

## Extraction and distribution

### The extraction

Often, albeit not always, natural gas is extracted from the same fields as oil. Just like oil, natural gas is the result of the transformation of organic substances deposited at the bottom of ancient seas and lakes (sedimentary basins). Therefore, there is no search for natural gas distinct from that of oil, but a single research activity for hydrocarbons: only after exploration wells are drilled is it possible to ascertain the nature of the deposit. The term “associated gas” is used when natural gas is dissolved into oil or makes up the top layer of the oil field; the expression “non-associated gas” is used when the field contains almost exclusively natural gas (for example, the large field of the North Sea or the Netherlands). Extracting natural gas from underground is quite easy. Usually it is trapped together with oil under a rock layer. Due to the big pressure, as soon as drilling is finished, the gas comes out and it is necessary to “direct” it into a pipe and guide it towards its final destinations or storage centres. The latter are not tanks like the ones containing oil, but they are exhausted natural reserves that once contained natural gas, oil or water and that are used today as real “warehouses” for the gas.

### The treatment

If the natural gas from the field is wet, it undergoes a preliminary conditioning to separate methane from the other gaseous hydrocarbons such as propane, butane and ethane. The separation is simplified by the fact that methane is marked by a much lower critical temperature (above which gas cannot be liquefied). The amount of wet gases available on the market is very large since gas extracted along with oil is always wet. After being liquefied, humid gases are bottled for household uses in 10/15 kg containers or bigger bottles for industrial purposes. Methane is distributed through the pipeline networks

Albeit rarely, the methane from some fields needs to be purified. The most damaging impurity undoubtedly is sulphur because it produces sulphur dioxide during combustion and when the weather is humid it causes acid rain, responsible for lung diseases, the deterioration of plants and anything being exposed to it. Sometimes the gas extracted contains precious substances too, such as helium, used to make airships fly and mixed with oxygen in scuba-diving bottles.

Although extraction is simple and the quality of natural gas as a fossil fuel is high (also from the environmental viewpoint), up to the second world war the use of methane was very limited.

### The transport

The long distance transport of natural gas started in 1958 when natural gas was imported from Canada into the U.S. At present natural gas is transported in the gaseous state through gas pipelines, else by means of natural gas carriers in the liquid state (Liquefied Natural Gas).

Gas pipelines allow the transport of a large quantity of natural gas directly from the place of production to the place of consumption without any loading or storing operation.

After the safest and more effective route is identified, a trench is dug to lay previously welded together steel pipes. To prevent any leak, each welding is x-rayed to check it is perfect. To prevent corrosion, the pipe is covered by a layer of bitumen, tar and synthetic resins and protected by means of dedicated electronic devices. Finally, the gas pipeline is buried and the landscape is restored. The presence of the gas pipeline is signalled by special signs. Every 100/200 km compression stations are installed to restore a sufficient pressure to make the natural gas move at a speed of 20-30 km/h. Gas pipeline networks also comprise storage stations where the natural gas is kept available in case of emergency. Depleted fields near the place of consumption are preferably used as deposits. Their geological features ensure maximum safety against possible leaks.

The whole of Europe is crossed by long gas pipelines that run underground. In this way the landscape is not spoilt. When resorting to gas pipelines is impossible – because the distance to be bridged is excessive or an excessively long

sea route needs to be covered - natural gas is liquefied and transported by LNG carriers.

At present 25% of natural gas is transported via LNG carriers. Natural gas is liquefied at  $-161^{\circ}\text{C}$  and its volume is reduced by 600 times as compared to the original natural gas. A LNG carrier on average carries 130,000 m<sup>3</sup> of liquefied natural gas, i.e. 78 million cubic metres in the gaseous state. Transport costs are higher in the case of LNG carrier is because different transshipments are necessary. The first takes place from the field to the coast via a gas pipeline. Then the gas is liquefied and loaded onto an LNG carrier equipped with heat proof tanks. Finally, after it has been unloaded from the LNG carrier it is turned into gas and conveyed into the gas pipeline. During the maritime transport part of the natural gas evaporates and contributes to keep the temperature low, part of it is used as fuel for the LNG carrier itself.

## Natural gas storage

The storage of natural gas plays an important role in regulating the supply in order to meet the great seasonal variation in demand. Consumption of natural gas is much greater in winter than in summer, while the supply of gas is relatively stable throughout the year. The excess supplies of natural gas produced or imported in the summer months are generally stored in depleted reservoirs and can be withdrawn in winter when demand is greater than supply. The storage of natural gas is implemented through an integrated infrastructure system that consists of depleted reservoirs, gas processing plants, gas compression stations and operational dispatching systems. The underground storage of gas has played and continues to play a significant role in the development and stabilisation of the gas market. Storage is called conventional when depleted or partially depleted gas production reservoirs are used, semiconventional when depleted oil reservoirs or aquifers are used and special when it takes place in caverns created in underground salt formations or in abandoned coal mines.

At present there are 10 natural gas storage fields in Italy with a total capacity of 16 billion cubic metres. In Italy, storage fields are obtained exclusively from nearly depleted gas reservoirs. This choice is a consequence of the geological characteristics of the country and of the fact that the depletion of some gas fields has provided structures that are suitable for use as storage facilities.

## The distribution

From the large pipes of the national distribution network, thousands of kilometres of smaller pipes are derived to convey natural gas to industrial plants and households. In the city networks managed by the distribution firms the gas pressure is maintained at lower levels than the large transport networks for technical and safety reasons. In 2014, 42% of the natural gas distributed in Italy is used in the civil sector, 30% in thermoelectric power plants and about 24% in industry (Source: Bilancio Energetico Nazionale 2015 - Ministero dello Sviluppo Economico).

Before being conveyed to the distribution network, natural gas is added odour, i.e. it is mixed with a substance characterised by a strong smell called "mercaptans". Therefore users immediately realise if there is a leak. In indoor environments, (e.g. a room), natural gas is mixed with the air and if an igniting factor is present (a flame or a spark caused by switching on the light), it explodes. Therefore, if we come back home or walk indoor and smell a strong odour, we need to avoid switching on the lights or starting any fire. Rather, we have to open doors and windows (natural gas is not toxic) and let it be dispersed outside. For those who cannot smell odours, ad hoc devices were created to signal any leak through visual or acoustic signals. Since natural gas is lighter than the air, such devices ought to be placed near the ceiling.

Environmental impacts associated with the transportation and distribution phases are of two kinds:

- Uncontrolled release of gas into the atmosphere as a result of leakage;
- Loss of water and gasoline deposited at the bottom of the pipeline.

In order to prevent gas leaks, gas pipelines are monitored constantly and the pressure along the entire distribution line is controlled so that leaks can be detected promptly. It has been estimated that over a distance of 4000 km, less than 1% of the gas transported by pipelines is lost. Generally, leakages are greater in the low-pressure urban distribution networks

that carry gas to the residential areas, because often the pipes are old. The substitution of old distribution networks and the use of innovative materials is the best solution to drastically reduce leaks.

## The distribution of gas in Italy

In Italy, imported natural gas is introduced into the national network at seven entry points, where the network connects to the import pipelines (Tarvisio, Gorizia, Passo Gries, Mazara del Vallo, Gela) and at the LNG regasification terminals (Panigaglia, Cavarzere). Italy's major supplier is Russia; 51% of natural gas imports originate from Russia and is injected into the national network at the entry point of Tarvisio and Gorizia. The second most important exporter is Libya with 13% and Algeria (13%); natural gas from Libya and Algeria is injected into the national network at the entry point of Mazara del Vallo in Sicily. The imports from Netherlands (8%) and Norway (5%) follow. Natural gas produced in Italy is injected into the national network at 51 entry points from the production facilities or from their collection and treatment plants; natural gas storage facilities are also connected to the network.

The gas distribution network reaches cities on the plains and in numerous valleys, bringing natural gas directly into the vast majority of homes. The transport of natural gas in Italy occurs at two main levels. The first, called "primary distribution", involves transport at a national scale through large pipelines. The second level or "secondary distribution" supplies gas locally through a widespread system. Primary distribution is guaranteed by a 29,300 kilometre-long gas pipeline network that spans the whole of Italy, with the exception of Sardinia. A new gas pipeline is being built to transport natural gas from Algeria to Italy via Sardinia. This new pipeline, called Galsi (the acronym of Gasdotto Algeria Sardegna Italia) will be completed in 2018.

In Italy natural gas is distributed for civil use (42%) and for industrial and thermoelectric uses (around 52%). Secondary distribution is carried out by municipal companies, local governments or private companies. The local companies that receive natural gas at delivery points outside the cities oversee its distribution through their networks in over 5,000 municipalities, delivering natural gas to families, commercial businesses and small industries.

## Decommissioning

When a gas field is depleted, the decommissioning of the production facilities follows. The activities carried out during the decommissioning phase include the safe removal of the pre-treatment plant, the platform structures, the compression structures and the hydrocarbon dispatch facilities and the removal of the wellheads and the pipelines that connect to the collection points. Following the dismantling of the production facilities, there is the environmental restoration phase. The areas where the wells and the treatment facilities were located are reclaimed and restored to pre-mining conditions, with the planting of grasses and trees. As far as the decommissioning of offshore facilities is concerned, operations to safely plug and abandon the well must be carried out and the installations and pipelines that connected the platform to treatment facilities on land must be removed. These operations are very delicate and require specialised personnel in order to avoid adverse environmental impacts. Once the installations have been removed, suitable sites must be identified for materials that cannot be reused and for the disposal of potentially polluting products. An alternative to the dismantling and removal of offshore installations envisages the reuse of disused platforms in-situ as artificial barriers, for example. In fact, it has been observed that many artificial structures placed in open water are soon colonised by benthic macrofauna and by a large number of fish species that find a suitable habitat to reproduce. Another alternative is the installation of offshore wind turbines on the disused platforms. In fact, these offshore platforms can support wind turbines with the advantage that they are far from the coast, where the winds are strong and constant, and where there they do not have a negative effect on the landscape. The option of leaving disused offshore platforms in place must be carefully evaluated from an environmental and a legislative point of view.