NATURAL GAS MADE CLEAR

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gaz nat

CONTENTS

GAZNAT

Supplying Western Switzerland with natural gas

Gaznat is a public limited company which supplies and transports high-pressure natural gas to Western Switzerland. It serves its customers on the most advantageous terms as regards safety and price.

Gaznat operates a network of high-pressure (70 bar*) gas pipelines which carry gas to customers who are directly connected to its network as well as to distributors. Distributors then deliver the natural gas to end-customers at a much lower pressure (5 bar or less).

Gaznat's main customers are distributors of natural gas as well as being shareholders of the company, such as the industrial services companies of cities in Western Switzerland. Large industrial companies are also numbered among its customers.

Gaznat's head office is in Vevey. The company's executive management and its Finance & Administration and Trading divisions are located there. Trading is responsible for supplying all Gaznat's customers with natural gas at the best price.
In order to achieve this, it optimises a variety of medium- and long-term contracts. It is also active on the short-term markets.
In addition, it holds and optimises a portfolio of import capacities on the various borders, as well as underground storage capacities. Furthermore, it supplies different types of energy services to customers who request them.

*bar: unit of measurement of pressure. 1 bar is equivalent to the average atmospheric pressure at sea level.

The Network division, which is responsible for operational activities and engineering, is based in Aigle. Its fully computerised Control Centre monitors the smooth functioning of the entire Gaznat network, which consists of some 600 km of gas pipelines and 55 delivery stations.

Gaznat employs around 60 people, including qualified technical teams for different specialist areas (mechatronics, electrotechnics, information technology and geomatics).

Gaznat is also active in the area of natural gas for vehicles.

NATURAL GAS

Key facts

Natural gas is a non-toxic hydrocarbon composed chiefly of methane (CH_4).

It is the least polluting source of fossil energy because it respects the environment throughout the production and value chain. Natural gas emits 25% to 30% less carbon dioxide ($C0_2$) than oil products. During combustion, water vapour is the main by-product in addition to CO_2.

Furthermore, emissions from natural gas or biogas vehicles are almost free from carcinogenic substances and fine particles. For all these reasons, natural gas deserves to be called the “cleanest fossil energy”.

Natural gas is non-toxic as well as odourless. An odorising agent is added to the gas for safety reasons so that leaks can be detected.

Biogas produced from green waste, household waste and sludge from waste-water treatment plants is injected into the distribution network, reducing the pollutant load of the natural gas even further. The gas in the network therefore contains an appreciable proportion of carbon-neutral renewable gas obtained from the fermentation of these various types of waste.

Natural gas carried in underground pipelines is unobtrusive. It does not impede traffic or spoil the landscape. Orange marker posts are the only visible indication of an underground gas pipeline.

WORLD GAS RESERVES

Huge global gas reserves

Natural gas was formed from organic deposits in sedimentary basins several million years ago.

When looking for deposits, geologists are guided by the presence of an old sedimentary basin, the nature of the terrain and the structure of the subsoil. However, this type of search is rather haphazard since only 15% to 20% of the wells drilled are productive.

Deposits that contain nothing but natural gas are known as dry deposits, whereas wet deposits contain other liquid hydrocarbons in addition to natural gas.
All the deposits are located at a depth of 1,000 to 4,000 metres.

Today, the world's proven reserves of natural gas are enough to last 63 years at the current rate of consumption. More than half of these global reserves are directly accessible from Europe. Russia, Iran and Qatar are the countries with the largest natural gas reserves in the world. These gases are referred to as "conventional" gases because they are trapped in an accessible deposit and are easy to extract.

A combination of two extraction techniques, horizontal drilling and hydraulic fracturing ("fracking"), enabled non-conventional gas production to be developed in the 1990s, mainly in North America. Today, such large volumes are produced that they have changed the dynamics of the global markets. The US, which used to be the number one gas importer, is well on its way to becoming the number one producer.
It has already started exporting non-conventional gas to Asia and Europe.

The International Energy Agency estimates that non-conventional gas will account for nearly half the increase in world production of natural gas by 2035, with most of it coming from China, the US and Australia.

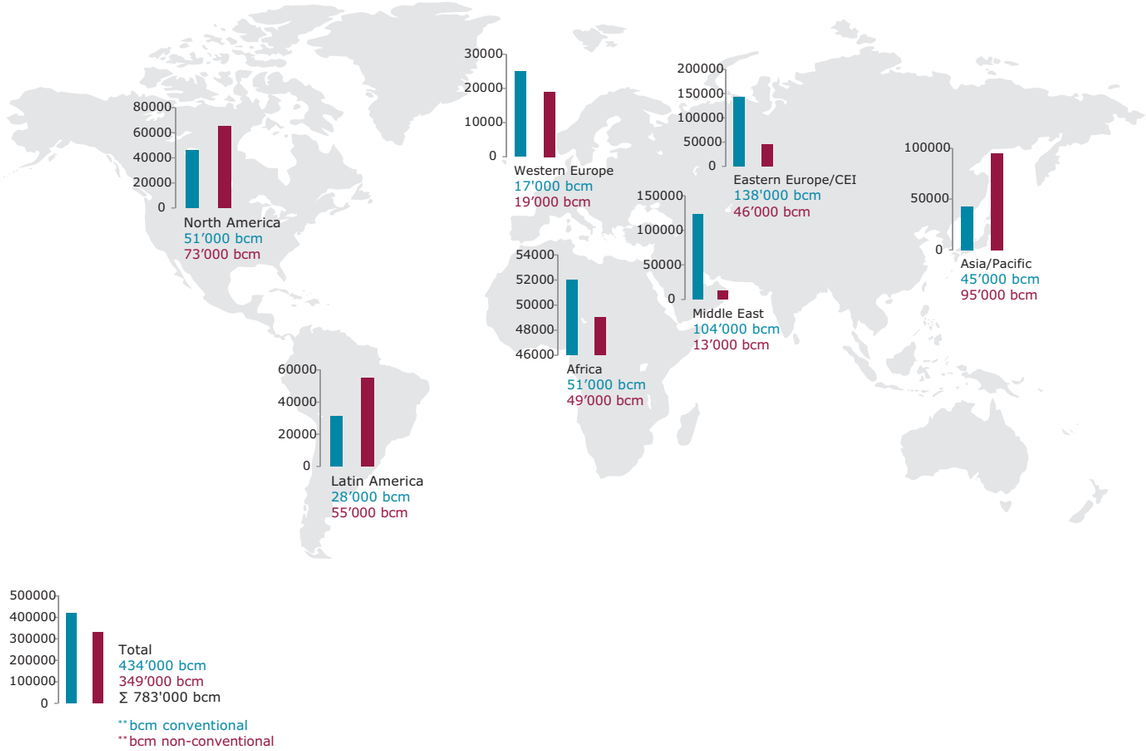
Reserves of non-conventional gas are spread over much larger areas compared with conventional gas.
These fields may cover hundreds or even thousands of square kilometres. The world has about 343,000 billion m^3 of non-conventional gas reserves, of which only around 19,000 billion m^3 are in Europe.

Most of the natural gas sold by Gaznat originates from Europe. Long-term contracts are concluded with major suppliers, particularly in Germany, France and the Netherlands.

"Non-conventional gas" is a generic term that covers several kinds of natural gas resources:

- Source rock gas, also known as shale gas, is gas which remains in the source rock in which it formed ;
- Coal gas, which remains trapped in coal as it forms (with the coal acting in the same way as source rock) ;
- Compact reservoir gas, which has normally migrated to a reservoir rock with very low permeability and porosity. This type of gas, which is widely exploited, is often regarded as a conventional gas ;
- Deep basin gas, which is similar to compact reservoir gas, comes from reservoirs with very low permeability where gas has accumulated over large areas in the deep parts of sedimentary basins ;
- Methane hydrates, also known as "methane ice", consisting of methane trapped under permafrost in Arctic regions, and in deep seas and oceans. However, the available resources and economic methods of production have yet to be defined, along with the ecological impact of this type of exploitation.

The world's conventional and non-conventional natural gas resources*



**Technically recoverable remaining resources
**billion cubic meters

Source: IEA 2016

GAS TRADING

Globally, the countries which consume the most gas are the US, Russia and China.
At 3.4 billion m^3 per year, or 39 TWh/year, Switzerland consumes less than 1% of Europe's gas. Natural gas consumption is expected to climb steadily in the years to come, owing to its key role in the energy transition to a carbon-free world, as well as the increasing requirements for electricity production. According to the International Energy Agency, European gas consumption should exceed 630 billion m^3 by 2035.
In order to meet this demand, 530 billion m^3 will therefore have to be imported, compared with only 33 billion m^3 today.

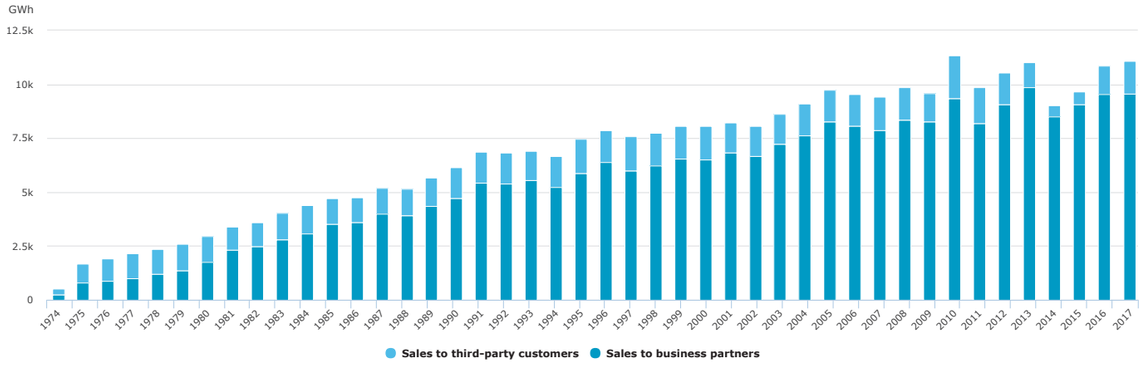
Gas purchases on international markets

The principal tasks of Gaznat's Trading division are to ensure continuity of supply and advantageous financial terms for its business partners and customers.

Two types of supply contract may be used:
- Long-term contracts (5 to 10 years)
- Short-term contracts (spot* for the next day and forward up to 3 years)

Gaznat's sales in Switzerland

Gaznat's sales amounted to 11,216 GWh in 2017.



Long-term contracts

Long-term contracts that ensure deliveries of sufficient quantities of gas to meet customer needs over the long term.
Gas purchases are made from different geographical sources. This kind of diversification reduces the risks connected with potential disruptions while at the same time cutting the overall costs by exploiting differences in price behaviour.

* Spot market: A market where transactions are very short-term, typically for the same day (within-day) or for the next day (day-ahead) in the gas and electricity market.

Gaznat has long-term supply contracts for delivery on the northern border of Switzerland and on the French border in the west. The gas comes from diverse sources: the North Sea, Russia, Algeria and other producing countries.
In addition, Gaznat has concluded a storage contract in France so that it can manage fluctuations in demand, especially during cold snaps.
These contracts form the backbone of Gaznat's supplies, enabling it to maintain a diversified portfolio originating from geographically varied and particularly reliable sources.

Short-term contracts

Short-term trading has developed gradually since 2007. When market conditions are right, Gaznat supplements its supply mix with spot* purchases. It is thus possible to exploit the price difference between long-term contracts and spot markets.
Around 40% of the gas volumes purchased in 2016 were acquired through transactions executed on the spot market.

Price formation

For the end client, the price of gas is made up of the commodity price of the gas, the cost of conveyance (high-pressure transportation followed by distribution), any contribution payable for storage, plus supply costs and taxes.

Services a priority

As part of its commercial activities, the Trading division develops added-value services for its business partners and customers.

The portfolio of services includes:
- Management of sales contracts (nomination, line-pack optimisation)
- Information on and monitoring of gas markets
- Purchase of standard gas products via a secure IT platform
- Management of invoices and consumption on a customer extranet platform
- Reporting customer positions and providing portfolio-management support

ADVANTAGES

The many uses of natural gas

Natural gas is primarily used for heating and cooking.
Modern condensing boilers adapt flexibly to demand, which makes them almost 100% efficient.

Thanks to newly developed heat pumps that run on natural gas, it is now possible to produce heating in winter and air conditioning in summer. Gas-fired central heating saves space as well as being cheaper to maintain than oil-fired systems.

Natural gas is also used in combined-cycle gas turbine plants, which produce heating and electricity simultaneously. These power stations are known as cogeneration plants. In small cogeneration plants, thermal engines driven by natural gas can supply housing estates and even whole districts with heating and electricity. Natural gas can also be used to produce electricity only.

Natural gas is also used industrially, as a source of energy for manufacturing purposes. Indeed, many industries utilise natural gas in their manufacturing processes: for producing steam, making hydrogen from natural gas, generating electricity, producing high-temperature heat for furnaces, rolling mills, etc. Natural gas can also be used as a propellant. In 2017, over 13,000 vehicles running on natural gas were on the road in Switzerland.
There are more than 140 filling stations offering natural gas in Switzerland – i.e. approximately one every 15 to 20 kilometres on main roads and through routes – so there is good coverage in this country.

Natural gas vehicles are a particularly good alternative from an environmental point of view, since they give off 25% less CO_2 than petrol vehicles and emit hardly any fine particulate matter or NO_x. These ecological benefits are joined by financial advantages, since the natural gas now on sale at more than 30 filling stations in Western Switzerland allows customers to save up to 50% on the price of fuel. Thanks to these advantages, a growing number of businesses are choosing this type of vehicle for their fleets or for transporting goods.
Biogas has an excellent reputation with corporate clients since it enables them to communicate their commitment to the environment while at the same time drastically reducing their carbon footprint, all by means of a pragmatic solution which does not reduce their range.

NEW TECHNOLOGIES AND APPLICATIONS FOR NATURAL GAS

Recent advances

Power-to-gas, or storing electricity in the natural gas network

Power-to-gas technology consists of transforming surplus renewable electricity (solar and wind) into synthetic carbon-neutral gas, then injecting it into the gas transportation network.

The transformation takes place in two stages:

1. The electricity is turned into hydrogen by electrolysis. At this stage, it is possible to inject pure hydrogen into the gas network.
2. The hydrogen is mixed with CO_2, which is then injected into the gas network.

This new technology allows surplus renewable electricity (the amount generated in excess of requirements) to be stored in the natural gas network while alleviating any bottlenecks in the electricity network by utilising the gas transportation network.

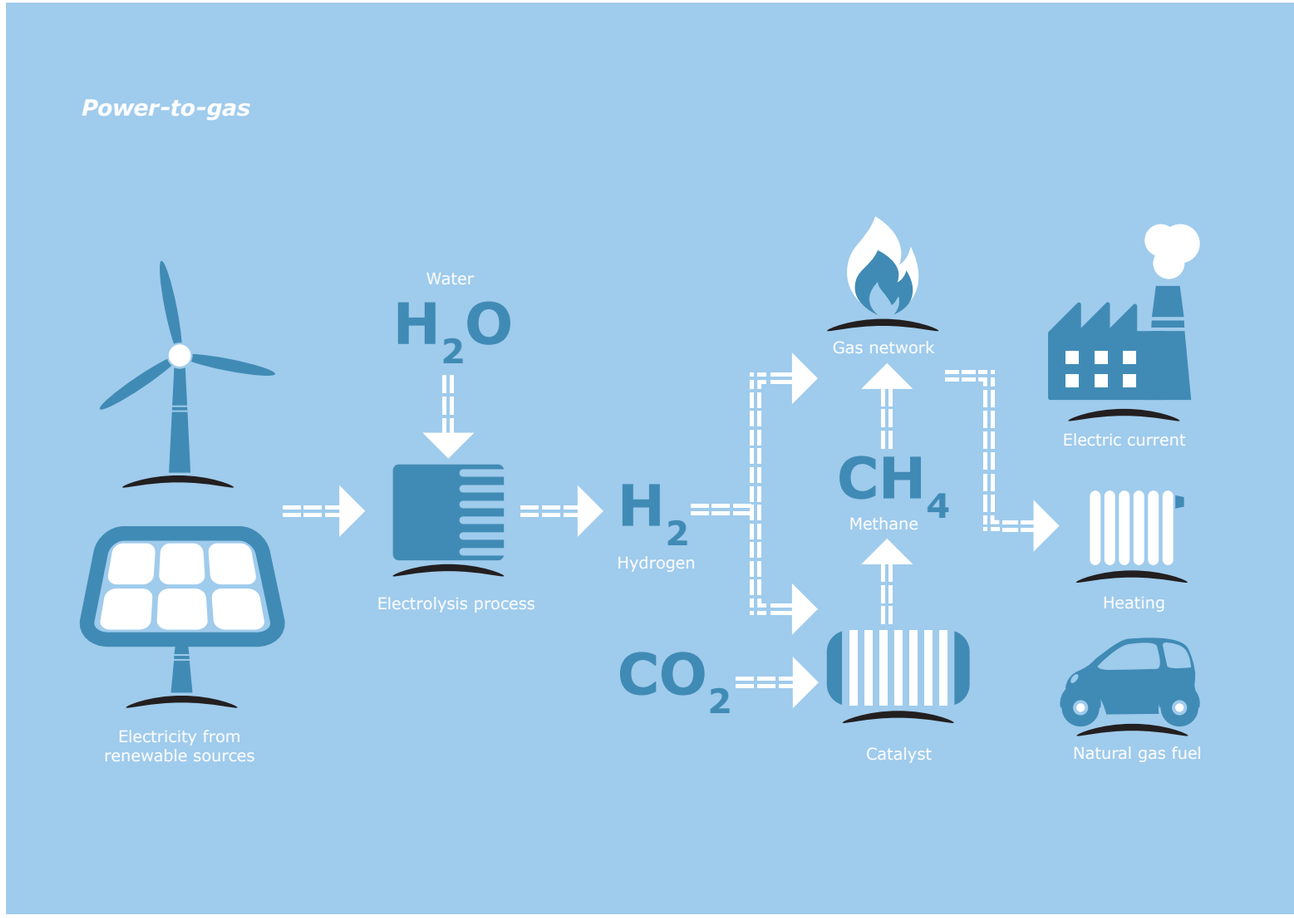
The resulting convergence of the electricity and gas networks means their use can be optimised without the need for major investment.

Fuel cells: ideal for individual homes and residential areas

Fuel cells can produce both electricity and heating from natural gas or biogas.

The transformation process is the opposite of electrolysis. It consists of a chemical reaction produced by the oxidation of natural gas.

Fuel cells have the following advantages:
- Renewable energy: using biogas enables renewable heating and electricity to be generated.
- Backup for the electricity network: a single piece of equipment produces heat and electricity at the point of consumption.
- Low or zero emissions from carbon-neutral biogas.



THE NETWORK

A global transportation network

Natural gas is extracted at a pressure of 200 to 300 bar. After being dried and purified, it is then conveyed in the form of gas at 70 bar or in liquid form.

In its gaseous state, it is transported in steel pipes that may be as large as 1.4 metres in diameter.
Gas pipelines are buried at a depth of at least 1 metre (underground gas pipelines) or immersed (undersea pipelines). They are insulated on the outside by a layer of polyethylene.
A particularly effective technique known as cathodic protection is used to prevent buried metallic structures from corroding.

Gas pipelines form a vast network of natural gas highways, with a combined length of 900,000 km throughout the world. The distance covered between the gas deposit and the point of consumption may exceed 4,000 km.

When gas travels at high speed, friction gradually reduces the pressure inside the gas pipeline. That is why compressor stations, which repressurise the gas to about 70 bar, are installed every 100 km.

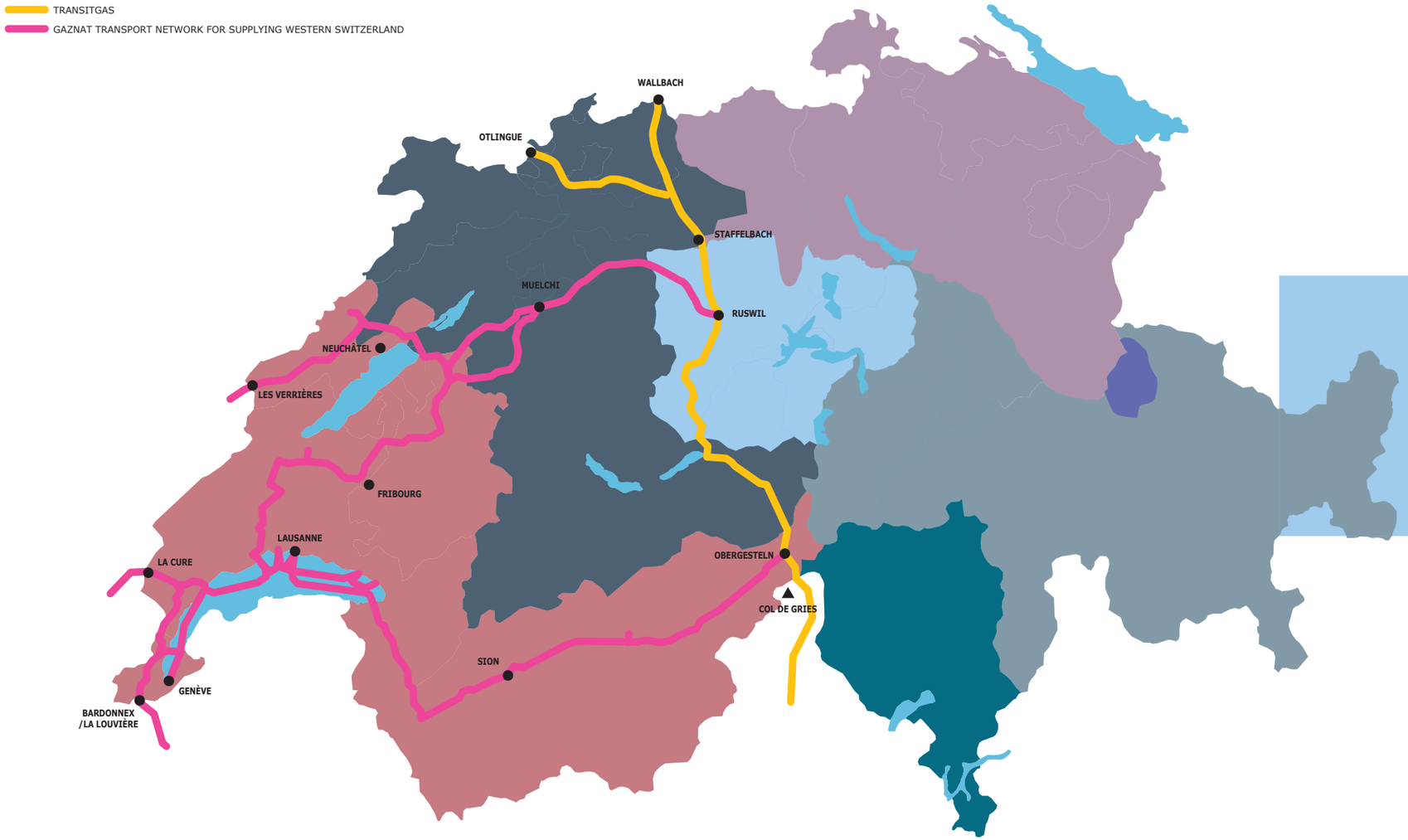
Unlike power lines, gas pipelines are invisible in the landscape. Marker posts are the only indication of the route taken by an underground gas pipeline.

A gas pipeline can transport large quantities of energy without adding to road traffic or polluting the atmosphere.

A pipe with a diameter of 40 cm can safely and easily transport enough energy to supply a city such as Geneva or Lausanne.

Gas is increasingly being transported by sea in liquid form, on ships known as LNG carriers. These are freighters specially equipped with tanks similar to giant vacuum flasks. At the port of shipment, the natural gas is liquefied by cooling it to -163°. This reduces its volume by 600 times. The ships deliver the natural gas directly to LNG terminals in Europe, the US and Asia, for example. There, the liquefied natural gas is stored in insulated tanks, then reprocessed and injected into onshore gas pipelines in gaseous form.

Natural gas transport network in Western Switzerland – as at Jan 2017



The natural gas in the Gaznat network is obtained either from the east, via the international Transitgas network, which crosses Switzerland from north to south, or from the west, via the main transportation pipelines entering from France and located along the Rhone axis. In Switzerland, the maximum pressure in the transportation network may reach 80 bar.
The pressure is reduced to 5 bar at the delivery stations, where the distribution companies take possession of the gas and supply it to the end-customers.
The same applies to the major industrial customers directly connected to the Gaznat network.

STORAGE

Using underground storage

Natural gas is extracted continuously throughout the year, whereas the amount consumed depends on times and seasons. There are large seasonal variations in natural gas consumption between the hottest day of summer and the coldest day of winter.
In fact, on a cold winter's day up to eight times more gas may be consumed than on a summer's day. In the same way, usage may also vary significantly during the day.

Storage enables the surplus gas received in the summer to be put aside or bought at an advantageous price, and then made available during cold snaps in winter when prices are higher. These surpluses may also be used to smooth out day-to-day fluctuations, so that deliveries can be adapted to customers' actual needs.

Storing natural gas underground is rather like using a storage dam for electricity. It acts as a "reservoir" which adapts supply to demand or vice versa.

Underground geological structures are often used for seasonal storage. In the case of saline structures, airtight cavities are emptied of water or salt, and natural gas is then injected into them for storage.
Another option is to create an artificial rock cavern.

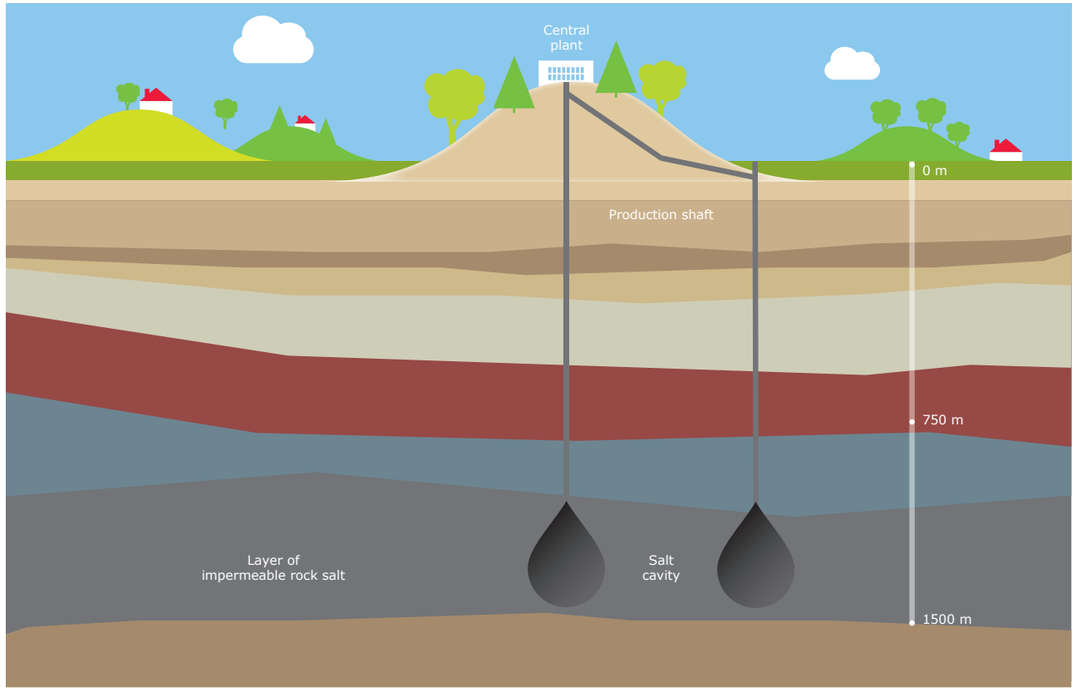
The largest aquifer reservoir, which is located in Chemery, France, can hold 7 billion m^3 of natural gas – equivalent to twice Switzerland's annual gas consumption.

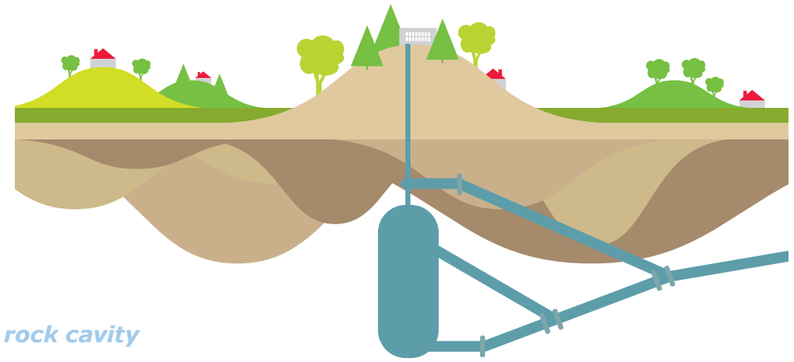
To guarantee continuity of supply and cope with the increase in the gas volumes required, the gas companies are developing regional storage capacities.
Gaznat has storage capacities in salt caverns in France, to help it manage seasonal and daily fluctuations.

Liquefied natural gas reservoirs can also be used for seasonal storage.

In order to smooth out daily or weekly peaks in consumption, natural gas may also be stored in buried pipes.

Underground storage in salt cavities





"Artificial" rock cavity

CONSTRUCTION

Safety, reliability and respect for the environment

Demographic change and increased economic activity in Western Switzerland have prompted Gaznat to invest in the construction of gas pipelines, while also expanding its network to provide reliable supply and enable new customers to be connected.

The service life of a gas pipeline is more than 50 years. However, there is a long run-up to its construction because the whole process takes several years to complete.

The first stage consists of assessing the scope of the work with regard to the requirements, and selecting the general route. A feasibility study is carried out in collaboration with the various parties concerned (Swiss Confederation, cantons, municipalities). The aim is to find the best compromise while taking account of the legislative, technical, economic and environmental constraints.
As a first step, a complete file (description of the project, environmental impact studies and risk reports) is submitted to the competent authorities for consultation. Secondly, the case file is thoroughly assessed.
Once any objections have been dealt with, the plans approved and rights of way obtained, work can commence.

Setting up a construction site of this kind requires particular care in order to reduce the environmental impact as far as possible.

Temporary paths for the construction vehicles are set up along the route, and attention is paid to preventing soil compaction as far as possible.

While the trench is being excavated, the subsoil is kept separate from the topsoil. The gas pipes are then delivered to the site where they will be laid, and are welded together section by section. All the weld seams are checked radiographically to ensure that the pipe is completely airtight and mechanically sound. A special polyethylene coating protects the pipe from corrosion.

The section of pipe, which may be as much as several hundred metres long, is then laid in the trench at a depth of at least one metre and welded to the previous section before being coated.
Leakage tests are performed and the gas pipeline is thoroughly inspected using a so-called smart pig to check that the work has been carried out flawlessly.

Scrupulous attention is paid to keeping the different types of soil separate as the trench is filled in, to ensure optimum soil fertility and allow crops to be planted as soon as possible. The terrain is thus returned to its initial condition. A survey is carried out when the work has been completed, to identify any damage caused to third parties, who will be compensated if this is warranted.

One year after completion of the work, no trace of the construction site remains. Orange marker posts are the only visible sign of the route of the gas pipeline.

SAFETY

Pipelines under tight surveillance

The operation of gas pipeline networks in Switzerland is governed by the Swiss Federal Pipelines Act and supervised by the Swiss Federal Office of Energy (OFEN). It is also closely monitored by the Federal Pipelines Inspectorate (IFP).

A large-scale monitoring system has been set up to ensure the safety and integrity of the structures right round the clock. The regional control and monitoring centre continuously manages and monitors the installations on the basis of precise data received via its own remote data transmission system. In the event of an anomaly or damage, an expert team stands ready to take action 365 days a year.

At the same time, the whole route is regularly inspected on foot or from a helicopter.
These inspections are performed to spot anomalies or unauthorised work being carried out near the gas pipelines which might damage them if no proper arrangements have been made in advance.

In Switzerland, valves are located every 15 to 25 km; they are remotely controlled from the control and monitoring centre, and allow a section of the pipeline to be isolated in the event of damage.
In order to ensure maximum safety and guarantee a high degree of availability, the pipes and ancillary installations are subject to a preventive maintenance programme and regular inspections.

GLOSSARY

Bar
1 bar corresponds to the pressure exerted by a column of water 10 metres high.

Sedimentary basin
A sedimentary basin is a depression in the Earth's crust located on a continent or continental shelf or in the sea, in which a thick layer of marine or continental sediments has accumulated during millions of years.

Biogas
Biogas is a gas produced by the fermentation of animal or vegetable organic materials in the absence of oxygen. This fermentation, which is also known as methanisation, occurs naturally in swamps and spontaneously in dumps containing organic waste.

Modulating condensing boiler
This highly efficient type of gas boiler continuously adapts to demand for heating.

Fossil energy
A fossil fuel (oil, natural gas and coal) is a combustible substance produced from rocks created by the fossilisation of living organisms (vegetable or animal) over the past 3.5 billion years or more. These combustible substances exist in limited quantities and are non-renewable in terms of the human time scale. The energy produced from this kind of combustible substance is known as fossil fuel.

Electrolysis
Electrolysis is defined as the process of converting electrical energy into chemical energy, whereby elements are separated or chemical compounds synthesised. Electrolysis is used in a number of industrial processes, such as the production of dihydrogen (H_2) via electrolysis of water (H_2O).

Hydraulic fracturing ("fracking")
Hydraulic fracturing is a technique in which rock is fractured by injecting a pressurised liquid.

Renewable gas
Renewable gas means any gas that can be used instead of or in addition to natural gas.
It is primarily composed of methane of non-fossil origin. This definition principally covers **biogas** produced by methanogenic fermentation; and gas produced by methanation if the raw material is renewable. Gas obtained in this way needs to be purified (cleaned of its impurities and undesirable components such as carbon dioxide, hydrogen sulphides and water) until it reaches the same quality as natural gas. It is then known as biomethane. Once it has been cleaned and odorised, biomethane can be injected into natural gas networks.

Geomatics
Geomatics covers the tasks and projects relating to gas pipeline routes.
These activities include plotting the route, updating the maps, and monitoring and maintaining the route.

Hydrocarbon
A hydrocarbon (HC) is an organic compound consisting entirely of carbon (C) and hydrogen (H) atoms.

Mechatronics
Mechatronics refers to all the mechanical and metrological tasks and projects necessary for operating a natural gas transportation network. Mechatronics covers mechanical equipment maintenance, metering systems and natural gas quality analysis.

LNG carrier
Ship designed to transport natural gas in liquid form.

Aquifer
An aquifer is a geological layer that is sufficiently porous and permeable to contain an underground body of water. It is covered by an impermeable layer forming a watertight seal. Using an aquifer for storage involves creating the geological equivalent of a natural deposit by injecting gas into this underground layer of porous, permeable rock which originally contained water.

Oxidation
Oxidation is a chemical reaction during which a substance becomes combined with one or more atoms of oxygen.

Smart pig
A smart pig is a device forced through a gas pipe by the flow of gas in order to analyse the structure of the gas pipeline and find any defects in the pipe. This tool is used in each section every ten years.

Polyethylene
Polyethylene is an insulating plastic material used to protect the steel pipes in a gas pipeline from corrosion.

Delivery station
Each distributor has one or more delivery stations which act as an interface between the transportation network and the local distribution system.

Cathodic protection
Cathodic protection is a technique used to protect an insulated metallic structure from corrosion during contact with soil or water.

Compressor station
A compressor station helps move fluids through the pipeline and compensates for pressure loss. The stations are located every 100 to 150 km on the network.

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Gaznat SA • Av. Général-Guisan 28 • CH-1800 Vevey • T +41 58 274 04 84 • F +41 58 274 04 85 • gaznat.ch