Natural Gas - Market and Environmental Needs

Presentation by

Rolf Beyer,
Member of the Executive Board,
Ruhrgas AG, Essen

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Sustainable Energy Production and Consumption
- Challenges and Opportunities -

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1. Introduction

Ladies and Gentlemen,

"Our Common Future" was the subject examined in 1987 by an UN Commission headed by your Prime Minister, Ms. Brundtland. The Commission invented the magic term "sustainable development". What has become of it, Minister Stoltenberg, Ladies and Gentlemen? I am pleased to be able to present some thoughts on this topic from the vantage point of an energy company with a direct link to market needs.

2. Importance of the North Sea Region

The inhabitants of the countries adjoining the North Sea total just over 165 million. This is roughly 50 % of the population of the European Union. The North Sea countries account for more than 15 % of the world's GNP. This is due to close interlinkage with world trade, to which our region contributes 20 %.

Apart from this economic potential, the North Sea is western Europe's main energy source. For instance, energy production in countries adjoining the North Sea accounts for 54 % of natural gas consumption and 35 % of oil consumption in western Europe. 80 % of west European energy exports come from the North Sea. It will remain western Europe's main energy-supplying region. I would like to single out the gas industry as an example. According to forecasts, gas consumption in western Europe will rise by approx. 35 % up to 2010. Gas from the North Sea will further expand its share in meeting this increased demand.

3. Sustainable Development: Balance Between Economic Use and Environmental Protection

However, the North Sea is highly important not only as an economic and energy-producing location, but also in terms of fisheries and tourism. These different types of use place competing quality demands on the North Sea. While economic use of energy resources is as the forefront for the energy industry, the environmental quality of the North Sea is of prime concern for fisheries and tourism. A delicate relationship exists between economics and the environment. Striking a balance between these competing uses makes high demands on policy-makers and business leaders.

The question therefore arises of how to maintain a viable balance between the competing uses. "Sustainable development" is the magic formula in this respect. This principle was first set out in 1987 by the World Commission on Environment and Development in its final report entitled "Our Common Future".

The report describes sustainable development as a development which satisfies present needs, without the risk of future generations being unable to satisfy their own needs.

This implies an economic process which can be maintained in the long run without overburdening the ecosystems of the earth and, in this case, the North Sea.

The safest way of not overburdening the earth's ecosystem would be to have an energy industry that leaves all non-renewable resources (energy reserves) untouched. Admittedly, at first glance future generations would not be in a worse position as a result. But for the present-day generation it would mean banning any economic activity which involved

- a reduction in the stocks of renewable resources,
- the consumption of non-renewable resources (coal, oil, gas) or
- impairment of the environment.

The energy industry would have to rely exclusively on renewable resources. Here I do not wish to dwell on the questions of

- whether world energy demand could be covered exclusively by renewable energy resources or
- whether use of renewable energy resources would be more environmentally friendly.

It is surely not necessary to explain why this method of realising sustainable development would cause both economic and social chaos worldwide.

Given a reasonable interpretation of sustainable development, the following goals can be derived for the energy industry:

- to conserve energy,
- to increase the use of renewable energy sources and
- to achieve greater energy efficiency.

These measures call for huge capital expenditure. This will give rise to a new balance between traditional capital and eco-capital. We thus face a problem of optimisation and not a task of minimisation. In the second part of my presentation, I will proffer some concrete examples.

How can this process of optimisation be handled? To my mind, there is no panacea. Yet politicians and administrations in North Sea countries are surprisingly unanimous in the view that the use of energy could be influenced optimally by taxes and charges. The main reason given is that the energy market is not able to bring about such a balance and maintain it in future.

Without going into details, I am unable to share this point of view. Energy taxes cannot be justified by the hypothesis of depletion of energy sources, nor by the expectation that they can efficiently reduce emissions. A striking example in this respect is the combined energy/CO_2 tax, which has been discussed in the European Union for almost three years now and is intended to limit energy consumption and lower CO_2 emissions. Numerous studies, including those of the EU and the IEA, have shown that such taxes are far from having the desired ecological efficiency.

In short, I would like to state that energy taxes, even if they bear the eco-label, have very low ecological efficiency. They are therefore scarcely suited for achieving sustainable development. This also applies to command and control strategies.

Instead this is likely to be achieved by alternative concepts, especially voluntary agreements, joint implementation and creation of favourable conditions for spending on modernisation aimed at, say, raising energy efficiency and lowering emissions.

In recent years and decades, probably the greatest changes have occurred in environmental awareness. In the 1960s, dust, soot and SO_2 as pollutants with a direct impact were at the forefront of local thinking. Meanwhile there has been a shift from pollutants to greenhouse gases, i.e. from direct effects to more complicated mechanisms, and from local to global thinking: the greenhouse effect, the ozone layer, etc.

Fig. 1
Change in Environmental Awareness

Nonetheless, the demand is that emissions be reduced. Natural gas can help in diverse ways to lower emission levels. But in a market economy this is only possible if gas - apart from meeting environmental needs - also satisfies market requirements.

4. Role of Natural Gas in Meeting Energy Demand: Market Needs, Technologies, Environmental Aspects

Over the past few decades, natural gas has evolved in the face of stiff competition from an initially derided newcomer to a mainstay of energy supply.

Yet the demands on the energy and gas industry have not exactly decreased over the years. There are now three key parameters:

- gas reserves and their availability,
- the market and customer needs,
- the political and legal setting in the shape of laws, regulations and directives.

I would like to confine my remarks to two issues:

- market changes and requirements,
- the relationship between natural gas and the environment.

4.1 Residential and Commercial Sector

The European natural gas era has just reached the age of 30, i.e. is still relatively young. In this period, the residential and commercial sector expanded dynamically.

In retrospect, natural gas experienced a success story, but the development of the market was not a "cinch". Gas had to prevail in fierce competition on the heat energy market. The popularity of natural gas is attributable to its competitive pricing, environmental credentials, energy-saving applications and ease of use.

Fig. 2
Residential and Commercial Final Energy Consumption in Western Europe

All these factors explain why natural gas is widely accepted among politicians and consumers. Today, the residential and commercial sector is the largest market segment for natural gas, accounting for approx. 45 % of gas sales in both western Europe

and Germany in 1994. On the west European heat energy market, natural gas is the most popular source of energy.

The proportion of homes with gas heating is rising annually. In the case of newly built homes in Germany, the share is about 70 %. But the question arises whether this trend will continue in undiminished form.

In Germany, for instance, important conditions are changing, which will lead to a decrease of specific heat energy requirements in new homes. This trend is at an advanced stage in Scandinavian countries.

Fig. 3
Specific Heat Energy Requirements

To my mind, there are two points of departure for safeguarding the use of gas in the residential and commercial sector:

1. reduction of costs in gas distribution and utilisation,
2. new appliance technology.

R&D activities relating to small gas-fired heat generators have had two main objectives over the last 15 years:

- to increase efficiency,
- to lower pollutant emissions.

As a result of the growing propagation of such appliances, natural gas already makes an important contribution towards energy conservation and emission reduction.

The breath-taking technical development can be illustrated best by nitrogen oxides, the only relevant pollutant remaining in the combustion of gas.

It is particularly notable that a considerable reduction of NO_x emissions has been attained even in the case of natural-draught gas burners frequently used in the residential and commercial sector.

Fig. 4
Milestones in NO_x Reduction

In fact, in the case of modern residential gas appliances, a point has now been reached where maximum efficiency and almost pollutant-free combustion are achieved simultaneously.

In view of the level reached, it is questionable whether further efforts to achieve improvements on the existing paths make sense.

4.2 Industrial Sector

The industrial sector is the second most important market area for natural gas. Here it is primarily used to produce process heat. The applications are highly varied.

Due to intensified efforts aimed at rational energy use and the introduction of energy-saving production methods as well as automation and structural changes, industrial energy consumption is declining in both specific and absolute terms.

Fig. 5
Industrial Final Energy Consumption in Western Europe

Despite this overall trend, industrial use of gas has risen further in the past few years. In western Europe, roughly 31 % of gas was used in industry in 1994, and in Germany the share was 29 %.

The reasons were:

1. Environmental considerations: Natural gas allows long-term compliance with statutory limits at relatively low capital outlay.

2. Financial considerations: Due to efficiency of use, simple authorisation procedures, little spending needed for environmental protection and its competitive price, gas is proving to be a truly economical energy source for industry.

But natural gas can also penetrate areas hitherto reserved for electricity if, as a result of suitable R&D activities, tailor-made applications are available to meet the respective requirements, especially incorporation into automated procedures. One example of such technical innovation in the high-temperature sector is the ceramic radiant tube. It is used for indirect heating.

Fig. 6
Ceramic Radiant Tube

4.3 Power Production and Cogeneration

Let me now discuss a market sector in which significant changes are anticipated in western Europe in the years ahead: power generation using natural gas.

Since the mid-1970s, the use of natural gas in power stations has been marked by a downward trend. Today, electricity production in western Europe is based above all on solid fuels and nuclear energy. This is the result of different resource endowments and the different thrust of national energy policies.

Fig. 7
Energy Consumption for Power Generation in Western Europe

However, a recovery of the use of gas for power generation is now emerging in western Europe. The reasons are:

- acceptability problems in respect of nuclear energy,
- forward-looking and favourably priced gas technology,
- locations near to the point of use due to low specific pollutant emissions,
- interest in small, flexible packaged power-generating systems.

In some countries, such as the Netherlands and Italy, natural gas already accounts for a relatively high share of power generation. Other countries are experiencing a distinct trend towards increased use of gas.

It is felt that natural gas can secure a growing share above all in the combined generation of heat and power.

The basic conditions governing the use of cogeneration throughout Europe differ from one country to another. The fundamental advantages of cogeneration are undisputed, however:

Fig. 8
Share of Cogeneration in Total Net Electricity Production in the EU

- great potential for saving energy (approx. 20 - 30 % compared with separate production of heat and power),
- low overall emissions and
- system economics.

Gas turbines predominate in the case of plants with high ratings. They are enjoying an unprecedented boom worldwide. Among other things, this is due to the fact that their electrical efficiency has been improved significantly since the early 1980s (approx. 28 %), with individual plants now attaining an efficiency of 38 %. In combination with a steam turbine (combined cycle power plants), as much as 58.5 % can be achieved.

Figs. 9 + 9a
Electrical Efficiency of Cogeneration Technologies

Despite the level already attained, further significant improvements in the electrical efficiency of cogeneration systems are expected in the next 10 years.

It can therefore be assumed that natural gas will gain further importance in power generation both in Europe and worldwide.

Emissions from power generation based on natural gas are already low. This applies to CO_2 emissions: specific CO_2 emissions of gas-fired power stations are the lowest per kWh. It also holds true of NO_x emissions: developments pertaining to burners and combustion chambers have led to a dramatic decrease in NO_x emissions. As a result, statutory limits can be observed without any secondary measures; flue gas treatment is therefore unnecessary.

A technology whose future use is anticipated in cogeneration is that of fuel cells. In such cells, the energy chemically bonded in a gas with a high hydrogen content is directly converted into heat and power. The hydrogen needed can be easily and economically obtained from natural gas.

Fig. 10
Emissions of Cogeneration Technologies

These fuel cells, of which various systems are being tested, are appealing in that they allow high efficiency, even for part-load operation, and cause very low emissions.

4.4. Natural Gas in the Transport Sector

The areas just described are familiar markets for natural gas. Let me now discuss a relative new market for gas: the transport sector.

In Germany and western Europe, the future use of natural gas in the transport sector is primarily being considered from an environmental point of view. Road traffic accounts for large shares of particular emissions. They play a major part in the formation of summer smog and lead to high pollution especially in inner cities and conurbations.

The main advantages of a gas engine are

- low pollutant emissions,
- quiet running and
- high knock resistance allowing higher compression.

The possibilities for emission reduction are already very clear, even though the technical potential of gas engines has by no means been fully exploited yet. For example, natural gas-fuelled buses have significantly lower emissions than diesel buses, and mono-fuel natural gas vehicles already comply with the Euro-III emission limits to be introduced in 1999.

As regards the exhaust gas components contributing to ground-level ozone (summer smog), natural gas has the greatest potential for reduction compared with conventional fuels, achieving more than 80 percentage points.

Fig. 11
Reduction in Ground-Level Ozone through Different Fuels

What market potential do natural gas vehicles have? This question was examined by the Prognos Institute, which expects up to 250,000 NGVs to be in operation in Germany by 2010. The main areas of use for gas engines are local transport of passengers and goods, especially fleet vehicles (buses, taxis, delivery vehicles, service vehicles, municipal commercial

Fig. 12
Emission Levels of Various NGV Concepts for Passenger Cars

vehicles), i.e. vehicles that can be refuelled at central sites. The ranges of approx. 300 km achievable using currently available on-board storage tanks are sufficient to cover by far most journeys.

The basic conditions for natural gas vehicles differ greatly in Europe. In Germany, only a few hundred NGVs are in use at present because economical operation is not possible, the main obstacle being the existing mineral oil taxation. The law-makers have meanwhile perceived the advantages of natural gas in reducing emissions and plan a temporary reduction of mineral oil tax on natural gas. This would clearly boost the position of NGVs in Germany.

4.5 Voluntary Commitments: Climate Protection Declaration of the German Gas Industry

By virtue of its properties and advanced applications, natural gas offers good opportunities for reducing strains on the climate and environment. Yet many of the areas in which there is still untapped potential for emission reduction have to be developed by suitable efforts, frequently in the face of diverse obstacles. Allow me to report briefly on an initiative based on a voluntary commitment between industry and government.

As part of the German industry's initiative for global climate protection, the German gas industry has voluntarily pledged to lower CO_2 emissions. It supplements the measures already taken on the gas industry's own responsibility that have in recent years very effectively assisted the rational use of energy, the reduction of CO_2 levels and the lowering of NO_x emissions.

The main elements of the German gas industry's CO_2 reduction pledge are:

a) for western Germany:

In residential space heating, specific CO_2 emissions from the production of useful heat are to be reduced by about 25 % between 1987 and 2005 through the use of natural gas.

b) for eastern Germany:

In residential space heating, specific CO_2 emissions from the production of useful heat are to be reduced by more than 50 % between 1989 and 2005 through the use of natural gas.

By raising annual fuel use efficiency in the production of useful heat and by replacing high-carbon energy sources by low-carbon natural gas, a steadily rising CO_2 reduction potential is being exploited in Germany, which will ultimately be 30 - 40 million t of CO_2 in 2005 compared with 1987 or 1989. Regular monitoring serves to ensure that this pledge is honoured. The German government has stated that in turn it will refrain for the time being from imposing further national taxes and charges.

5. Conclusions

The ideal energy does not exist as yet. It would have to meet a long list of requirements: it would have to be not only affordable, capable of storage and transportation as well as inexhaustible, but also economical, versatile and free of any pollutants, residues and emissions. No energy satisfies all these conditions. Yet in key respects, natural gas comes close to this ideal.

When combusted, natural gas causes minimal pollutants because it contains virtually no pollutant-forming substances, such as heavy metals, sulphur, chlorine or fluorine. It does not leave any solid residues in the combustion space, such as ash, slag, dust or soot. Furthermore, the formation of thermal NO_x, which was the only factor still of some significance in gas combustion systems, has decreased to a very large extent as a result of technical advances.

Moreover, in curbing the anthropogenic greenhouse effect, in which context carbon dioxide is of key interest, natural gas can make a significant contribution towards reducing CO_2 emissions due to its very high hydrogen content. Of all fossil fuels, it contributes least to the anthropogenic greenhouse effect.

As the reserves situation has constantly improved in recent years owing to technical progress in numerous fields, I am convinced that there are also sufficient volumes available for natural gas to play an important role in ensuring protection of the global climate and environment. The extent to which it can do so depends decisively on the prevailing economic and political conditions. If they are right, the North Sea region will gain a double dividend - economically and ecologically.

Fig. 1

Change in environmental awareness

ruhrgas

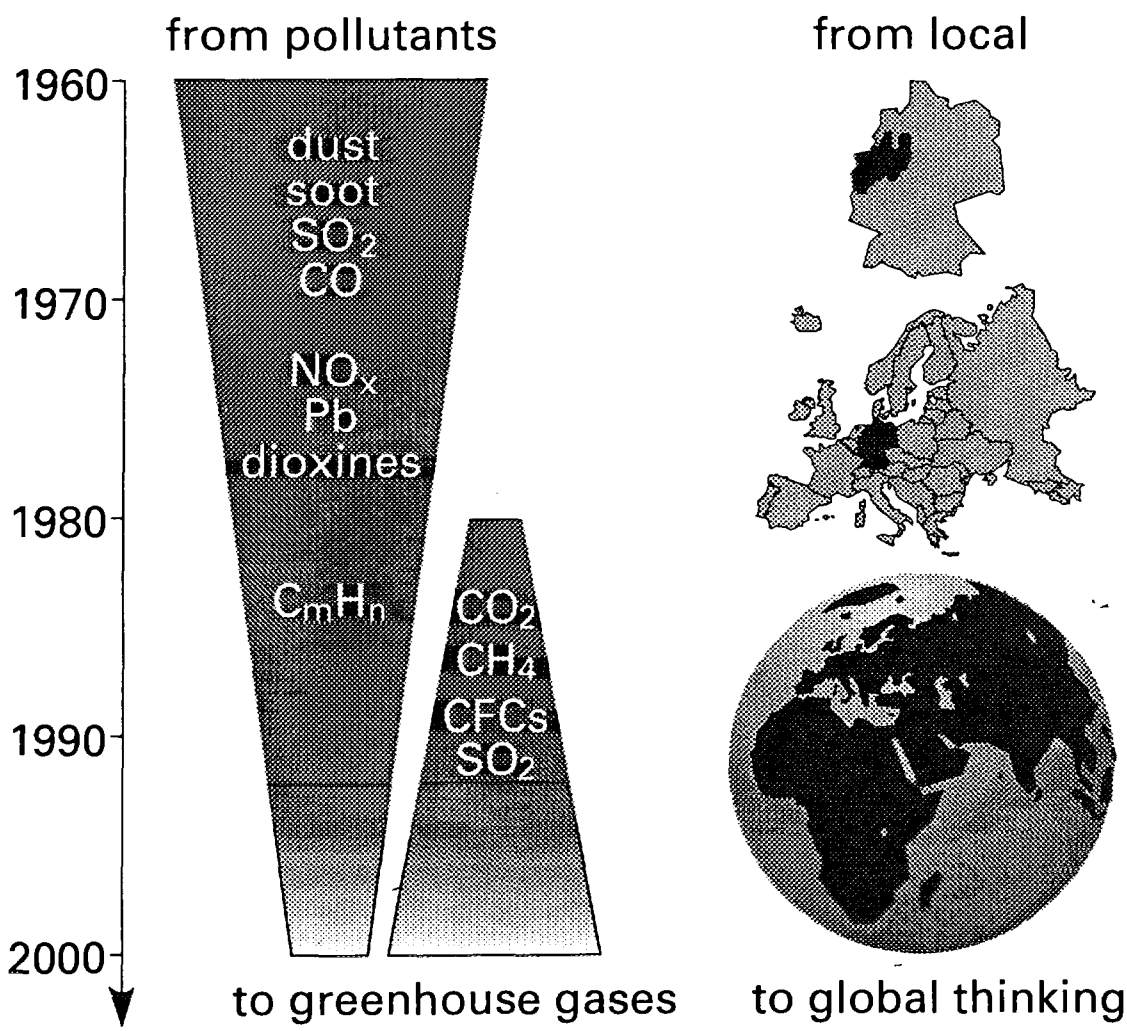

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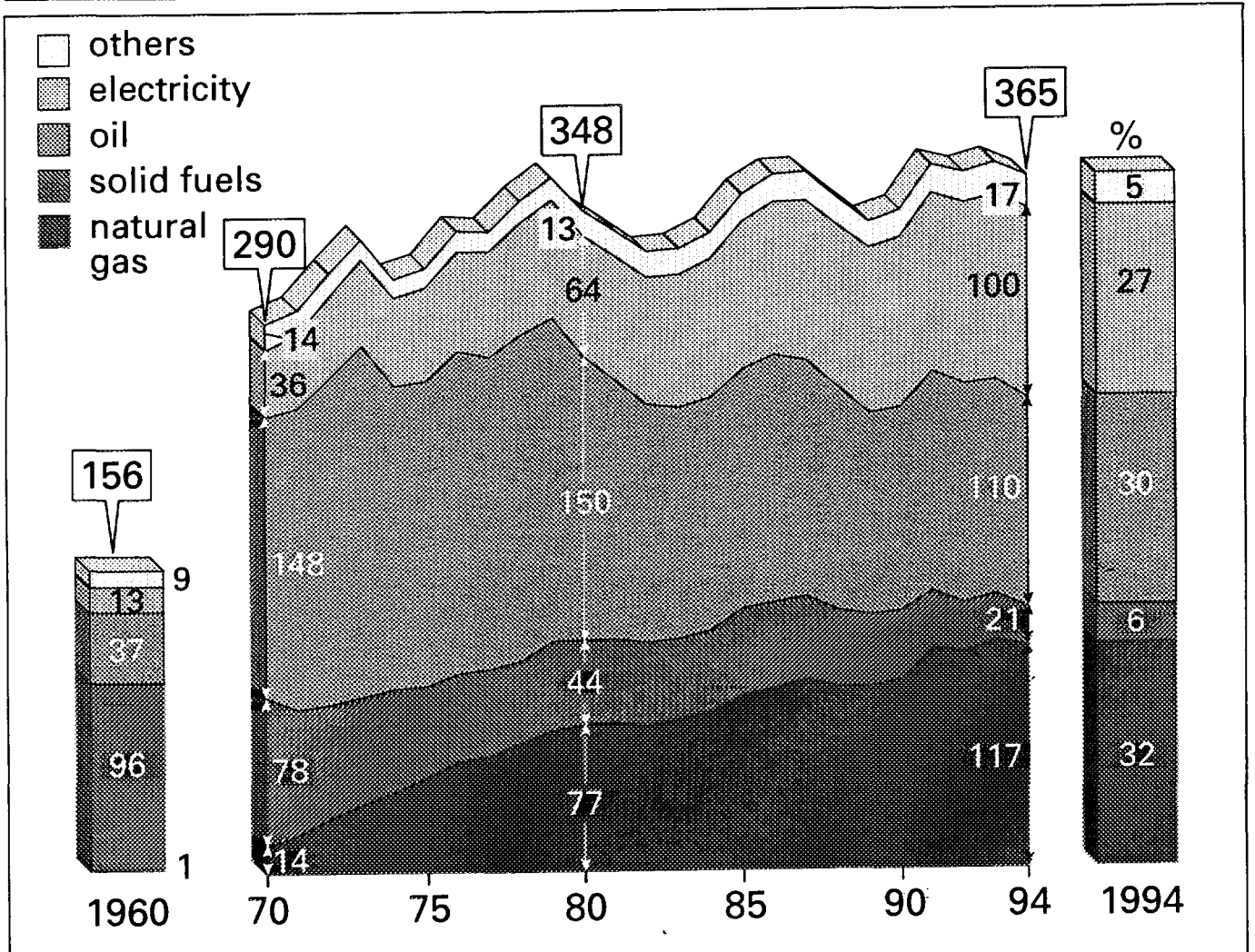
Fig. 2

Residential and Commercial Final Energy Consumption in Western Europe (mtoe)

ruhrgas



provisional data for 1994
Source: OECD (since 1970 incl. former GDR)

1995

1380

Fig. 3

Specific Heat Energy Requirements as a Function of Building Standard

ruhrgas

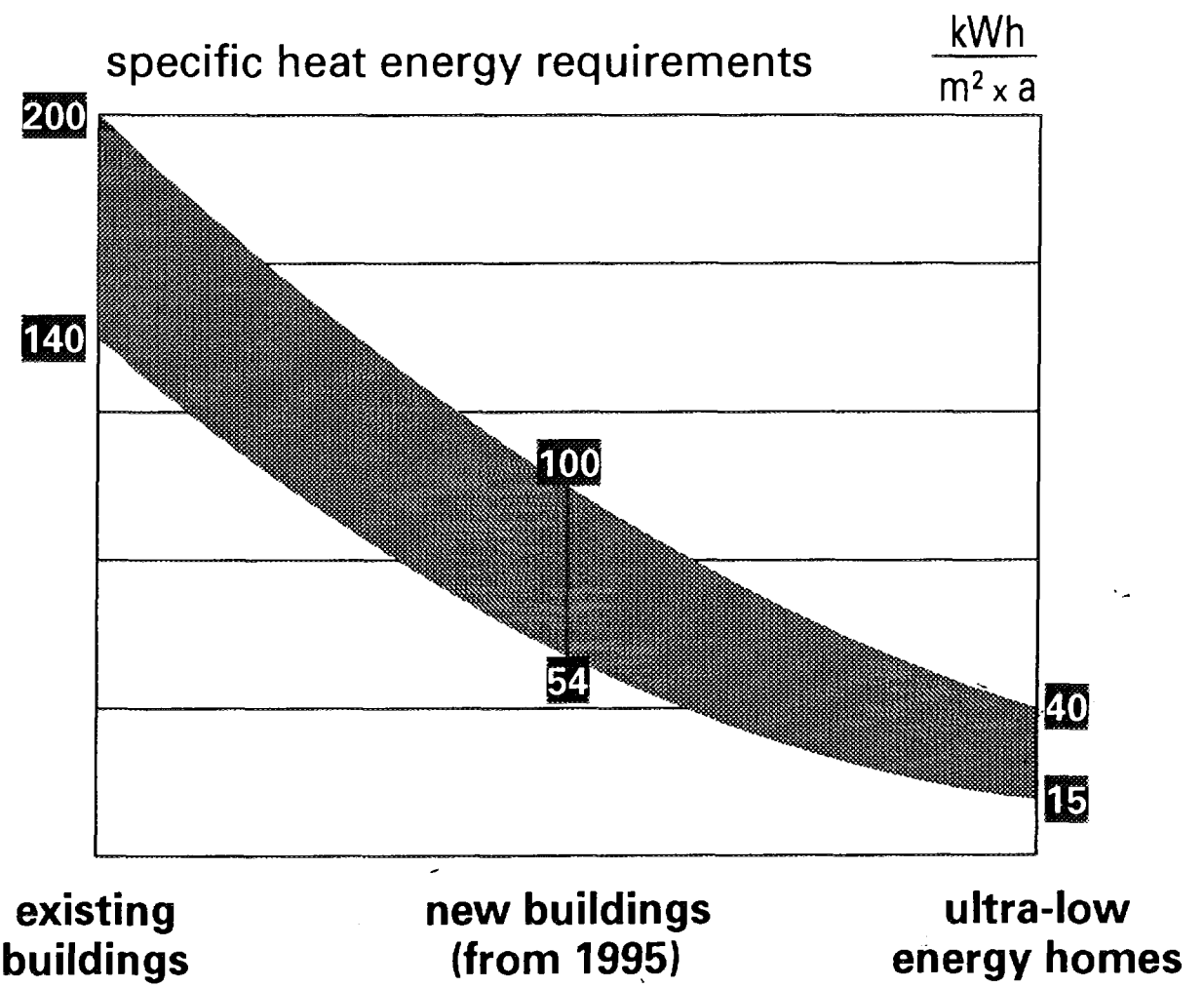


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Fig. 4

Milestones in NO_x Reduction for Residential and Commercial Gas Burners

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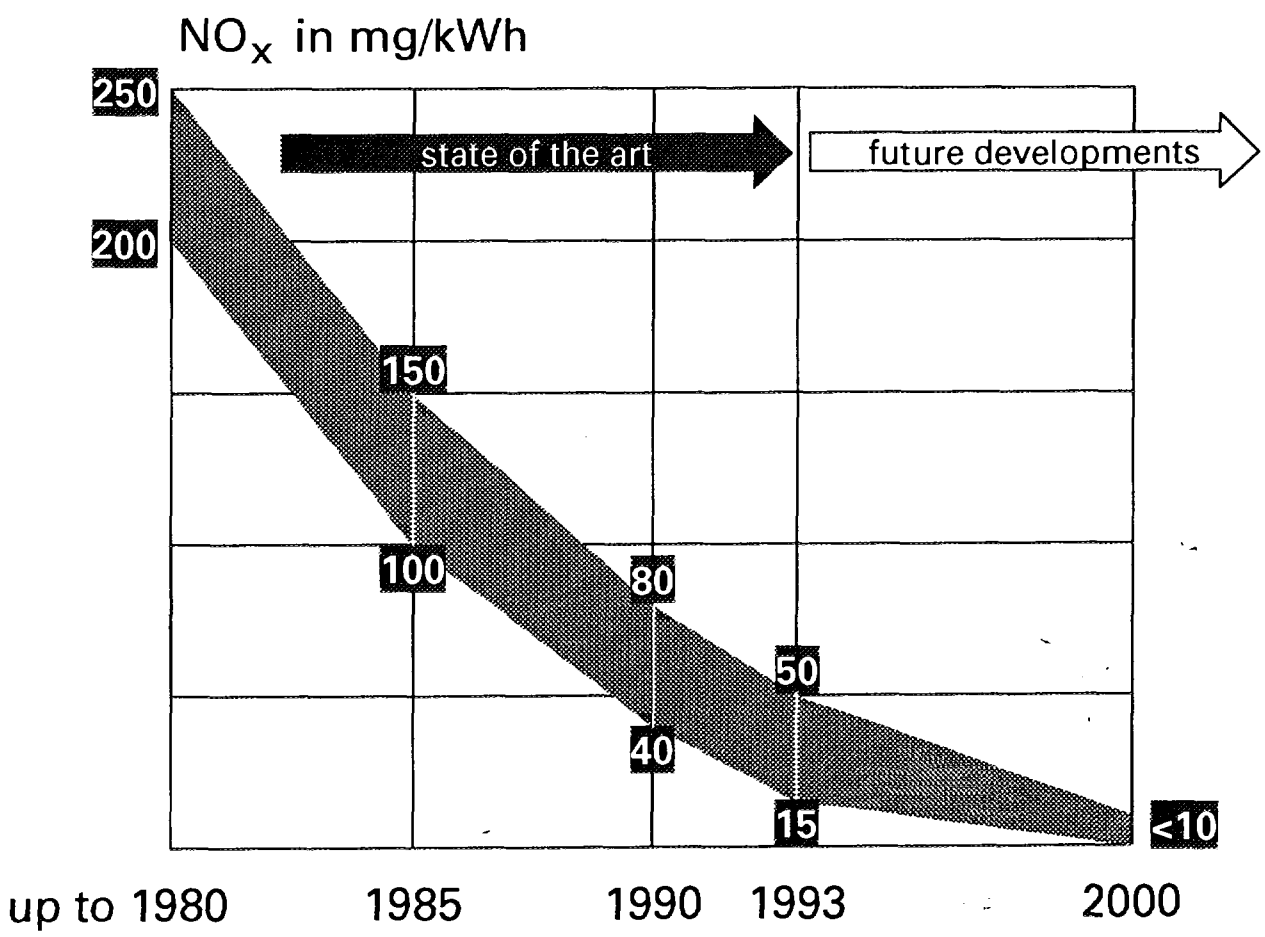

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Fig. 5

Industrial Final Energy Consumption in Western Europe (mtoe)

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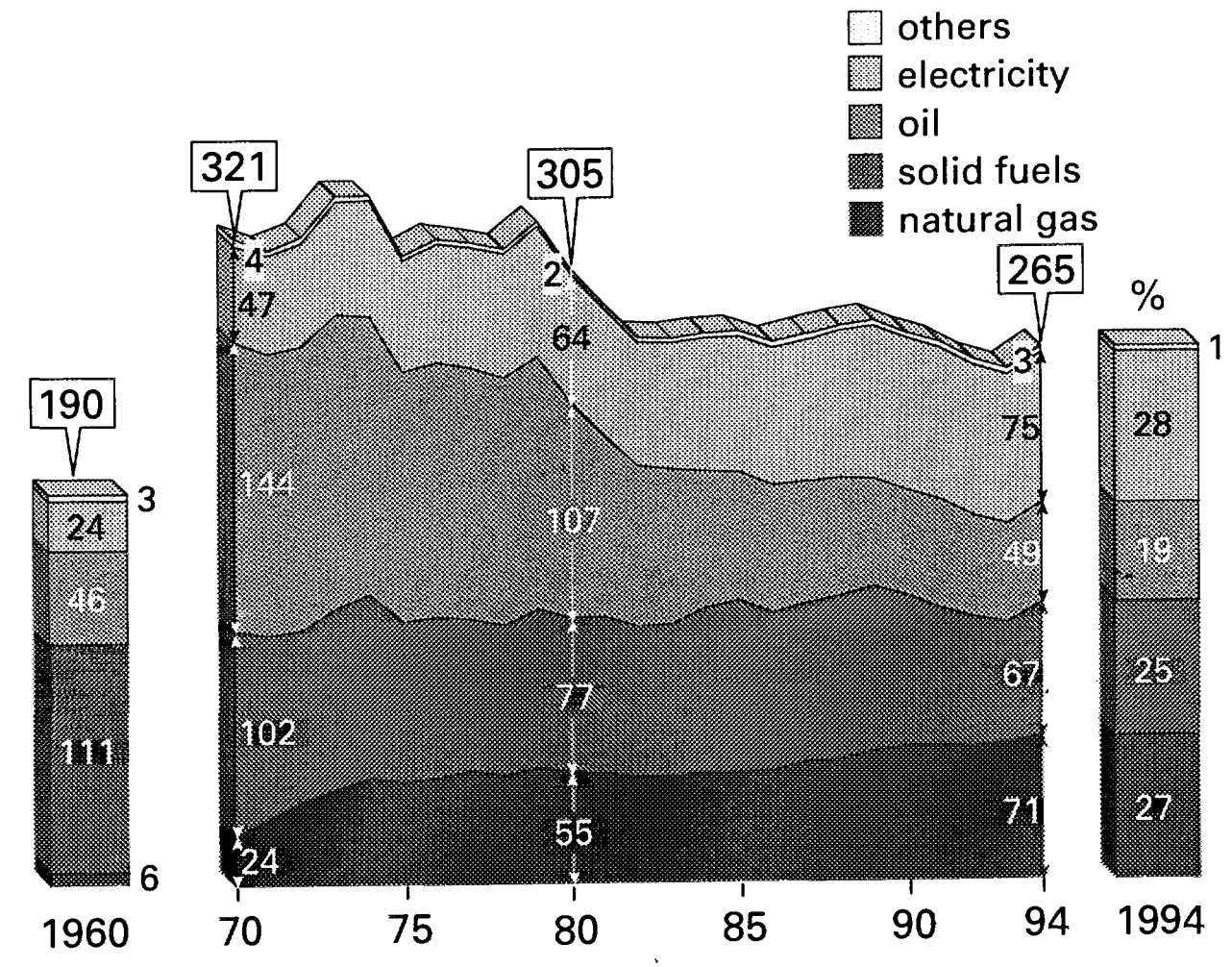

provisional data for 1994
Source: OECD (since 1970 incl. former GDR)

1995

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Fig. 6

Ceramic Radiant Tube

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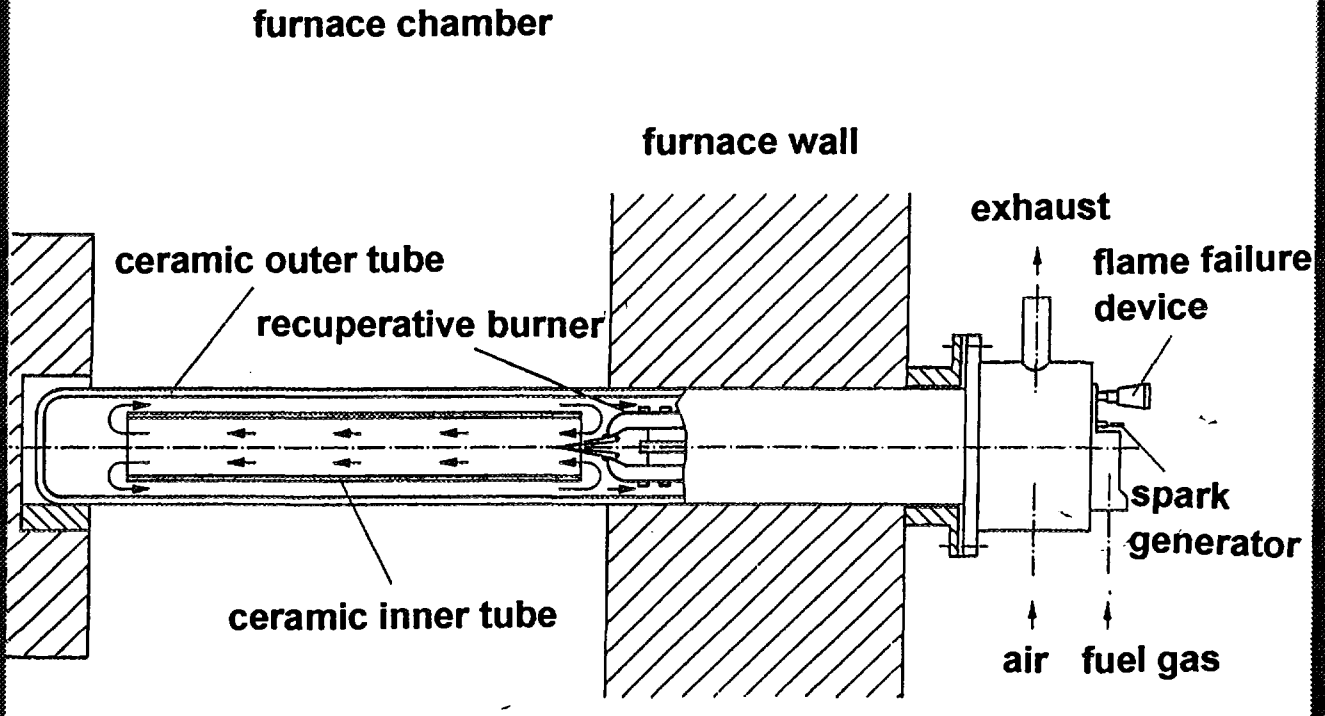

1994

Fig. 7

Energy Consumption for Power Generation in Western Europe (mtoe)

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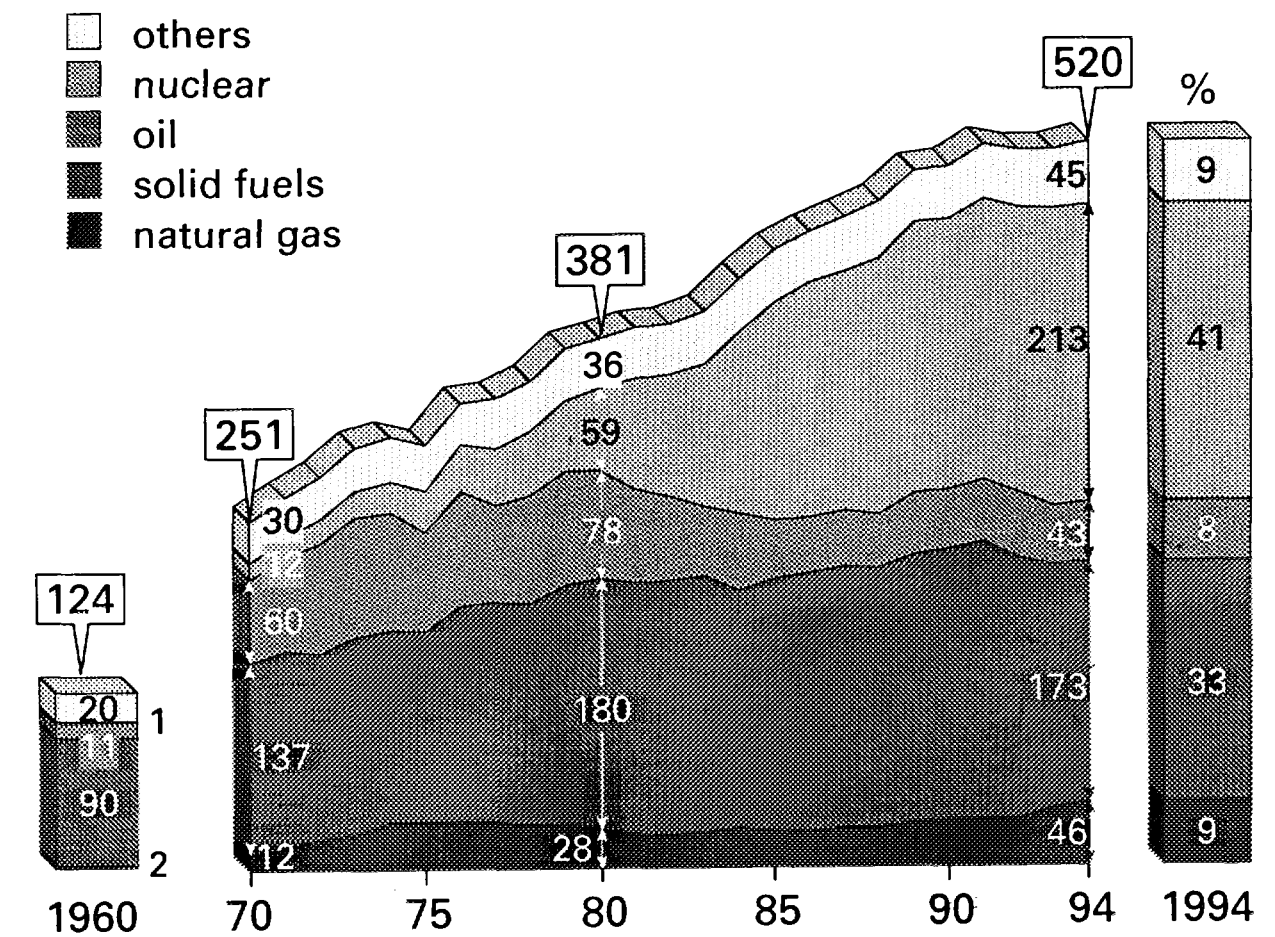

provisional data for 1994
Source: OECD (since 1970 incl. former GDR)

1995

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Fig. 8

Share of Cogeneration in Total Net Electricity Production

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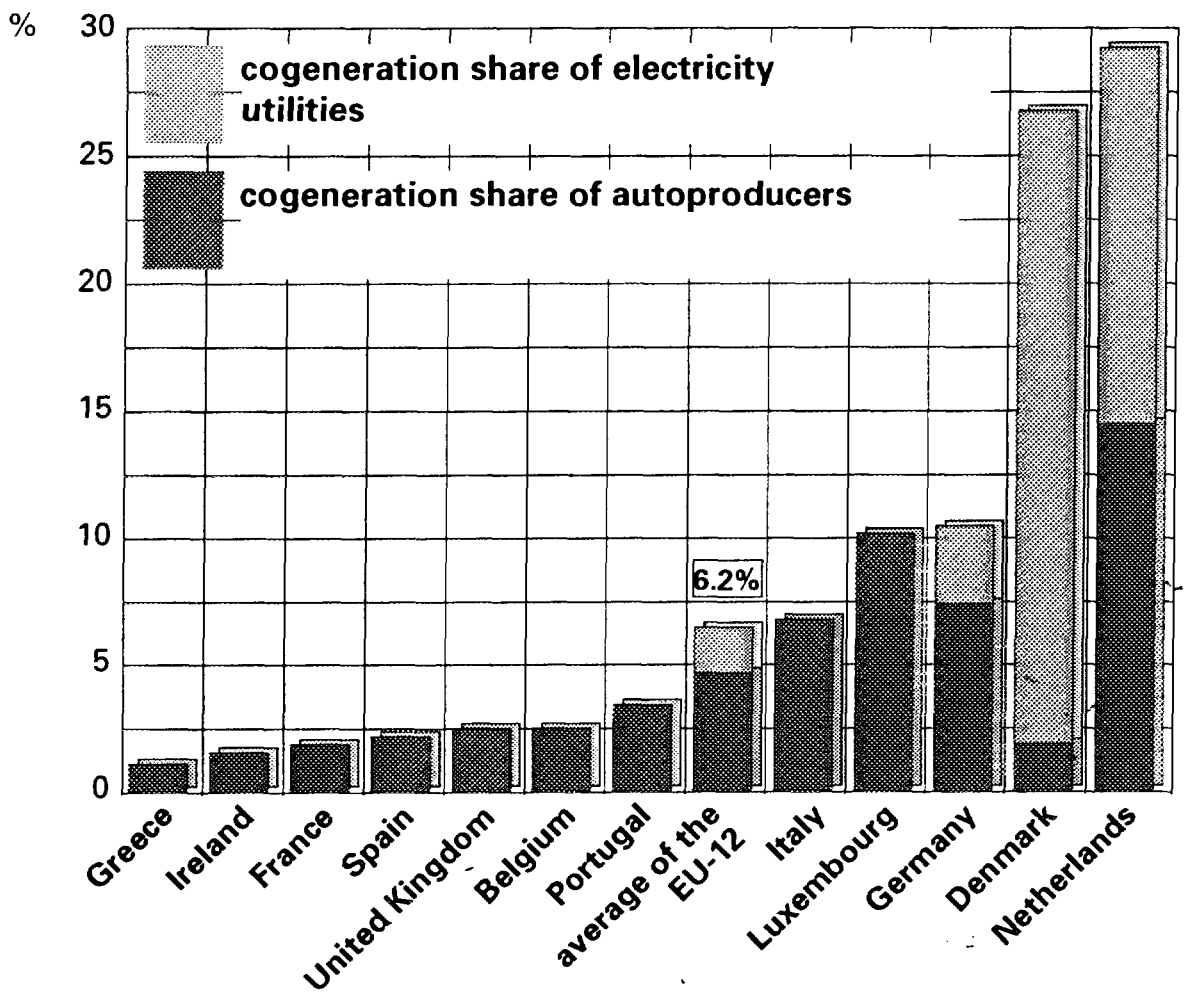

Source Cogeneration in Europe, Günter Marquis, 1994

M1

Fig. 9

Electrical Efficiency of Cogeneration Technologies: Current Status 1995

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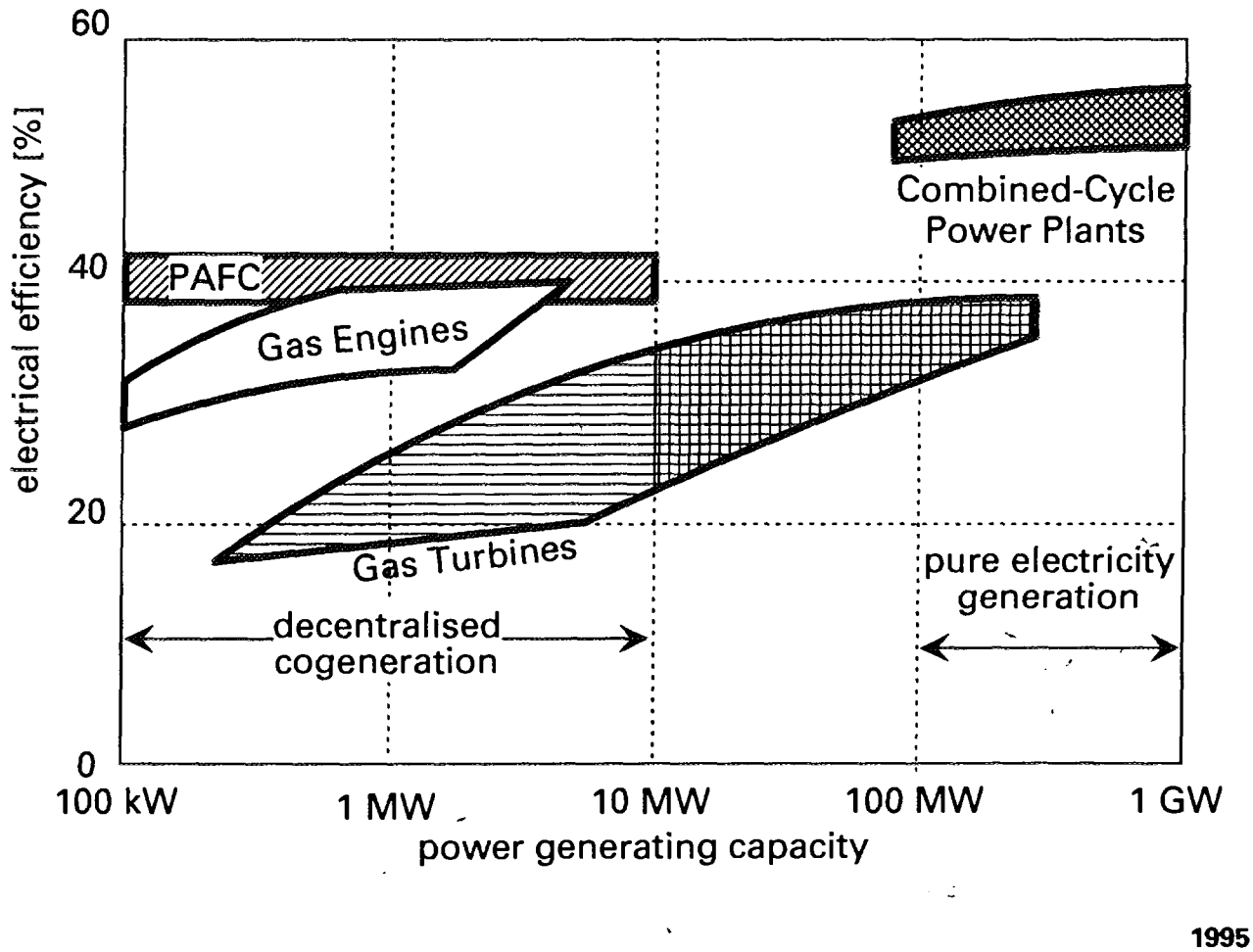

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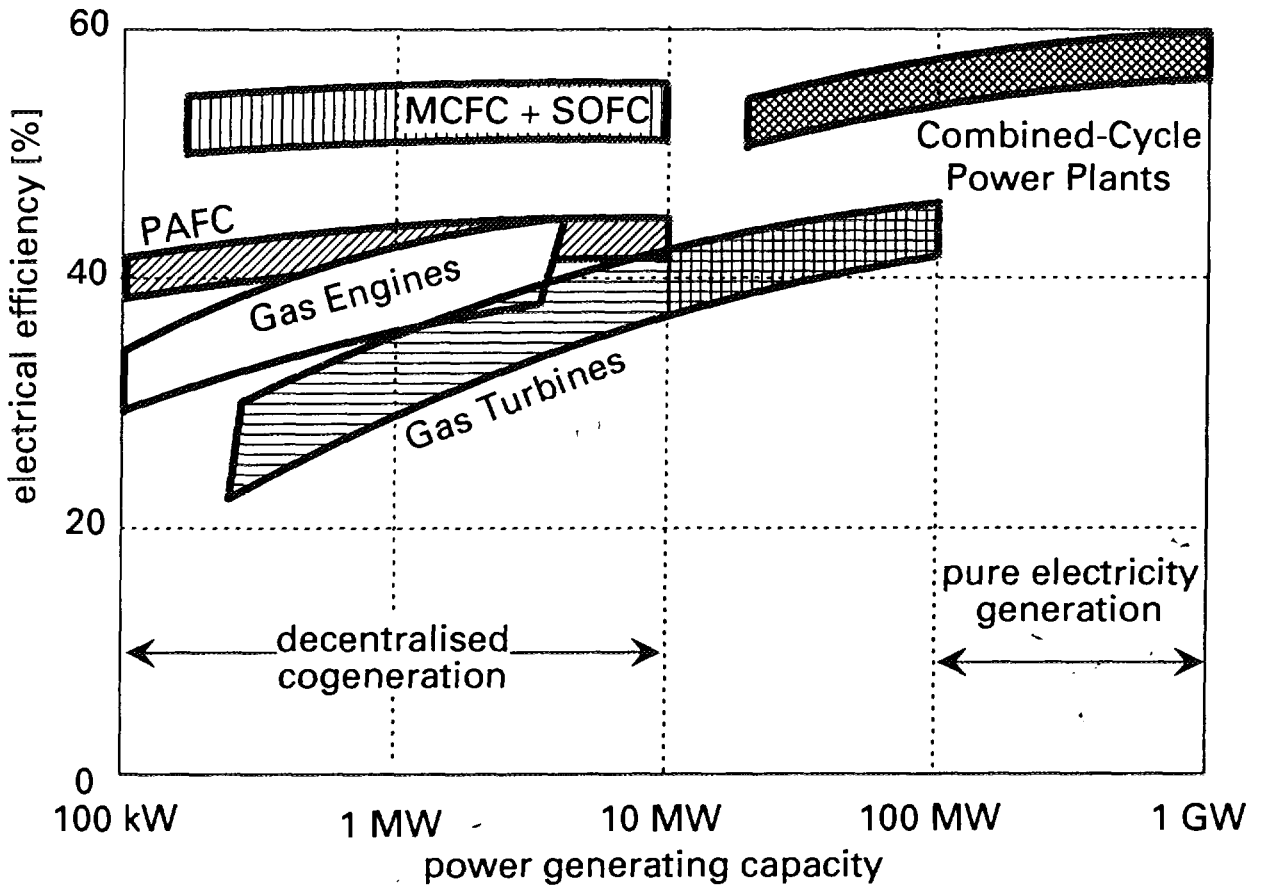
Fig. 9a

Electrical Efficiency of Cogeneration Technologies: Forecast for 2005

ruhrgas



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3177b

Fig. 10

Emissions of Cogeneration Technologies

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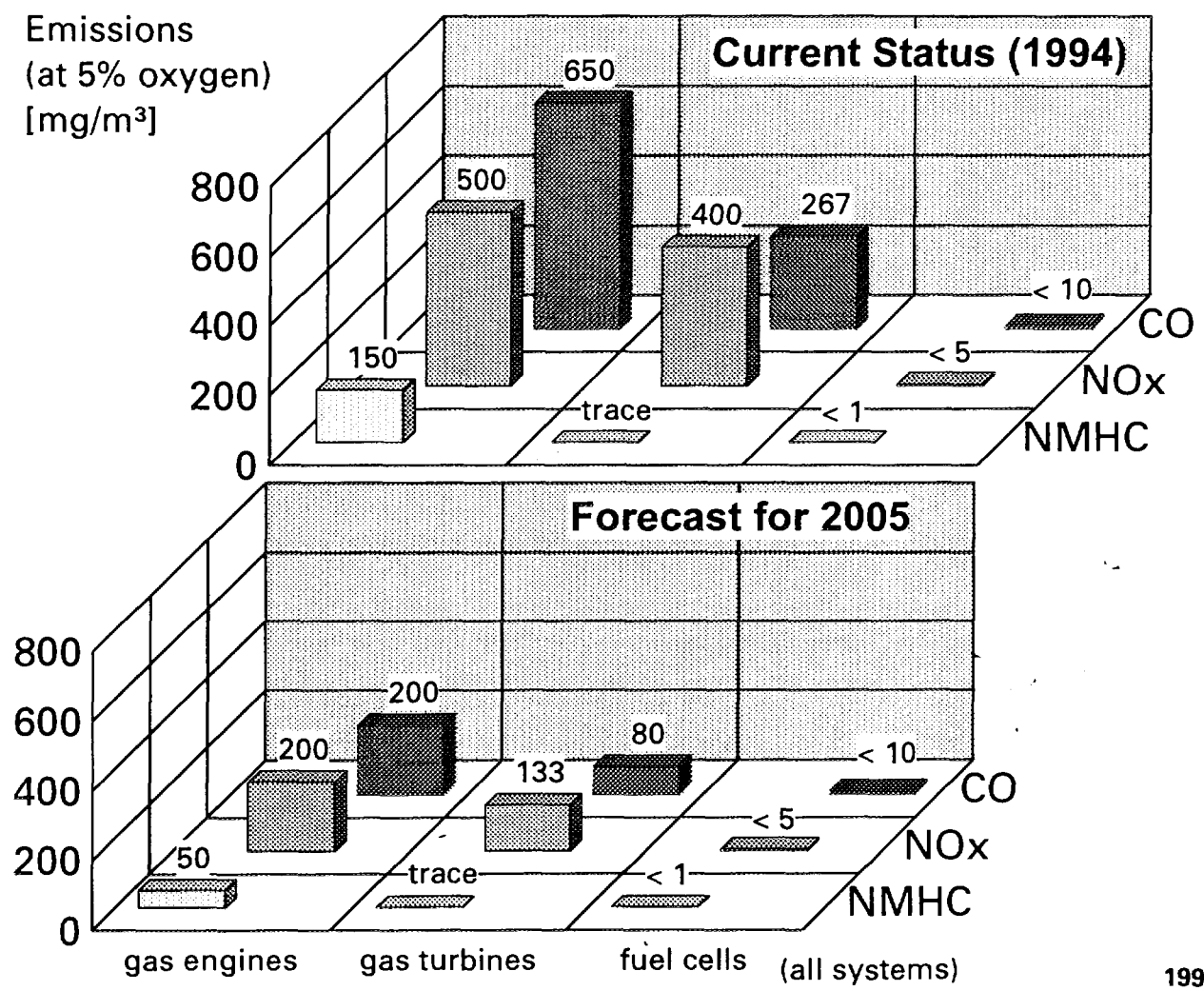

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Fig. 11

Reduction in Ground-Level Ozone through Different Fuels

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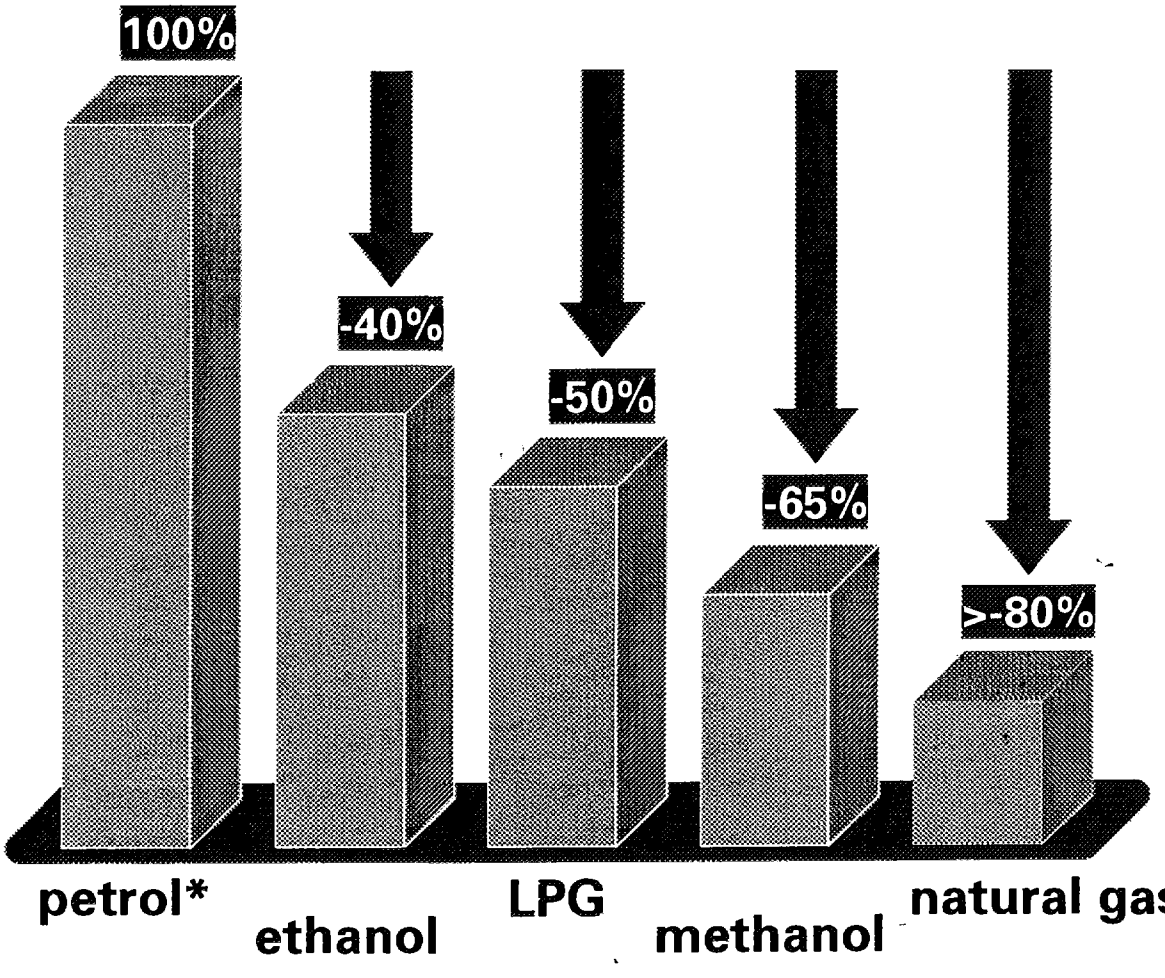

* similar relations for diesel

1995

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Fig. 12

Emission Levels of Various NGV Concepts for Passenger Cars (Status: 1995)

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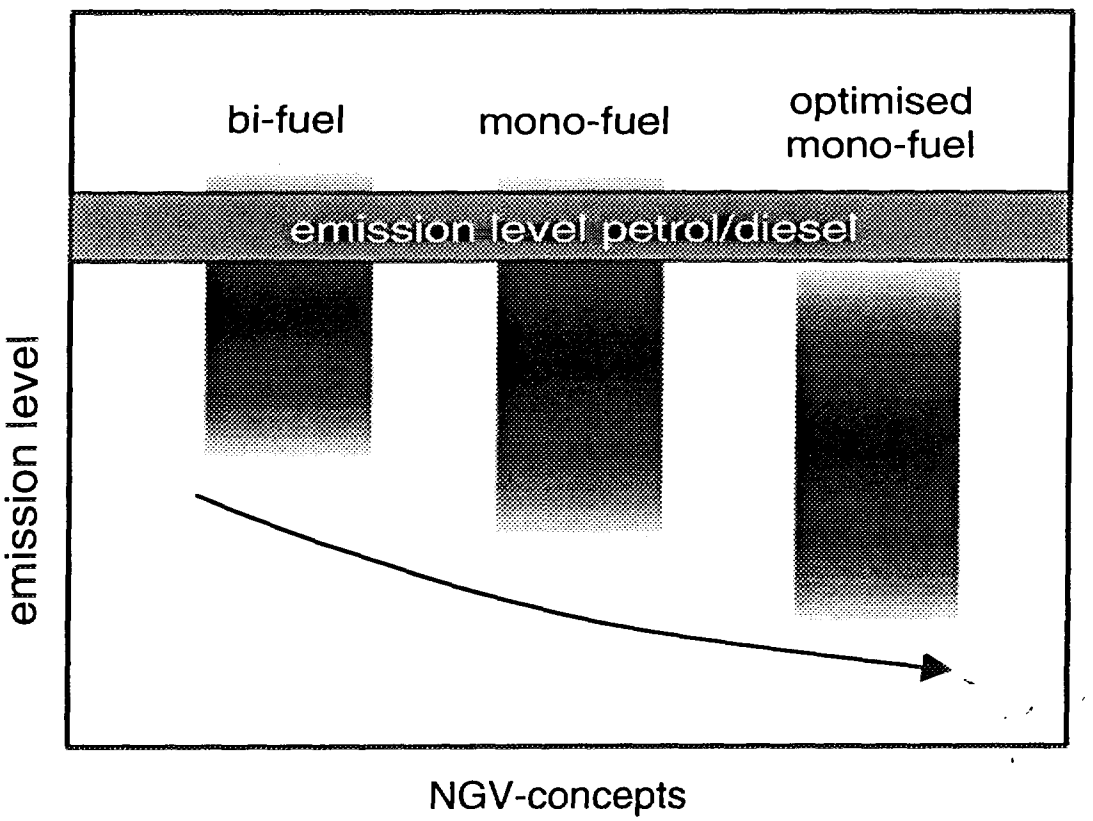

Note: The basis for the emission level is a qualitative overall assessment of emissions (limited and non-limited) in the ECE cycle;

diesel: state of the art technology (TDI+ catalytic converter)

1995

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EMINGVA2
04.08.1995