

# Pipeline to the future



euro  gas

## Introduction



Satisfying the world's huge demand for energy and at the same time protecting the climate and environment is one of the greatest challenges of this age. Throughout the 21st century, sustainable use of fossil fuels will make the main contribution towards meeting this challenge until eventually adequate development and commercialisation of new technologies and applications of renewable energy sources is assured.

In this context, natural gas will play an increasingly important role. Of all fossil fuels, it has the lowest emissions of pollutants and carbon dioxide. For many applications, its efficiency cannot be



surpassed. Natural gas is increasing its already high market share in space heating, is gaining more and more ground in industrial uses and is to a growing extent being employed for power generation. It is also advancing in the motor fuel sector.

The European gas industry is committed to sustainable use of this resource. In cooperation with their customers the R&D centres of gas companies continually develop new technologies for the efficient and environmentally friendly use of natur-

al gas. Also gas companies are researching into modern concepts incorporating renewable energies. Gas producers and transporters constantly devise new technologies so that additional gas volume can be brought to consumer markets, a task which is becoming ever more challenging. Thanks to continuous improvement and expansion, the gas transmission and distri-

bution systems in Europe are among the most modern and efficient infrastructures of their kind worldwide.

European gas companies have joined forces in the European Union of the Natural Gas Industry,

Eurogas. As a non-profit organisation, it promotes the exchange of know-how between companies and represents the interests of the European gas industry vis-à-vis the European Union and internationally. The common goal of making the best possible use of natural gas for European energy supplies well into the future is at the heart of the dynamic European gas industry. Natural gas is the bridge to sustainable development. EUROGAS is committed to helping to build this bridge.



## Exploration and production



### SUCCESSFUL DEVELOPMENT OF RESOURCES

As European countries incorporated natural gas into their energy markets, a pioneering gas exploration and production industry emerged in western Europe. Difficult geological conditions called for pronounced innovative capabilities, first in exploring and developing onshore resources and subsequently offshore.

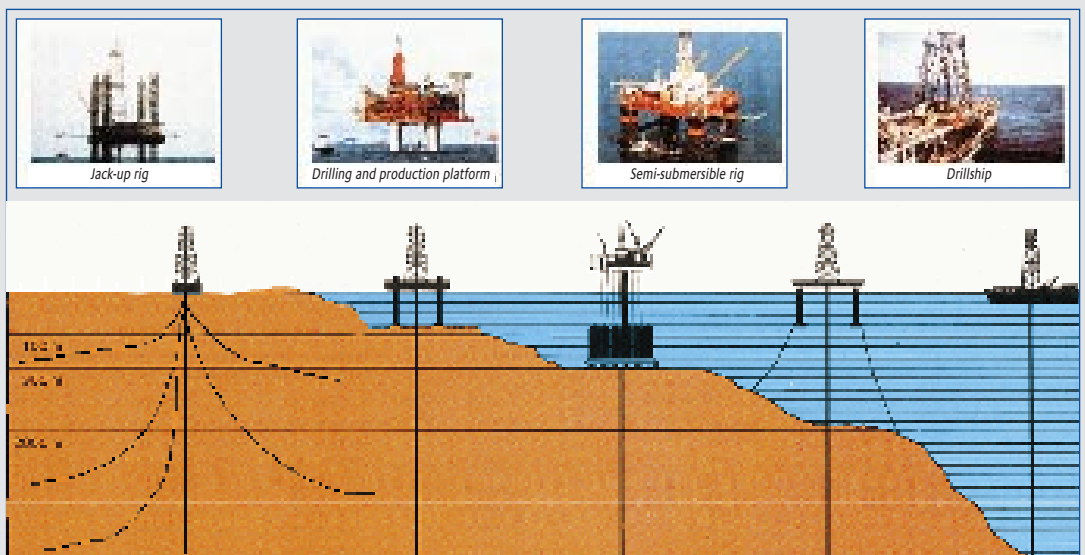
European companies are at the forefront in applying innovative technologies for improved efficiency and safety of natural gas exploration and production on a worldwide basis. They also place their knowledge and experience at the disposal of other producers.

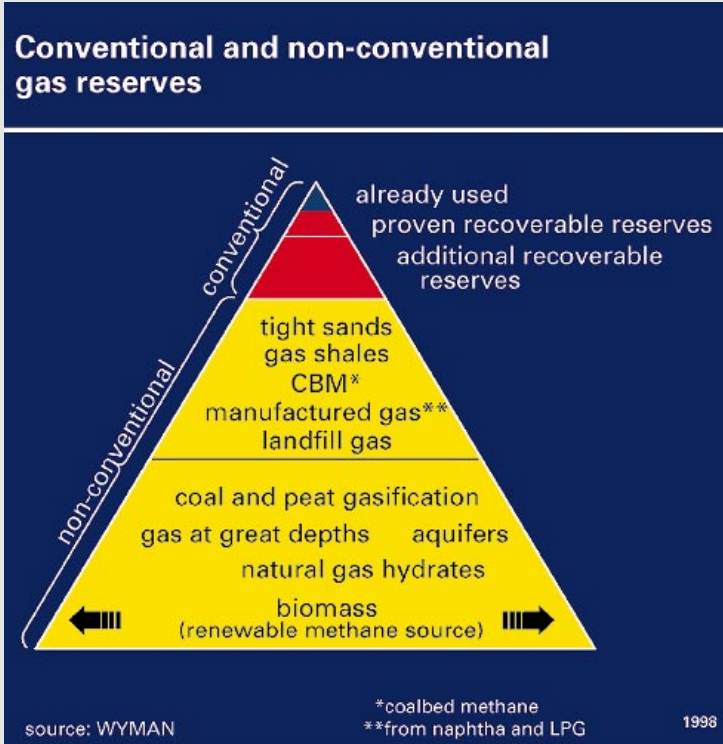
Leading expertise in geoscience and reservoir modelling has led to highly accurate predictions with 3 D maps of the locations of underground gas reserves and the most practical routes for exploration. This reduces the number and cost of exploration and appraisal wells and also ensures maximum

yield from a field before decommissioning. Modern drilling and production technology allows gas to be extracted from reservoirs not only in difficult geological formations, but also at great depths. The extensive know-how and proven methods are essential and valuable prerequisites for tapping non-conventional gas resources in aquifers or deep coal beds.

The latest materials science and design techniques have reduced drilling schedules with significant cost savings. Advanced drilling solutions have pioneered the cost-effective access to previously uneconomic gas reserves.

European technology has also led the way forward in offshore gas processing and treatment solutions. Corrosive contaminants, moisture and other impurities are removed using special treatment plants so as to prevent pipeline damage and maintain a consistently high quality of gas. New high strength steels, welding techniques and inspection tools are being developed to allow for higher transmission pressures over longer distances both undersea and onshore.





European gas industry laid the foundations for successful and efficient gas production and processing in offshore fields. New materials, facilities and techniques ensure that specific offshore conditions, for instance in the North Sea, can be safely handled. North Sea production platforms are today among the world's largest industrial plant. The dynamically growing sub-sea pipeline system sets technical, economic and ecological standards in energy transmission world-wide.

Research and development, practical experience and technical innovation of the

economic and ecological standards in energy transmission world-wide.



# Transmission

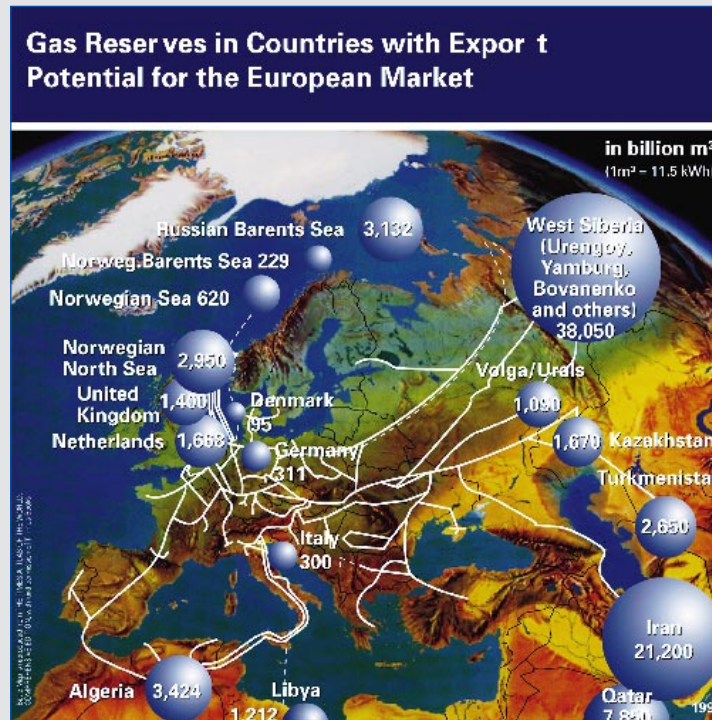


## SECURING THE SUPPLIES

Despite substantial indigenous resources, western Europe needs to import to meet its energy demand. Gas demand requires gas imports. Western Europe, however, is well located in relation to other large reserves of natural gas in other parts of the world.

### Pipeline Transmission

Modern pipeline technology permits gas to be transmitted safely and cost-effectively over great distances. Gas pipelines not only link up with gas reserves in the British, Norwegian and Danish sectors of the North Sea and the Dutch fields. They also connect western Europe to the world's largest gas resources in western Siberia and to the reserves in North Africa.



The pipeline grid is continuously expanding and further interconnections increase flexibility in terms of diversification of supplies. Increasing the choice of supply routes enhances security in gas transmission and will promote further market development.

### LNG Carriers

Liquefied natural gas (LNG) results from cooling to a temperature of around -160°C, thereby decreasing its volume 1/600th. This vastly reduced volume can make shipping gas by special ocean tanker economical.

The first LNG transportation chains were set up to bring Algerian gas to Europe, with the establishment of a portfolio of patents and know-how. In Western Europe LNG is imported by France,



Photo: Médiathèque GDF



Belgium, Spain and Italy. The technological advances in the field have been considerable. Europe has established a prominent position in global LNG transportation and storage technology.

LNG accounts for a quarter of the international trade in natural gas. Currently, Europe's share of the global LNG market amounts to 22%. This share will probably grow over coming years with new LNG import projects coming on stream, the expanding LNG spot market and the joint efforts of the operators to lower costs in the LNG chain.

#### Technical Safety

Safety is always paramount for the natural gas industry. Regulations and specifications, sophisticated prevention, monitoring and inspection systems as well as good operational practices give western Europe an outstanding safety record for gas industry activities achieved by cost-effective means.

Constant maintenance of transmission grids is a basic prerequisite for safe and secure gas supplies. A major goal of R & D activities is to protect buried pipelines against internal and external corrosion. Electronic devices, known as "pigs",

enable entire pipeline sections to be inspected automatically; they detect at an early stage any initial signs of damage caused by corrosion and allow on-site repairs without the flow of gas being interrupted. Modern, properly maintained and protected gas pipelines will function safely and without any problems for many decades.





## Storage

### ENSURING A FLEXIBLE ENERGY SUPPLY

To balance the steady flow of gas from producing regions and the seasonal or cyclical fluctuation of offtake in consuming regions, use is made of underground gas storage facilities. Gas is stored there at times of low demand, mainly during summer months. When demand is at a high level, gas is taken from the storage facilities and supplements the deliveries arriving from producing regions. Storage facilities not only make gas supplies more flexible and secure; they are also a method of achieving economic optimisation. The European gas industry currently possesses storage capacity of almost 60 billion m<sup>3</sup> and is considered the world's leader in storage technology.

Most underground storage facilities are developed today in depleted hydrocarbon reservoirs, aquifers and salt cavities, by means of proven techniques based on the use of the existing geological environment. The safety of this type of storage is ensured by the principle of natural confinement. The availability of suitable underground storage sites largely depends on the geological structure of the area. The total storage capacity in Europe far exceeds expected

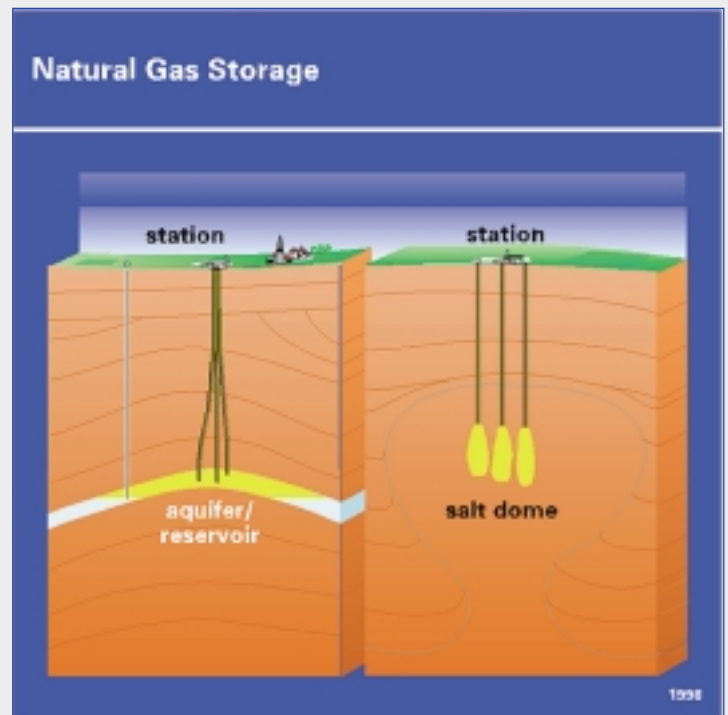
demand, contributing significantly to Europe's energy security of supply.

#### Storage in depleted reservoirs

Gas and sometimes even oil reservoirs that are no longer workable may, under the right conditions, be converted for underground storage of natural gas. Most of the facilities operated around the world are of this type (nearly 450 such storage reservoirs are in operation, primarily in the U.S. and Russia) for geological and historical reasons, and this technique is used in Europe notably in Italy, in Germany and the Netherlands too, and offshore UK

#### Storage in aquifers

Storage in an aquifer necessitates a geological structure at a suitable depth, roughly





1000 meters, comparable to that of a natural reservoir. Such a structure consists of water-impregnated rock which is porous and permeable, capable of containing gas, and an impermeable cap-rock. This type of storage reservoir which is found in Italy and France, offers capacities up to several billion cubic meters.

**Storage in salt cavities**

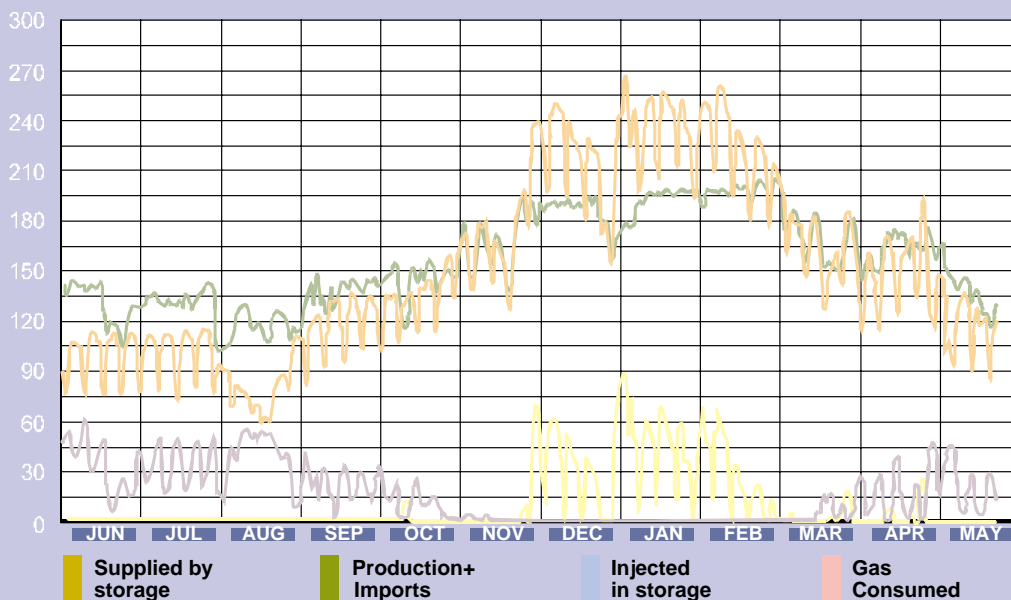
Salt-cavity storage facilities are created in salt strata at a depth of 800 to 1500 meters. Water is injected to leach out the salt. The brine is then removed, leaving vast cavi-

ties in which natural gas can be stored at high pressure. This technique affords high withdrawal rates. It is used in Germany and the UK and also France.

**Innovation Storage Techniques**

A number of major gas operators are researching the development of innovative, even more unobtrusive storage techniques. These include such projects as natural gas storage under pressure in lined rock caverns and the creation of cavities in thin salt seams.

**Daily Profile of Gas System Flexibility of one European Country**



## Distribution



### NOVEL TECHNOLOGIES FOR BRINGING GAS TO THE CONSUMER

In western Europe, extensive distribution networks currently supply gas to some 66 million households as well as office buildings, commercial users and industrial plant.

The dynamic gas market development in western Europe is inconceivable without modern distribution systems. State-of-the-art materials and technologies are used to design, construct and maintain local and regional gas distribution systems, thus attaining a high degree of safety and efficiency.

Flexible polyethylene pipes and space-saving or even trenchless pipe-laying methods permit gas supply systems to be installed even under difficult conditions in cities or conurbations. Careful planning and grid calculations ensure reliable and cost-effective supply. Modern maintenance techniques increase the dependability of local gas supply systems. Cost-reduction potential is also exploited in buildings by the combined installation of service lines. Existing grids are documented in digitalised maps with the aid of radar and ultrasonic detectors.

Damage can be detected by modern methods that avoid the need for excavation.

#### Gas at the turn of the tap

Ease of use, efficiency and clean combustion have made natural gas the prime choice for space heating and hot-water production. This success is due not only to its favourable properties but also to the European gas industry's constant commitment to enhancing appliance technology and expanding the use of gas in the residential sector. By developing and commercialising



condensing appliances and low-NOx burners and carrying out various other refinements, the industry has over the past few decades considerably increased the efficiency and decreased the environmental impact of gas-fired space heating.

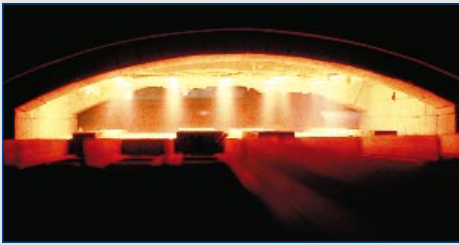
In households, the use of gas is not restricted to space heating, hot water production or gas cookers. Other appliances can also be run cleanly and economically with gas. This applies above all to washing machines, dishwashers and tumble dryers. In the near future, it will even be possible for households to generate their own electricity with the aid of gas-fired mini fuel cells.



**Becoming the main energy source for industry**

In commerce, public services and industry, the advantages of gas are appreciated by many users. In various west European countries, it has already become the main energy for industry, being particularly advantageous in a large number of production processes. Mutual support and technology transfer between companies of the European gas industry permit innovative solutions to be found even in very difficult cases.

Photo: GDF - Dir. Recherche



**Gas-fuelled power stations are particularly clean and economical**

The use of gas will increase in west European power generation. Gas-fired power stations can be constructed and operated very cost-

effectively. They are also characterised by very high efficiency and low pollutant emissions, especially if they are combined heat and power generation plant.

**Gas can also be used for cooling and transport**

The use of natural gas is not confined to producing heat. Technological progress has made the utilisation of gas for cooling and air-conditioning an increasingly viable option.

In road and rail transport, fleet and other vehicles running on natural gas can contribute significantly to the reduction of air pollution and CO<sub>2</sub> emissions.





## Supplying the energy of tomorrow

In the future in many European countries, more and more electricity will be produced from gas, which is more efficient and less polluting than production of electricity from other fossil fuels. The use of modern gas fired combined cycle plant and of combined heat and power plant (CHP) is already making a significant contribution to Europe's energy and environmental objectives, producing cleaner electricity for cities and industrial use all over Europe.

Trends are evident towards the further decentralisation of power generation. Eventually, households could even start to produce their own electricity using gas, with heat as a by-product, in a process of micro-generation. If more electricity is generated in the home than needed, it can be supplied to the grid.

More Solar power could also be used in combination with gas.

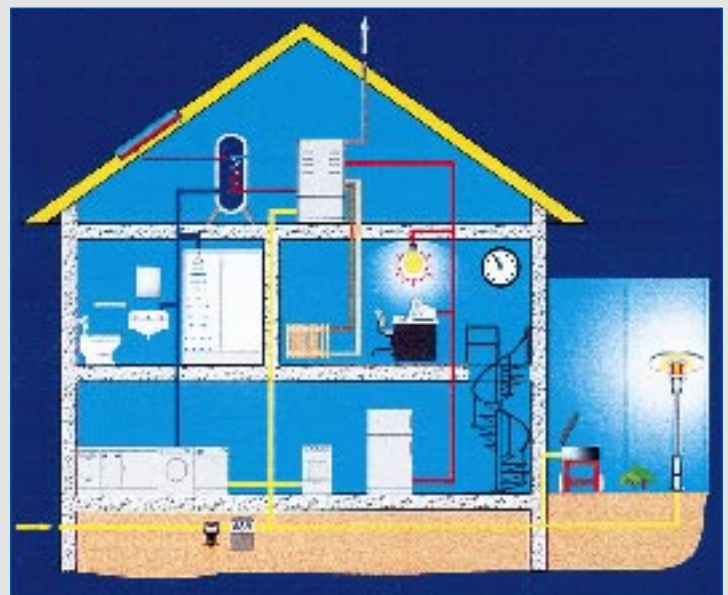
In the house of the future there could be :

- Electricity system, PV and micro-cogeneration. Home generated electricity could also be used for the car. Alternatively the car could run on natural gas. Natural gas powered vehicles are already available on the market. Significant improvement of total energy consumption and reduction of

emissions of households would result.

- Gas/solar combination boiler supplying heat, hot sanitary water and hot water for the hot fill applications; combination of passive solar heat and natural gas.

The development of new applications means looking to the future and some technologies like fuel cells for power and heat generation are now on the verge of commercial availability. Fuel cells have high power-generating efficiencies and almost negligible pollutant emissions. Whereas phosphoric acid fuel cells (PAFC) are already commercially available, significant input is needed world-wide to commercialise other types, such as solid oxide fuel cells (SOFC) and proton exchange membrane cells (PEM). The gas industry and manufacturers collaborate closely. Further forward-looking technologies concern the development of small gas turbines.



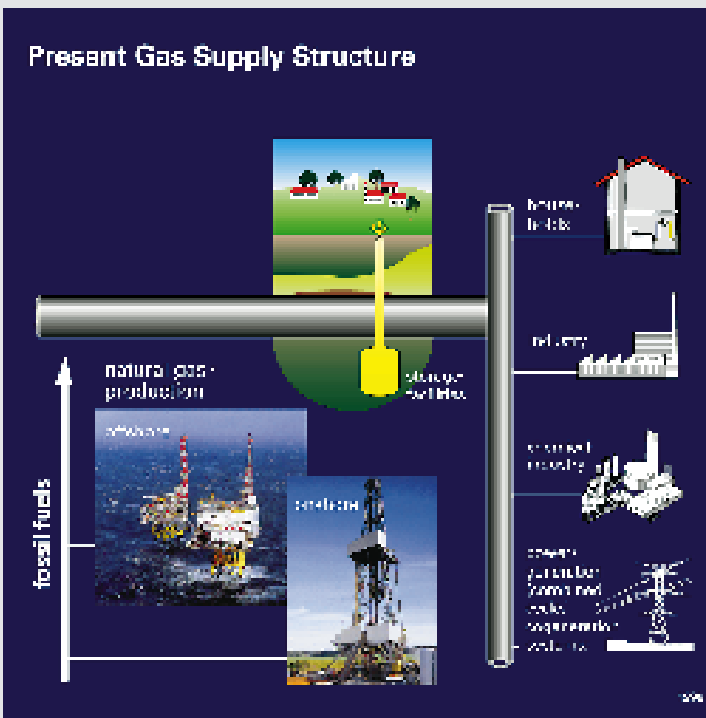
## Natural gas: pipeline to the future



Natural gas is not only an environmentally friendly energy source; it has also long-term available reserves, making a significant contribution to secure energy supplies for Europe.

European gas companies have made substantial investments in supply security and infrastructure for gas supplies well into the 21st century. Though an end to the upward trend for natural gas in Europe is not in

The present supply structure has a pipeline network which can be used for future sustainable energy systems without need for any fundamental modifications. It virtually provides the cornerstone for a new supply structure in the future. It is possible to inject into this system a mixture of fossil fuels from conventional and non-conventional sources, hydrogen from renewable energies and methane from biomass. The existing storage facilities can be utilised for intermediate storage. On the consumption side, particularly in the residential sector, there will be a combination of fossil and renewable fuels, including solar energy. More and new challenges lie in possible further technical developments e.g. in the conversion of electricity and natural gas to hydrogen. Excess electricity can be converted to hydrogen and the hydrogen can then be stored.



sight, gas companies are nonetheless looking further ahead and developing scenarios for using natural gas together with, perhaps, renewable energies as a “pipeline to the future”. In this context, a major role is likely to be played by gas hydrates, still untapped gas reservoirs under the earth’s poles and the exploitation of hydrogen. Of all fossil fuels, natural gas has the highest hydrogen content and is thus suitable for building the bridge to a future hydrogen economy.

The commercial development of such techniques will depend on improved efficiencies and lower costs. In particular natural gas, as a so called back-up energy, could also be converted by catalysts to hydrogen. In future, micro-generation-hydrogen fuel cells could be the basis for power and heat in the residential sector, with domestic applications switched from the use of natural gas into the use of hydrogen instead.



Another practical use in future could be the conversion of the local natural gas grids to local hydrogen grids. Alternatively

into its system.

Gas will play an important and interesting part in shaping Europe's energy future.

other energy forms like bio-gas could eventually be injected into the gas grids used today for the transport of natural gas.

In the long run, the availability of reserves and the cost structure for producing hydrogen and methane from other sources will determine the extent to which the existing gas supply system also transports other gases. The natural gas industry is actively involved in efforts aimed at incorporating renewable energies

