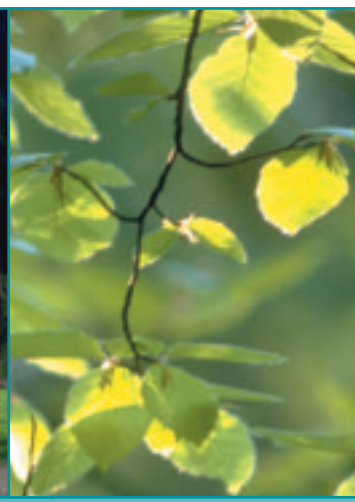
Introduction

"There is pressing need to renew commitment both at community and member state level to promote energy efficiency"

These opening words to the Commission's Action Plan to improve Energy Efficiency in the European Community reaffirmed in 2000 the importance of energy efficiency policy for environmental and economic reasons. The Green Paper "Towards a European strategy for the security of energy supply" issued in March 2001 highlights in its conclusions the priority of controlling the growth of energy demand as an element of sound supply security policy. The European Climate Change Programme presented in Gothenburg in Spring 2001 to Heads of Government also emphasised energy saving policy. Subsequent policy statements notably the Commission's Communication on actions to meet the Kyoto targets issued for the climate change talks in Marrakech in October 2001 continue to place energy efficiency and demand management at the heart of integrated EU strategy.

Eurogas, the European Union of the Natural Gas Industry, welcomes the



determination to give a fresh impetus to the objective of energy efficiency. Eurogas agrees that a policy aimed at controlling energy demand and meeting that demand more efficiently using cleaner fuels including natural gas will contribute to twin goals of environmental improvement and security of supply.

From source to end-use, natural gas is the natural choice for an energy efficient approach. This brochure explains why, and also how European gas companies seek to maximise the potential of natural gas in efficient end-use.

" Tomorrow is closer than you think"

To achieve a fully sustainable future, a new energy world is foreseen by the middle of the century increasingly based on renewables and the introduction of hydrogen based systems.

Natural gas acts as a bridge to this future, elements of which are already in place. Gas companies are promoting new and more efficient use of gas and are developing hybrid schemes combining gas and renewables (such as wind, solar, biomass). Furthermore the present gas network can be used for transporting hydrogen under appropriate

conditions without significant fundamental modifications being necessary.

Efficient use of energy can be achieved throughout the gas chain.

Using the most efficient measures for the production and transport of fuel

Upstream, efficient gas production and processing maintain a focus on safety, environmental protection and operating efficiency. The transport of gas by pipeline is generally unobtrusive, especially when compared with the transport of other fossil fuels.

Europe has a substantial indigenous gas supply, but to meet its energy demand also requires gas imports. Modern pipeline technology ensures that gas can be carried safely and cost-effectively over long distances. Gas also arrives in Europe carried on ship in liquid form, which is achieved by cooling the gas to a temperature of around -160 °C.

Modern production technology including the application of new techniques and new materials ensures the most efficient exploitation of natural gas sources, paying high attention to safety and environmental considerations.

Energy transportation (2.3 10^6 GJ:day)

Natural gas	Gasoil	Coal
↓	↓	↓
1 underground pipeline	1465 gasoil trucks	1518 wagons
↓	↓	↓
		
	↓	↓
	± 60 gasoil trucks/h	± 3 trains/h

Natural gas requires little processing between extraction and end use.

by choosing a fuel which especially when used efficiently, has lower environmental impacts than other fuels.

Based on the chemical composition of natural gas, the CO_2 produced by gas consumption is 25-30% lower than petroleum products and 40%-50% lower than coal.

Other physical qualities of gas which guarantee its environmental friendly characteristics are widely recognised. Producing no dust or ash, virtually no SO_2 less NO_x generally than other fossil fuels on combustion, natural gas is well placed to contribute to air quality and climate change objectives (1). The physical qualities of gas bring additional advantages. The absence of solid residues and the nature of the combustion process have enabled the design of highly efficient gas fuelled appliances and plant, so reducing emissions further.

1

Europe

Green Gas Scenario

Eurogas base case analysis suggests that CO_2 emissions will be higher than the level needed to meet the Kyoto commitments. But the *green gas scenario* shows that gas can play an important role in helping to fulfil the target. Environmental benefits are achieved through increased use of natural gas and slightly lower primary energy consumption. Eurogas had previously developed a rule of thumb that increasing the natural gas share of the EU energy mix by 1% would reduce CO_2 emissions by more than 2%. From the analysis we have developed for the next 20 years the reduction in CO_2 appears to be 3% if natural gas use is increased by 1%. Switching to natural gas improves efficiency thus lowering overall energy consumption and leading to further reductions in pollutants.

2

Switzerland

CHP, gas fired engine with three-way catalytic converter

The new World Meteorological Organization (WMO) Headquarters office, in Geneva, is a model of energy economic design. For its heating and cooling systems and a third of its electricity needs, the WMO installed a CHP plant, driven by a gas fired engine with three ways catalytic converter. Compared with separate sourcing of power and production of heat, energy savings of about 30 per cent have been achieved with an overall energy efficiency of 80%; this represents a reduction in CO_2 emissions of about 1200 tonnes per year.

Electricity and Heat Production

Compared with conventional power stations, gas fired power stations and CHP plant are much more efficient and in addition offer very economically attractive means to construct and then to operate than centralised power stations. Combined cycle gas turbine stations (CCGT) technology allows the waste heat from the initial gas turbine electricity production cycle to be used for the production of additional electricity in a steam turbine cycle. Based on the lower heating value of the fuel, efficiencies can be increased from 38 % of a conventional power station to approaching 60 %.

Combined Heat and Power (CHP) technology, in which most of the waste heat is recovered from the electricity generation process driven by gas engine (2,3) or turbine (4) and used to produce steam or hot water for heating/cooling or for direct use in industry, can achieve even higher overall efficiency rates, especially by smaller decentralised systems. Gas CHP attracts innovative approaches, e.g. in combination with decompression stations (5).

3

Spain

CHP Gas fired engine plant

Three textile companies in northern Spain co-operated in the building of a gas fired CHP plant to cover all their energy needs, i.e. electricity, thermal oil, steam and hot water.
The plant delivers 6.270 KW of electrical power. The waste heat recovered from the exhaust gases of the engines is used to produce steam and to heat a circuit of thermal oil. Heat from the engines cooling system is used in the manufacturing process.
Yearly fuel savings amount to around 4000 tonnes of oil equivalent compared with a conventional installation. Corresponding savings in CO_2 emissions amount to 12.500 tonnes.

4

Italy

CHP Plant with a gas turbine

A chemical plant, operated by ENI has installed a CHP, turbine operated, plant, with a total power capacity of 3472 KWh and thermal capacity of 6300 KWh, based on 8000 hours/year.
Compared with separate power and heat generation, the plant realizes an energy saving of about 2400 tonnes of oil equivalent/year.

5

Belgium

CHP Station

A 5MW electricity production plant, combined with a natural gas decompression station and a cogeneration process producing preheated combustion gas yields an efficiency of 75 percent, in terms of electricity production. Surplus heat from the process heats nearby buildings and the efficiency rises to 85 percent.
On a yearly basis the calculated savings in CO_2 emissions compared with normal gas fired 5 MW power production reach 9000 tonnes CO_2 per year.
This project shows that extension of gas decompression turbines operations combined with CHP technology can greatly enhance energy and emissions savings.

Further significant potential lies in gas fuelled decentralised technology, including micro CHP. The wider use of fuel cells for power and heat generation is now on the verge of commercial availability.

Fuel cell technology, for which the necessary hydrogen can be obtained from natural gas will also become more important, and offers significant environmental benefits (about 80% total efficiency, and no or negligible emissions).

Decentralisation of generation has the potential to transform the grid based system familiar to today's users; instead of travelling over long distances, electricity is produced and used locally, reducing efficiency losses in the grid and improving its capacity use. In the future households could produce their own electricity in a gas fired CHP process, with heat as a by-product. Excess electricity produced by households could be supplied to the grid.

Industrial and commercial

Conversion from coal, oil, or LPG to gas fired plant can deliver significant efficiency benefits to a business, realising lower energy costs in the manufactur-

6 UK

Conversion of brick manufacturing plant from lpg to natural gas

A brick making factory in England converted one of its sites using LPG fired kilns. Conversion to natural gas resulted in CO_2 emissions reduction of nearly 26.000 tonnes/year and significant savings in fuel costs.

7 Sweden

High efficiency space heating

In 1996 in large industrial premises in Malmo, characterised by a high ceiling height and poor insulation, used for metal working, a warm air heating system was replaced by gas fired infrared radiators.

In addition to a much improved working climate and lower fuel costs, energy savings of between 55 and 65 percent, about 2400 KW, have been achieved corresponding to about 750 tonnes/year CO_2 emissions reduction (for 1000 working hours per year) together with decreased pollution levels.

8 The Netherlands

High efficiency air heaters

A gas-fired condensing air heater has an efficiency of about 107% (relative to Net Calorific Value) instead of 84% for the traditional gas-fired space heater. Potential annual energy saving is 67 million m^3 Dutch gas (2.2 TJ) with 60.000 air heaters installed at 45 KW capacity and 850 hours/year each.

This equates with an annual CO_2 reduction of 0,12 million tonnes of CO_2, compared with non-condensing gas fired air heaters. Compared with 60.000 electric air heaters fed with thermally generated power at the same heating conditions the CO_2 reduction obtained with the condensing air heaters would be 0,8 million tonnes of CO_2 per year.

ing process as well as lowering emissions of CO_2 and pollutants (6).

Since the flue gases in natural gas processes do not contain solids, direct heat recovery is possible. Heat recovery units improve energy efficiency – energy efficiencies to above 80% have been demonstrated.

Efficient systems have been developed for commercial and industrial needs, which range from space heating to specific manufacturing process.

Heating of large areas like factory floors is traditionally provided by centralised steam based systems, inefficient in so far as the boilers tend to be oversized and the distribution system leads to heat losses. Natural gas plant offers a decentralised alternative which can lead to savings of over 50% (7).

Gas fired condensing air heaters offer very significant advantages (8).

Improved burner design enhances efficiency, delivering environmental benefits (9).

Furthermore, the technique of "wet way" combustion (WWC) can be used very successfully in natural gas plant either in turbine cycles, or with a water vapour pump (WVP) cycle. The WVP which can be adapted to a number of industrial and commercial

9

France

Regenerative burners with flameless oxidation principle

At a factory in Thionville, a company belonging to world leading group in manufacturing either forged or moulded rolling mill cylinders decided to change one of its six furnaces.

The latest technology was selected, a furnace equipped with sixteen regenerative burners which maximise operational efficiency by maintaining a uniform temperature in the manufacturing process. Compared with a standard system these burners allow up to 50 percent energy saving and a very low NOx level (lower than 200 mg/Nm³ around 3% O_2).

10

Germany

Direct Industrial Drying using Natural Gas

Drying processes consume around 136,000 GWh of energy annually in Germany, which is equivalent to 20% of industry's total final energy consumption. Natural gas accounts for around 30% of this market (40,000 GWh), higher than electricity and oil.

The demand for heat for industrial drying is decreasing by around 1% annually, primarily as a result of greater energy efficiency.

The use of direct drying, in which transmission losses are avoided, also offers further potential savings. Direct drying using the flue gases from the combustion of natural gas is suitable for many industrial processes, such as the drying of bricks and tiles, grain, textiles or paper. Such technology necessitates less investment than indirect drying methods and, in addition, offers the advantage of lower conversion losses.

11

Finland

Infrared drying of coated paper

In Finland, more than 40% of total energy input in industry is used for paper or board and pulp production and drying processes. Hence the interest of energy efficient processing. The drying of 1 tonne of paper requires approximately 6 GJ of heat. A common drying method is infrared (IR) heating; IR emitters can be gas-fired or electric powered.

A number of elements affect the efficiency of the process, but overall the calculated efficiency of a gas emitter in IR drying is 45-50%, and that of an electric emitter 30-35%.

If all dryers were gas fired, the total energy saving can be calculated as around 1.5 million MWh/year, which could result in emissions reductions of over 8 million tonnes of CO_2/year.

applications, offers very high efficiency and significant NOx reduction (in some cases reaching 90 %).

Direct drying processes (10) compared with indirect steam methods produce an increase in efficiency. This can be applied in:

- food and agricultural industry
- textiles
- construction materials
- car industry (drying the paint)
- paper and board (11).

In the restaurant and catering trade, gas-fired dishwashers offer significant potential efficiency savings (12).

Domestic

A large item in a household's energy budget is usually space heating. Existing heating systems are often inefficient, with outdated, oversized, or poorly maintained boilers, no control systems or thermostats. More efficient appliances and systems are promoted. Improvements in the performance of household appliances offer an effective and rapid means to curb energy consumption

For the domestic market, the efficiency of gas boilers used for space heating and hot water production has signi-

12

Spain

Commercial gas fired dishwasher

Conventional commercial dishwashers, which are required to wash with water at temperatures of between 85-90°C, use electrical heating systems. Energy consumption and associated running costs are high.

Compared with conventional electric fired models, the gas fired system delivers primary energy savings of 50-60 percent. Savings in running costs amount to between 50 and 65 percent and 60 percent reduction in CO_2 emissions.

If nationwide such systems would cover the demand of 2700 units per year and replacing electrical systems, additional savings of between 15000 and 20000 tonnes/year of CO_2 emissions would be achieved each.

13

The Netherlands

Domestic condensing boilers

A drive in The Netherlands to develop and install high efficiency (HE) condensing boilers achieved their use in over a third of the potential market of individually centrally heated homes ; 1.8 million HE boilers are installed.

Based on an average natural gas use of 2000 m^3 (66 GJ) a year, the annual saving is about 350 m^3 (11.6 GJ) for each user, a total of 600 million m^3 (20 GJ) per year compared with traditional gas boilers.

This is equivalent to an annual CO_2 reduction of 1,1 million tonnes of CO_2.

14

The Netherlands

Domestic gas heated tumble drier

A gas heated tumble drier has an electronically controlled gas burner that heats the circulation air required for the drying process. This process saves on electricity, offers a shorter drying time and therefore lower energy consumption costs.

Compared with an electric drier's use of 3,35 KWh for one drying cycle, the gas heated drier uses only 0,25 KWh and 0,41 m^3 (13.4 MJ) gas. Assuming 250 cycles a year CO_2 reduction is 220 kg for each gas drier, an annual CO_2 reduction of 0,7 million tonnes of CO_2, if all 3 million electric driers were replaced in The Netherlands.

ficantly improved in the past years, as a result of the co-operation of the manufacturers and natural gas companies, in the first place in research and development and then in the promotion and marketing of such appliances.

Condensing boilers optimise the gas use, by a process in which heat is released from condensation of water vapour, which in the traditional systems is otherwise lost. Energy savings reach up to 40% when an old gas boiler is replaced by a condensing boiler.

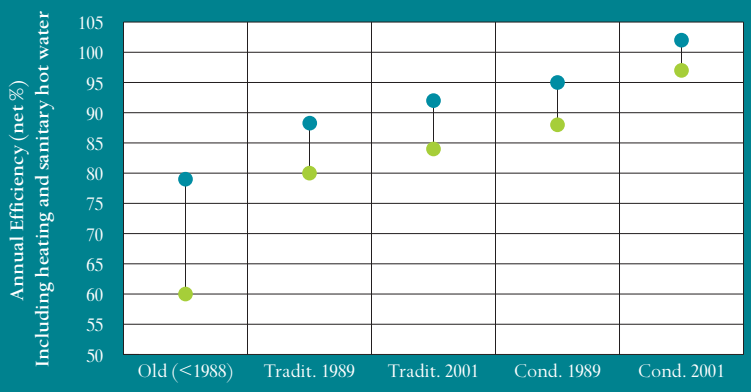
Potential CO_2 savings are considerable (13).

Domestic gas appliances also offer energy efficiency savings compared with electric appliances, e.g. washing machines, dishwashers, tumble dyers (14) and refrigerators.

By promoting the most efficient end-use appliances, plant, and technologies

Energy conservation, energy management and energy efficiency have become essential concepts for environmental policy, but for gas companies they are also fundamental

Range of annual efficiency and evolution for different boiler type



Source DGC (Dk)

The values of annual efficiency are calculated for a 10000 kWh annual heat load and for a sanitary hot water need of 4000 kWh.
The values are calculated for tradionally sized radiators. Improvement might be achieved for condensing boilers by increasing the total radiator surface.

aspects of their market competitiveness. Consumers domestic, commercial, and industrial are always eager to reduce their energy costs and gas companies highlight the energy efficiency aspects of natural gas and associated equipment compared with other energy forms as well as its lower environmental impact. As competition transforms the energy market increasing customer choice in energy supply, customers increasingly "shop around" to meet their needs. The energy efficiency afforded by gas use enhanced by technological developments, is increasingly a factor in their choice.

The European gas supply industry is very active in promoting higher efficiency appliances, equipment and plant in all customer sectors. The supply companies co-operate with national and local authorities in efforts to improve energy efficiency as well as with consumers' associations, builders, and other interested parties (15,16).

The scope of gas industry's actions is very wide, including:

- educate and advise all categories of end-users on means to economise

15

Germany

Domestic / Industrial Gas Condensing Appliances

Some German gas supply companies provide financial incentives and conduct seminars to promote the further use of condensing appliances.

In 1990, gas condensing appliances sales in Germany totalled about 10,000 units. Thanks to extensive efforts by gas suppliers, gas appliance manufacturers, heating system installers and the relevant commercial and industrial companies, total annual sales increased to 95,000 units in 1995 and then to 260,000 units in 2001. This means a market share of 39%. Compared with conventional low-temperature boilers, condensing appliances can save additional 10% of energy.

16

Denmark

Advice given to customers

European gas companies of France, Belgium, The Netherlands and Denmark in co-operation with national authorities have made a joint effort to support installers in guiding customers on deciding boiler replacement.

A system of authority grants to promote replacement of traditional boilers by condensing boilers combined with internet published information for installers and customers and home-visits have resulted in the share of the condensing boilers being installed rising from 17% in 1998 to 50% in the first six months of 2001.

on energy use; promote and disseminate information on correct use of appliances, systems and plant;
- promote use of energy audit espe cially by industrial customers;
- promote use of higher efficiency appliances and plant: commercial and technical development activities;
- co-operation with developers, architects, engineers, installers, to promote the development of energy efficient-housing;
- involvement in research and development of high efficiency gas plant and appliances; co-operation with manufacturers of gas plant and appliances, to stimulate their manufacture and promote their use.

Not all companies or associations carry out all activities, but typically all carry out core activities.

For industrial and commercial consumers, tailored audits and consultancy services are available. Industrial users are typically offered technical services and audits, which analyse the energy and environmental performances of existing plant and systems, and advise on potential effi-

ciency improvements and achievable environmental benefits.

In the industrial sector, technical support for modifications to existing plant design may be offered by companies. Important incentives may automatically be offered (e.g. co-financing of the plant design or of the construction, reduced rate loans, price discounts).

Some companies encourage industrial sectors and services to "compete" with each other in making energy efficiency gains, awarding prizes to high achievers.

Clearly presented billing increases customers' awareness of energy consumption encouraging savings. New meter technologies have the potential to inform customers not just about consumption, but associated costs.

Also, in the domestic sector, gas companies variously offer to assist in purchase and/or installation costs, and may promote market interests by making available leasing or hire-purchase schemes.