Introduction

Most of the incoming gas is from Russia. It is distributed to the Austrian provinces and neighboring countries via systems that branch out like the spokes of a wheel. The Baumgarten compressor station also meters, tests and compresses the gas before transmission to other destinations.

Europe’s gas hub

Starting with the signing of the first delivery contract for the import of natural gas, the Baumgarten compressor station located near the Slovak border and the Zwerndorf gas field became one of the most important natural gas platforms in Europe.

Along the large transit pipelines (HAG, Penta West, SOL, TAG and WAG) there are, in addition to the compression facilities necessary for transportation, a large number of branching points and transfer stations to send gas to Austrian and foreign consumers.

The map on the flap of the back cover gives a detailed view of pipeline routes.

Use of natural gas for domestic, commercial and industrial purposes, and power generation has grown by leaps and bounds over the past three decades. Because it can be put to use in so many economically and environmentally friendly types of energy consumption it is good to know that usable reserves of natural gas are constantly increasing.

Through constant improvements in detection methods the discovery of natural gas continues to outpace production. Security of supply, low emissions and environmentally friendly transportation mean that natural gas is set to become a key energy source of the future.

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The energy all-rounder

Natural gas is the most environmentally friendly fossil fuel. The main combustion products are steam and very small amounts of carbon dioxide (CO₂).

Natural gas is a primary energy source. This means that it is a natural product from which energy can be gained directly without undergoing any conversion.

In addition to traditional uses such as cooking, heating and hot water systems, natural gas provides energy for refrigeration and power generation.

Natural gas is also increasingly being used to fire combined heat and power plants. And in combination with fuel cell technology it is once again playing a revolutionary role.

In a fuel cell, the natural gas is first converted into hydrogen in order to generate electricity. Fuel cell technology can be used for stationary applications such as mini power plants, or mobile ones in the form of vehicles. Pilot plants are already in operation.

Automobile manufacturers, too, have discovered the advantages of natural gas as a fuel, and offer vehicles equipped to run on compressed natural gas (CNG).

Natural gas is a mixture of hydrocarbon compounds. After the removal of any fractions of higher hydrocarbon compounds such as propane and butane (liquid gases) what remains is approx. 97% methane. Due to its purity, the chemical industry uses methane to manufacture a vast range of products.

The smallest component of natural gas is a CH₄ molecule (1 carbon atom and 4 hydrogen atoms).
Oil and gas were now mobile, and they separated from one another and accumulated, tending to collection in locations such as the undersides of domes of impermeable stone – clay, for example – whose pores were too fine to permit further ascent.

A reservoir is formed

Directly below the impermeable layer is the natural gas, which forms a gas cap; oil is below the gas and under the oil is the saline water of the primeval oceans.

The processes described above are still going on today, at various speeds and intensities. One example is the Black Sea, which is cut off from marine currents by the Bosphorus.

Additional sedimentation, as well as the formation of mountains, further raised the pressure and temperature. At depths of around 2,000 meters (m) and temperatures of over 70° C it was mainly oil that was formed, but at greater depths and at temperatures upwards of 200° C only natural gas was produced. As a result of the increase in volume due to the conversion of kerogen into oil and natural gas, and of the pressure of overlying rock formations, these hydrocarbons were pressed out of the plastic clay. Because of their lower specific gravity, they migrated towards the surface, only to be captured in microscopic pore cavities in porous sandstones.

This process is known as migration (Fig. 3).

In the process, the pressure and temperature increased (Fig. 2). At a temperature of 50° C, biochemical processes generate so-called kerogen, the parent material for subsequent conversion into petroleum and natural gas.

The resultant fine-grain rock, which contains enough organic material for the formation of hydrocarbons, is known as parent rock.

Nature’s bounty

Over millions of years petroleum and natural gas formed from vegetable and animal residues.

Natural gas is a mixture of gaseous substances; some 97 % is pure methane (CH4). The rest is made up of ethane, propane, butane and noncombustible materials such as carbon dioxide (CO2) and nitrogen (N2). Some natural gas deposits also contain small amounts of hydrogen sulfide (H2S).

Petroleum and natural gas originated millions of years ago, when large areas of the today’s landmass were covered by oceans. Their formation required ocean basins without circulating water which encouraged the growth of vast quantities of animal and vegetable plankton. When these organisms died they sank slowly to the ocean bed, and began to decompose, and the oxygen dissolved in the water was soon used up.

Further sinking organic matter, also including large quantities of dead land plants, migrated to the resultant oxygen-free depths. Due to lack of oxygen, decomposition ceased, and the wholly or partially undecomposed organic matter (proteins and fats) gathered on the ocean bed together with precipitating fine clay particles (Fig. 1.)

This mixture of organic residues and clay is called digesting sludge. Over the course of millions of years further sedimentation including layers of sand and clay pressed the organic slime further into the depths.
**Set to run and run**

According to current estimates the world has enough natural gas to last for the rest of the century. New exploration methods are constantly extending the lifetime of probable reserves.

The largest proven reserves in Europe are in Norway, the Netherlands, the United Kingdom and Romania.

The world’s largest gas producing regions are Russia and the Middle East. The presently known natural gas reserves that can be economically extracted using current technology are sufficient to meet global demand until the next century. Constant improvements in exploration methods mean that worldwide more gas is being discovered than produced. In fact, the undiscovered reserves are far larger, and are certain to last for generations.

Alongside the world’s conventional deposits there are also unconventional ones in the form of gas hydrate accumulations on the sea bed; however, given the current state of technology these are non-viable.

Gas hydrates are solid, snow-like compounds of natural gas and water that are found in permafrost regions and on the ocean floor. They are expected to make an increasing contribution to the natural gas supply from the middle of this century onwards. Even if only a fraction of the hydrate reservoirs can be exploited, this will transform the gas reserve situation.
Historical milestones

From a geological point of view some 50% of the total area of Austria is oil and gas prospective.

Most of Austria’s natural gas is in the Vienna Basin and throughout the Prealpine Regions which were filled with sand and gravel in the course of the weathering of the Alps.

There are producing fields in Lower Austria, Vienna and Upper Austria, at depths of between 500 and 6,000 m.

All gas fields are named after the cities or towns under which they lie. The largest ones in Lower Austria are Aderklaa, Höflein, Matzen, Roseldorf and Zwerndorf. In Upper Austria they are Lauterbach, Schwansenstadt and Voitsdorf, and in Salzburg Nusdorf and Zagling.

Natural gas production in Austria began at Oberlaa, to the south of Vienna, in 1951. However, the reservoir contained only 15 million (mn) cubic meters (cbm) of natural gas, and this was used to fire the Simmering power plant for two years. The first major natural gas discovery was made in 1952, near Zwerndorf.

It was not possible to start building up a sustainable natural gas industry until 1955, when the rights of the Soviet Mineral Oil Administration (SMV) were transferred to the Austrian government after the signing of the State Treaty.

The production operations of the newly founded Österreichische Mineralölverwaltung (ÖMV) centered on the Zwerndorf Field, where it used newly acquired drilling rigs and equipment inherited from SMV. The Matzen Field followed in the Seventies.

Back in 1955 output was 700 mn cbm, and by 2000 it had risen to 2 bcm a year. Domestically produced natural gas now meets about 20% of Austria’s needs.
With a little bit of luck

Natural gas reservoirs are situated between 500 and 8,000 meters below the earth’s surface. At such depths they cannot be precisely pinpointed, but their presence can be deduced from seismic and geophysical test data.

The only survey method used to identify hydrocarbon deposits in Austria is **3D seismic**.

Special heavy vehicles set off vibrations which spread outwards in all directions, like sound waves.

The seismic waves take longer to travel through some kinds of rock strata than others. The waves are reflected by the interfaces between geological layers, like echoes. Geophones, which work similarly to microphones, pick up the vibrations and convert them into electrical impulses.

These signals are analyzed by special computer programs that generate 3D images of the subsurface.

These images allow geologists to determine whether given formations are likely to be hydrocarbon bearing on the basis of their depth, shape and size.

However, only exploration drilling provides complete certainty that potential reserves are actually in place.

In the depths of the Earth

A drilling rig’s turntable rotates a roller or diamond bit, which “eats” its way into the earth’s crust.

The well starts with a diameter of 70 – 100 cm and progressively narrows as it increases in depth.

To prevent the well from caving in, it is cased with steel tube, section by section, and insulated from the surrounding rock with cement.

As soon as the first casing string is in place so-called “blowout preventers” – safety rams – are installed for protection against uncontrolled gas releases. During the drilling operations the rock chips cut away by the bit and washed back up to the surface are constantly analyzed to gain information about the characteristics of the formations being bored into.

A successful gas well does not necessarily result in production. Only after lengthy investigations does it become clear whether it is worth building a production system. If a reservoir turns out to be prolific the discovery is developed by drilling extension and production wells.
One step from perfection

After purification and drying natural gas is ready for use.

Natural gas is under pressure, and thus flows to the surface of its own accord (it exerts downward pressure on the water table, which rises when gas is extracted). The gas travels via gathering lines to central processing plants.

There, natural impurities are removed and the gas is brought up to necessary commercial quality. Fine sand particles are filtered out, and the gas is “dried” by regenerative processes that separate out the water vapor it contains.

The composition of the gas varies from field-to-field. The main component is always methane (97 %), but some reservoirs also contain concomitant substances such as carbon dioxide or sulfur compounds.

Chemical and physical scrubbing in treatment units removes these impurities from the gas.

Special treatment processes convert the sulfur compounds in so-called “sour gas” into elementary sulfur. This is mainly used by the chemical industry to produce sulfuric acid which is then employed in other chemical processes.

Far fetched

Austria’s gas fields meet 20 % of domestic demand.
The other 80 % come mainly from …

... Siberia

Most of Austria’s gas imports come from Russia. West Siberia holds about one-third of the world’s recoverable gas reserves. It is about 45 times the size of Austria, and has a harsh climate.

Gas production takes place under very severe conditions, using ultra-modern technology. Winter temperatures range from -20° to -50° C, and the permafrost is over 400 m deep. In 1968 OMV became the first western energy group to conclude a long-term supply contract with the former USSR. Its example was subsequently followed by other western gas companies.

Current supply agreements with the Russian gas producer Gazprom guarantee deliveries through to 2027.

The combined length of the Russian pipeline system represents more than half of all that of all the transmission pipelines in Europe. Siberian gas takes about six days to reach the Baumgarten transmission hub, traveling over 4,000 km.

... the North Sea

Back in 1986 – eight years before the largest production platform at the Troll field was completed – OMV signed supply agreements with durations up to 2020 and beyond with a consortium of Norwegian producers.

The Norwegian gas comes from offshore fields (i.e., under the sea bed), and is transported by subsea pipelines to the German North Sea coast, continuing its journey to Austria along the European transmission network.
International gas trading

Most international gas transportation is via pipelines.

Since many large gas fields are in places where there are no consumers, much of the world’s natural gas has to be transported over long distances.

The most economic method of transporting natural gas is via pipelines, this is because gaseous substances cannot be shipped in conventional tanks. Gas pipelines are usually under ground or run along the sea bed. One exception is Siberia where the pipelines are laid above ground due to the permafrost.

In Europe, gas travels below ground, in steel pipes with diameters of 200 – 1,400 mm. This form of transportation is environmentally friendly and is unaffected by weather conditions. Compressor stations located at regular intervals along the pipeline ensure that the gas keeps flowing at approximately 8 m/sec. (30 kph) over long distances.

A turbine similar to a jet engine generates the energy required to drive a compressor capable of compressing the gas to over 70 bar.

New departures

Following the deregulation of the European gas market, trading activity has been on the increase at the entry and exit points of the Austrian pipeline network. Short-term trading platforms — so-called trading hubs — have been set up in response to the steadily growing demand for this type of contract.

The only trading hub in Austria — and one of the largest in Europe — is operated by Central European Gas Hub (CEGH). The company does not engage in proprietary trading, but offers gas traders flexible services which help them to do business at the Baumgarten, Murfeld, Oberkappel, Überackern and Weitendorf trading points. It is also launching a new gas exchange which will open the way for still more flexible trading. Trade will then be made directly with CEGH as the counterparty, rather than bilaterally between buyers and sellers.

Short-term trading is an ideal addition to long-term supply contracts, which are normally concluded for decades into the future. It contributes to increased competition by enabling gas traders and prices to respond to shifts in supply and demand.

In addition to its exchange function the Central European Gas Hub also conducts annual online auctions under the so-called Gas Release Program, by which 250 bcm of natural gas is auctioned off to Austrian and foreign bidders.
Where pipelines are ruled out for economic or geographical reasons, liquefied natural gas (LNG) tankers link producer and consumer.

This involves liquefying the gas at a special plant at the terminal, where it is cooled to ~162°C. In this state natural gas shrinks to 1/600 of its original volume.

At present, LNG tankers have capacities of up to 266,000 cbm (equal to 160 mn cbm in a gaseous state). The cargo is stored in a number of well insulated tanks.

LNG is unloaded at its destination and temporarily stored in tanks. It is then transferred to a regasification plant where it is heated to return it to its original gaseous state, before being injected into the pipeline network.

Japan imports its entire demand for natural gas with LNG tankers because the surrounding waters are too deep for the laying of a pipeline.

On the high seas

About one-quarter of global gas transportation is via special tankers.
Alternative mobility

Natural gas vehicles (NGVs) are vastly superior to their conventional counterparts in terms of both running costs and environmental performance.

Around 10 million NGVs are already on the road worldwide. The automotive industry has responded to the growing demand for environmentally friendly drive systems by building several standard monofuel (natural gas only) or bi-fuel (with a choice of natural gas or gasoline) models.

The natural gas/air mixture in the combustion chamber allows for a higher compression ratio than a gasoline/air mix, resulting in improved performance and lower fuel consumption. For drivers this means a 30–40% reduction in fuel costs.

The special tanks in the vehicle, which are built to very strict safety standards, store gas at a pressure of 200 bar without limiting space in the trunk or cabin. Refueling with compressed natural gas (CNG) is just as quick and simple as with gasoline or diesel.

CNG is not only an ideal fuel for internal combustion engines in both cars and buses, but for forklifts and other special vehicles as well.

Between 2006 and autumn 2009 the number of CNG stations in Austria rose from 36 to 150 (about 60 of them operated by OMV). For information on natural gas vehicles, subsidies and filling stations visit www.erdgastanken.at.

Potential emission reduction through CNG

- CO\(_2\) (Carbon dioxide): -95% - 90%
- NO\(_x\) (Nitrogen oxides): -90% - 80%
- CO (Carbon monoxide): -80% - 60%
- NMHC (Non-methane hydrocarbons): -80% - 60%
- Particles: -90% - 80%
- Ozone depletion potential: -90% - 60%
Inventories on call

Constant output and swings in demand make storage a must.

Consistent production and inconsistent swings in demand make storage necessary. Not only is up to seven times more natural gas used in the winter than in the summer, but individual weeks are also subject to changes in the rhythm of consumption.

Even in the course of a single day, gas use fluctuates from hour to hour. To cope with these constant ups and downs, producers and suppliers must store gas.

Underground storage facilities
Depleted reservoirs are ideal natural storage facilities. Inventories are temporarily stored in the pores of the same rock that held the original natural gas for millions of years.

A total of 4.4 bcm of natural gas can currently be held at the Schönkirchen-Reyersdorf and Tillesbrunn storage facilities in Lower Austria, and the Haidach, Puchkirchen and Thann facilities in Upper Austria, at depths of between 500–1,500 meters and pressures of up to 120 bar.

Apart from depleted natural gas reservoirs, artificial caverns, excavated from salt and rock formations, are used to store gas in Europe. Above-ground spherical tanks are used for small volumes.
Non-stop control

Transportation on the OMV Gas network is precisely controlled from the floridotower building in Vienna.

To ensure that customers at home and abroad receive their gas at the right time and pressure, OMV operates a state-of-the-art dispatching center.

The staff there can control assets on-line from the tiniest valves up to entire storage facilities and compressor stations hundreds of kilometers away at the press of a button, and are connected to international centers in countries such as France, Germany, Italy, Norway, Russia 24 hours a day.

Systematic maintenance

Gas pipelines are constantly monitored, maintained and cleaned.

The Austrian gas pipeline system is divided into five large sectors of roughly equal size. Each has a maintenance center at a central location with good transport links.

The staff at these centers have all the tools and machinery they need to monitor the condition of the pipelines and related equipment under their control, and maintain them.

Due to the fact that operation of the entire pipeline is fully automated, an emergency service team is available around the clock for reasons of safety.

The pipelines are inspected from the air by helicopter at regular intervals; while doing so the pilot follows the yellow markers that indicate the pipeline route. An inspection on foot also occurs once each year.

The use of “smart” pigs carrying highly sensitive detection equipment assures trouble-free operation.
High-tech in the North Sea

The Troll A production platform is one of the greatest engineering feats in history. It is 472 m high, stands in over 300 m of water and weighs almost 680,000 tonnes.

The Troll platform is located on top of some 1,300 bcm of reserves—a thousand times as much gas as Austria produces in a year.

The 36 m high skirts and the platform were built in dry dock. After the various modules had been prefabricated on land, they were mounted on the 343 m high concrete base in Norway’s Vats Fjord. Water ballast tanks sank the base far enough down in the fjord for the superstructure to be towed out on pontoons by tugs and maneuvered into place on top of it.

After final assembly the platform was raised to 230 m above sea level, and ten tugs towed it to its destination, 170 sea miles away. The gas travels along subsea pipelines to the German North Sea coast. From there it continues its 4,000 km journey on the European natural gas network, arriving in Oberkappel on the Austro-German border.

When the Troll field has been depleted, in 50–70 years’ time, like all other disused offshore production installations the platform will be dismantled down to its anchor base on the seabed, and environmentally sound disposal will take place onshore.
Birth of a highway

The open trench method is used to lay pipelines on agricultural and forest land. From the planning stage onwards, every effort is made to minimize disruption to the natural environment.

Planning and designating the route, taking account of the topography and all environmental aspects.

Removing the topsoil – a job that calls for particular care, as the humus layer is used for subsequent recultivation.

“Stringing” the plastic coated lengths of pipe along the right-of-way and bending the elbow sections.

Aligning and welding pipe sections on a right-of-way no more than 27 m wide

Testing, sealing and protecting welds. Every single weld is ultrasound and x-ray tested, and the results documented. Finally, the joints are protected against corrosion.

Digging the trench. The topsoil is stored separately from the other excavated material.

String lowering and pressure testing with water. The testing pressure must be at least 1.3 times normal operating pressure.

Backfilling the trench with the stoneless excavation material. An 8 m wide strip along the course of the pipeline must be kept free of deep rooted vegetation.

Topsoil laying and recultivation, taking great care to restore original natural conditions. Afterwards, the yellow “caps” of the aerial markers are the only sign of the course of the pipeline.
Gas on the move

Running the Trans-Austria-Gasleitung (TAG) – how a gas pipeline is operated, maintained and inspected

The Trans-Austria-Gasleitung (TAG) is 384 km long, and has a maximum diameter of 1,050 mm. It passes from Baumgarten an der March in Lower Austria to Arnoldstein on the Italian border.

In 1987 and 2006 two additional pipelines (“loops”) were laid parallel to the original transit pipeline, built in 1974.

The main function of the TAG is gas transit to Italy, Slovenia and Croatia. It is also used to supply the Austrian provinces of Burgenland, Carinthia, Lower Austria and Styria via branch lines.

The gas, which comes from Russia at a pressure of approx. 50 bar, is cleaned, dried, metered and quality tested on arrival. Compressors then raise the pressure to 70 bar – otherwise, the gas would not continue to flow through the pipeline. After crossing extended route sections, some of which have extreme differences in altitude, the gas loses pressure and must be recompressed. The gas itself provides the energy needed for powering the compressors.

In order to ensure that the pipeline is completely safe and is in constant operation around the clock, it is regularly observed from vehicles and aircraft, and once a year it is inspected on foot.

The pipeline is closely checked for possible internal corrosion damage by means of so-called “pigging” operations. The pigs are launched and removed via “pig traps”, installed at the ends of each pipeline section.

The first step is to send a cylindrical disc pig (made of rubber-like material) down the pipeline with the gas stream, and remove any contamination. Then a dummy inspection pig is passed down the line to ensure that the real thing will glide through it smoothly.

Only when this has been done can the actual inspection, by a highly sensitive “smart” pig, take place. These devices use a non-destructive test method – magnetic flux leakage detection – to identify any pipe wall and weld damage. Powerful circular permanent magnets with steel brushes mounted on them magnetize the pipe wall. Sensors arrayed in rings between the brush rings detect local distortions of the magnetic field caused by faults such as pipe manufacturing defects, cracks or corrosion.

To ensure that the data is precisely recorded the inspection pig travels at a constant velocity which may not exceed 3.5 m per second.
Behind the scenes

A number of treatment processes are required to make natural gas suitable for transportation and use. The various stages do not necessarily take place in a given sequence.

Preheating: Natural gas is stored underground at pressures of up to 120 bar. The fall in pressure when it is withdrawn results in a sharp drop in temperature, so that it must be preheated to 25°C – the ideal temperature for dehydration – by a so-called “heater.” Heaters consist of a fire tube immersed in a bath, and heating coils for the medium to be heated. The liquid in the bath is usually water.

Cleaning: Solids and fluids are removed by filter separators. The gas is passed through candle filters, and particles larger than 15 microns are caught in the filters’ cellulose mantles. The gas is then passed over baffle plates with which the moisture droplets collide. They collect in the reservoir under the unit, and are automatically released.

Compression: For natural gas to flow through pipelines or be injected into underground storage facilities, it has to be compressed, that is, its pressure must be raised. A turbine similar to a jet engine generates the energy required to drive the compressor, which can compress the gas to over 120 bar. Because the gas heats up during compression it must be run through a cooler afterwards.
Natural gas is invisible and odorless. For safety reasons – to ensure that its presence is noticed – an odorant is added to the gas before delivering it to the customer.

**Drying:** The most widespread process for removing water vapor from natural gas is glycol dehydration. Glycol is a highly hygroscopic (moisture absorbing) liquid. Natural gas and glycol flow in opposing directions through a pressure vessel with a number of perforated trays, and the glycol absorbs the water vapor in the gas. The glycol is then heated to approx. 200° C, and the water in it evaporates. The regenerated glycol can then be reused to dry gas.

**Odorization:**
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Security of supply, low emissions and environmentally friendly transportation mean that natural gas is set to become a key-energy source of the future.

Most of the incoming gas is from Russia. In addition to the Baumgarten compressor station, other important stations in Austria where gas is transmitted include the HAG, Penta West, SOL, TAG and WAG. Along the large transit pipelines the gas is metered, tested and compressed before transmission to other destinations.

Europe’s gas hub

Starting with the signing of the first delivery contract for the import of natural gas the Baumgarten compressor station located near the Slovak border and the Zwerndorf gas field became one of the most important natural gas platforms in Europe.

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Most of the incoming gas is from Russia. A network of high-pressure pipelines enter Austria at Baumgarten and neighboring compressor stations that branch outwards like the spokes of a wheel. The Baumgarten compressor station also meters, sizes and compresses the gas before transmission to other destinations.

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Along the large trunk pipelines (HAG, Pentawest, SOL, TAG, WAG) there are, in addition to the compression facilities necessary for transportation, a large number of measuring points and transfer stations to send gas to different end-use concentrations.

The map on the back cover gives a detailed view of pipeline routes.