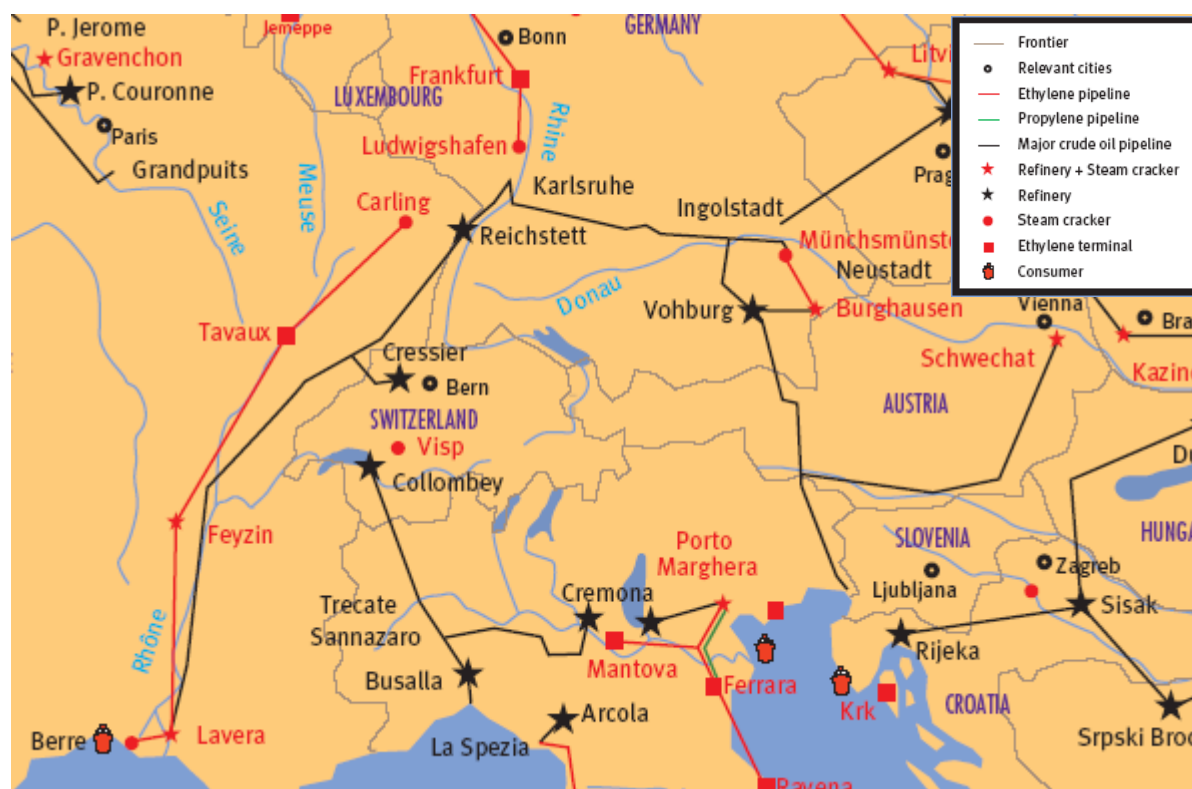


Fig.12 - Refineries, Product Pipelines and Crackers in Europe (Source: APPE, 2004)

While the LNG terminal in Fos-sur-mer at Marseille secures natural gas supply for the regions in Beziers, Toulon, Lyon and partly Paris, the Bavarian chemical sites obtain natural gas via a pipeline network from Russia.

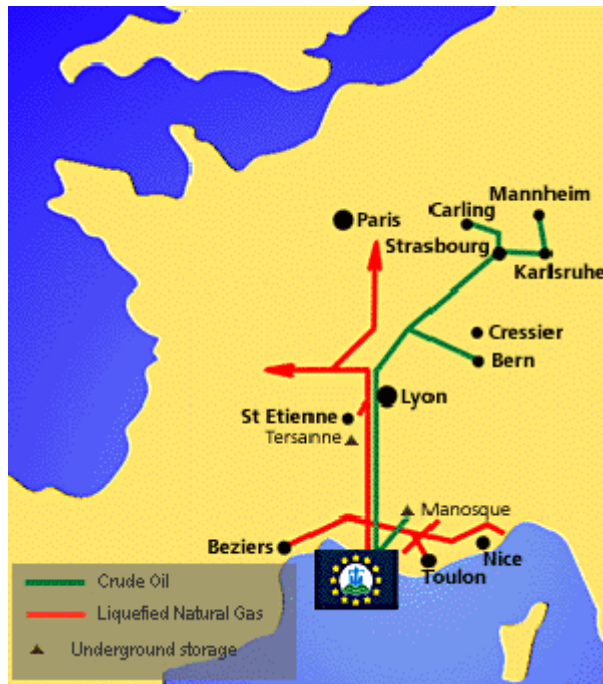


Fig.13 - Oil and natural gas pipelines at Marseille (Source: Port of Marseille)

The Marseille refineries distribute products such as fuel, gasoil, gasoline, jetfuel and naphtha via the Mediterranean-Rhone pipeline (PMR) which is operated by Trapil. An ethylene pipeline connects the Marseille area to Carling via St. Auban and Pont-de-Claix thereby supplying the Lyon region.



Fig.14 - The Mediterranean-Rhone pipeline PMR (Source: Trapil)

As can be seen in the APPE map above, the Ruhr Oel refinery at the petrochemical complex in Münchsmünster supplies the Bavarian chemical triangle in the area of Burghausen with ethylene. The Bavarian chemical triangle is a chemical cluster with a well established network between the three major sites at Burghausen, Burgkirchen/Gendorf and Trostberg. An

ethylene pipeline from Ludwigshafen via Karlsruhe to Münchsmünster will connect the Bavarian chemical triangle to the extensive ARG ethylene network in Northwest Europe. Construction works are scheduled for spring 2007 and the pipeline should be operational by the end of 2007.

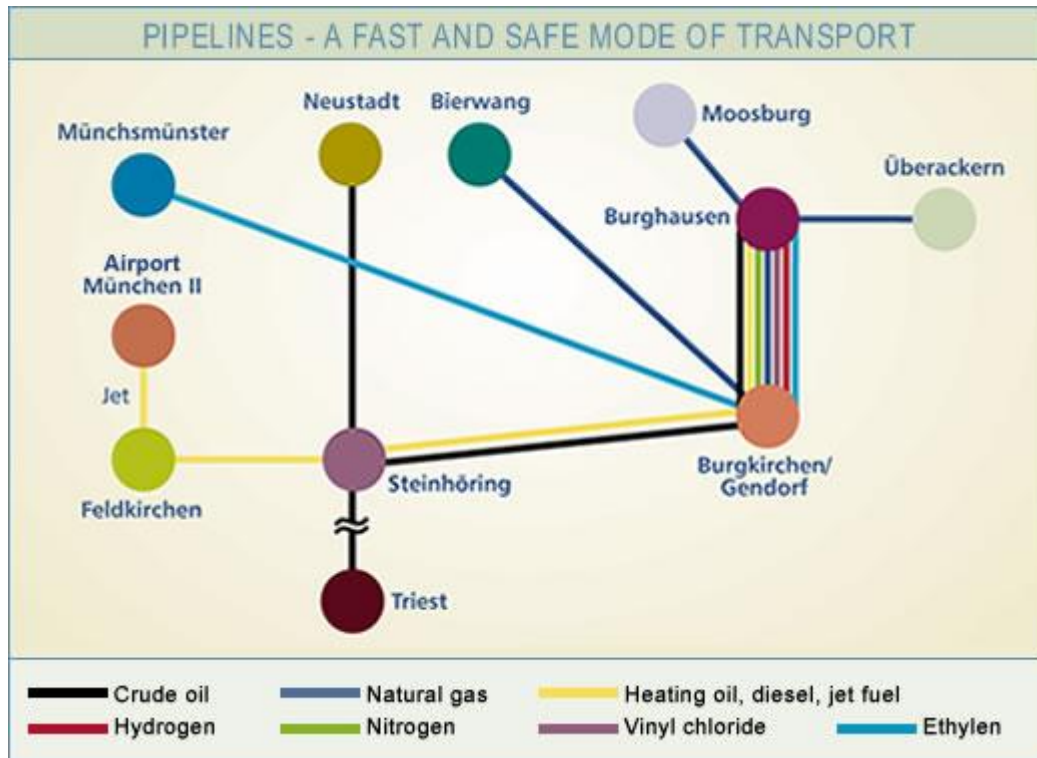


Fig.15 - Interactions in the Bavarian chemical triangle (Source: Bavarian chemical triangle)

The Rhône and the Mediterranean Sea offer good waterway connections to the Marseille and Lyon area whereas the Bavarian chemical triangle has no waterway connections. The Ingolstadt refinery can however be supplied with oil from the Caspian Sea by using the Donau and Black Sea waterways.

5 Eastern Germany:

The chemical sites in the Central German Chemical Triangle are supplied with Russian crude oil by two joining pipelines: The Rostock-Schwedt pipeline and the “Drushba” pipeline.

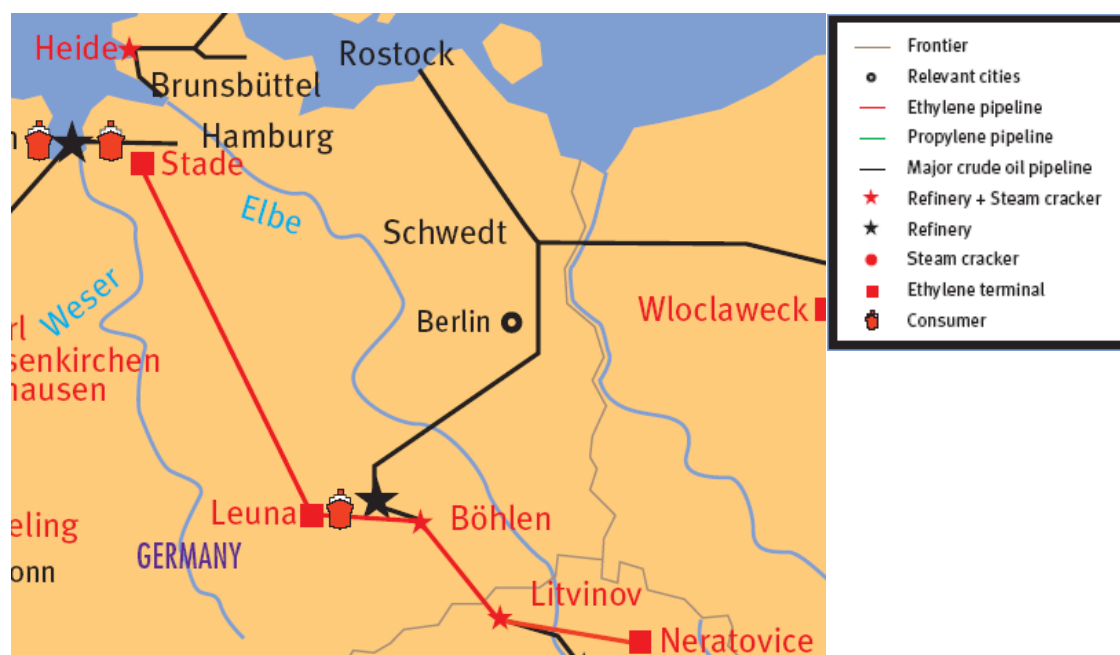


Fig.16 - Refineries, Product Pipelines and Crackers in Europe (Source: APPE, 2004)

The Verbundnetz Gas AG supplies natural gas bought mainly in Russia.

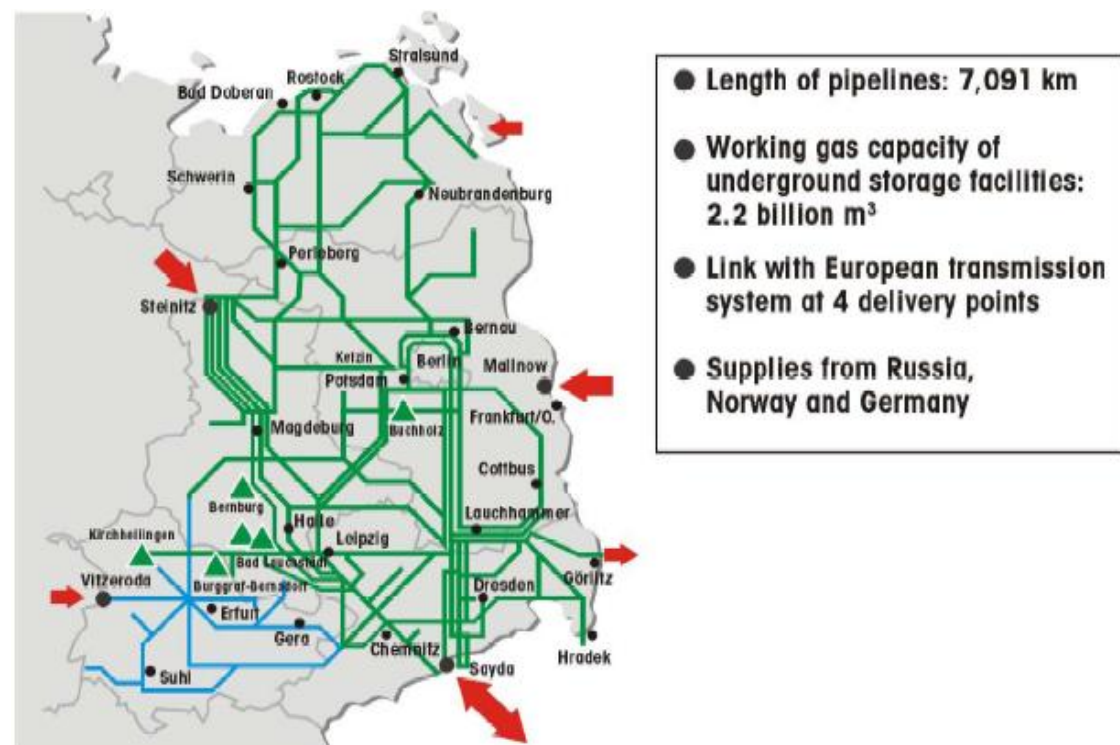


Fig.17 - The Verbundnetz Gas AG natural gas pipeline grid (Source: Verbundnetz Gas AG)

The Central German Chemical Triangle's sites in Leuna, Merseburg, Bitterfeld/Wolfen, Zeitz and Schwarzheide are connected by an extensive pipeline system transporting raw materials and intermediates.

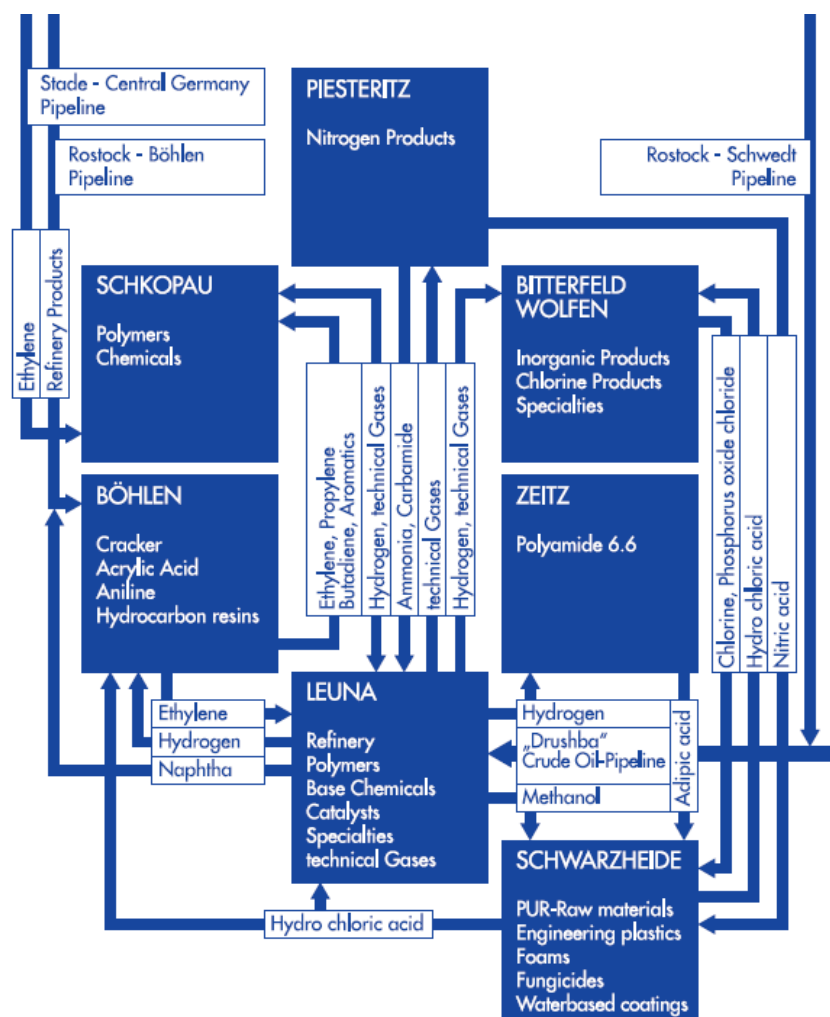


Fig.18 - Central German comprehensive interlinked materials flow network (Source: CeChemNet)

In 2003 Dow put its ethylene pipeline connecting Stade to Leuna on stream. The ethylene terminal in Stade is supplied by ethylene shipments on the Elbe. If an additional cracker at Boehlen was built, the pipeline could be used in the reverse direction to transport propylene. The ethylene network extends further to Litvinov and Neratovice in the Czech Republic. Another pipeline transports propane and pentane from Rostock to a plant in Boehlen.

Linde AG operates a hydrogen supply network as hydrogen is produced almost entirely by a single natural gas reformer.

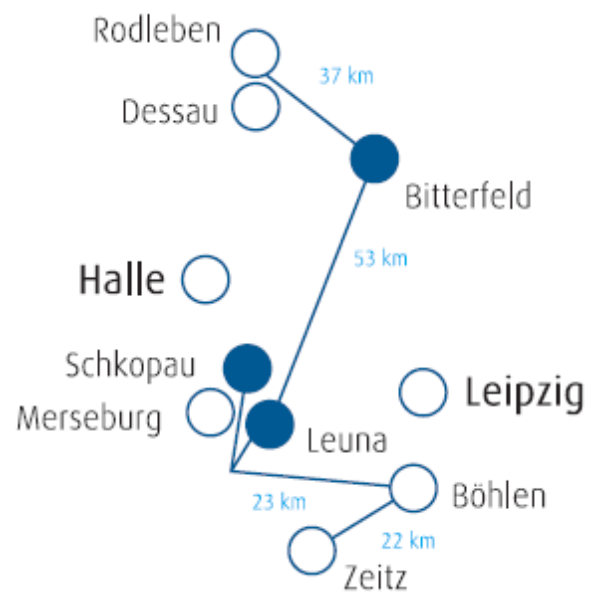


Fig.19 - The Linde hydrogen pipeline network in Central Germany (Source: Linde AG)

6 Italy:

With limited domestic energy sources, Italy is highly dependent on imports to meet its consumption needs. In absolute terms, oil consumption has remained relatively static since 1970, but oil's share of Italy's primary energy mix has decreased significantly, steadily replaced by natural gas.

In December 2001, Eni completed the 85-mile Monte Alpi pipeline, with a capacity of 150,000 bbl/d. The Monte Alpi system connects the Val d'Agri oil project with Eni's Taranto refinery in the South of Italy.

Italy has the third-largest natural gas transmission system in Europe. According to Snam, the system consists of 19,000 miles of pipelines carrying over 2.7 Tcf of natural gas per year.



Fig.20 - Major natural gas pipelines in Italy (Source: Edison)

Most of Italy's natural gas imports enter the country through international pipelines. The 670-mile Trans-Mediterranean (Transmed, also called Enrico Mattei) line runs from the Hassi R'Mel gas field in Algeria to Sicily, via Tunisia, where it interfaces with the domestic gas

network. Completed in 1983 and doubled in 1994, Transmed has a capacity of 2.33 billion cubic feet per day (Bcf/d). There are plans to construct an additional compressor station along the Transmed that could increase capacity to 3.48 Bcf/d. The Trans-European Pipeline (TENP) and the Transitgas pipeline bring natural gas from northern Europe (mostly the Netherlands and Norway) into Italy, entering the country at the Passo Gries transit point near Milan. Italy imports natural gas from Russia at two entry points: via the Trans-Austrian Gas Pipeline (TAG) at Tarvisio, and via Slovenia at Gorizia.

In October 2004, natural gas flowed for the first time through the Greenstream pipeline linking Mellitah, Libya to Gela, Sicily. Majority-owned by Eni, the 370-mile Greenstream has a capacity of 970 million cubic feet per day (Mmcfd) and connects Italy with the Western Libya Gas Project. In order to comply with Italian energy regulations, Eni has agreed to sell all gas supplied by Greenstream to other natural gas companies.

Imports of LNG constitute a very small portion of Italy's total natural gas imports. The country has a single LNG receiving terminal at Panigaglia, located on the country's western coast near La Spezia. According to Snam, the terminal's operator, the Panigaglia facility produced 240.9 Mmcfd of natural gas in 2005.

Polimeri Europa operates two ethylene pipelines on the Sicilian territory allowing ethylene to be transferred from the Priolo site to the Ragusa and Gela sites. Polimeri Europa also interconnected its sites in the North East of Italy: Ethylene supply from the naphtha cracker to Mantua and Ravenna via Ferrara is secured by the naphtha cracker on the Porto Marghera site. Only the Ferrara site is also linked to the cracker by a propylene pipeline. Ferrara supplies Ravenna with ammonia.



Fig.21 - Ethylene and Propylene Pipelines in Italy (Source: APPE, 2004)

Both Spain and Portugal do not have any significant underground or continental shelf oil and gas reserves and, consequently, depend upon imports for most of their oil needs. Like most oil-importing EU countries, Russia is a major supplier, followed by Mexico, Saudi Arabia and Libya. Most of the oil is transported by ships to locations at the coast where most refineries and petrochemical complexes are situated (except Puertollano, which is supplied with crude oil by a pipeline from Cartagena).



Fig.22 - Refineries, crude oil and oil product pipelines in Spain (Source: concawe, 2006)

Spain imports natural gas through two international pipelines. The Trans-Pyrenean pipeline, linking Calahorra, Spain to Lacq, France, began operations in 1993. This pipeline has a capacity of 330 million cubic feet per day (Mmcf/d), allowing Spain to import natural gas from Norway via France. The second import pipeline is the 1,000-mile, 820-Mmcf/d Maghreb-Europe Gas (MEG, also called Pedro Duran Farell). MEG, completed in 1996, connects Algeria's Hassi R'mel gas field with Cordoba, Spain, via Morocco. In August 2001, Algeria's Sonatrach, part owner of MEG, awarded ABB a \$93 million contract to build a natural gas

compressor station on MEG in order to increase the line's capacity to 1.78 billion cubic feet per day (Bcf/d) by the end of 2006.

In July 2001, a consortium led by Spain's Cepsa (20%) and Algeria's Sonatrach (20%) agreed to build the Medgaz natural gas pipeline, a second link between Algeria and Europe. The 120-mile, \$1.3 billion Medgaz will link Beni Saf, Algeria to Almeria, Spain, with an eventual extension to France. In September 2002, the consortium completed a study of the line's feasibility, but delays have pushed initial construction on the project to late 2006. Medgaz should be completed by 2009 and will have an initial capacity of 770 Mmcf/d.



Fig.23 - Natural gas grid in Spain (Source: Stanford Institute for International Studies)



Fig.24 – LNG Terminals in Spain

Spain is one of Europe's largest LNG importers. Enagas operates three LNG receiving terminals in Spain: Barcelona (2.5 Bcf/d), Cartagena (1.4 Bcf/d), and Huelva (1.7 Bcf/d). The Bahía de Bizakaia Group, a consortium of BP, Repsol-YPF, Iberdrola, and Ente Vasco de la Energía (EVE), operates an LNG terminal at Bilbao, with a capacity of 1.2 Mmcf/d. The consortium also owns an 800-megawatt (MW) power plant fed by the terminal. The Sagunto LNG terminal, owned by a consortium of Union Fenosa, Iberdrola, and Endesa, has a capacity of 1.2 Bcf/d.

Union Fenosa and Endesa are also leading construction of the El Ferrol LNG terminal in northwest Spain. Slated for completion in late 2006, the El Ferrol plant will produce 350 Mmcf/d of natural gas using LNG supplied by Algeria's Sonatrach.

In October 2003, Portugal completed its first LNG terminal in Sines, with an output capacity of 530 Mmcf/d of natural gas. The Sines terminal, operated by Galp Energia subsidiary Galp Atlantico, allows Portugal to seek greater independence of its natural gas supply, which at present is dependent on Spain's natural gas network to process and transport natural gas to the country.

There are no significant interconnections between chemical sites on the Iberian Peninsula. However, the coastal location facilitates the transport of feedstock and products by waterway.



Fig.25 - Spanish Automotive fuels pipelines



Fig.26 – Spanish Natural gas network