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Gas to Power in Europe

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ABSTRACT

There is little argument among stakeholders regarding the significant potential for gas-fired generation in Europe, as detailed in the International Energy Agency's World Energy Outlook 2004 projections. However, some players are concerned that actual conditions are not entirely favourable and may impede full realisation of this prospect. The most important factors that may affect future decisions to build new gas-fired power plants are the perceptions and expectations held by power generators about the relative fuel prices for coal and natural gas. Other factors contributing to the uncertainty of future of gas-fired generation involve the potential role of nuclear energy and how the European CO_2-emission trading scheme will develop.

With the exception of policies for nuclear power generation, the choice of fuel for new power generation in Europe, in principle, is left to the market. Nevertheless, some governments appear to be more supportive of new gas-fired generation than others.

As regards the preferences of power generators, there is a geographic distinction between northern Europe, where gas-fired power generation is not considered economical for newly built base load power plants because of gas price expectations of local power producers; and southern Europe and the UK, where almost all newly built power plants are combined cycle gas turbine units. Part of the reason for this distinction can be found in the structure of the existing generation portfolio (highly dependent on coal and nuclear power in parts of northern Europe) and the availability of low-cost coal and lignite in some countries.

In terms of potential obstacles to gas-fired generation, power generators stress the need for effective gas market opening and transparent and efficient third party access to gas transport and flexibility services. Gas companies also point to the need to ensure adequate investments in new infrastructure to bring in new gas supplies. But the main impediment for gas-fired power generation appears to lie in the pricing structure applied in Continental European gas markets which exposes the power sector to the risks of price movements in international oil markets.

From a regulatory perspective, this highlights the need to improve and harmonise gas grid access conditions, providing transparency in transportation and flexibility services; and to facilitate investments in new infrastructure in support of new gas supplies.

If the gas industry intends to make further efforts to secure the potential of gas-fired generation in northern Europe, it will be faced with the decision to either accommodate the power sector by means of differentiated pricing terms in new supply contracts; or more actively move towards an independent (spot) price for gas, which at least offers a transparent basis for decision-making by power generators. This decision lies essentially with gas producers, but it is unclear which direction they will take.

Stronger competition between gas and electricity companies, both becoming active in each others' traditional markets, is a key driver for the formation of vertically integrated companies in order to capture the full value of natural gas for power generation from wellhead to the power plant. Bringing new gas supplies to European markets will be increasingly in the hands of these integrated undertakings.

Foreword

The International Gas Union (IGU) is a non-profit organisation registered in Vevey, Switzerland, with the secretariat located in Hørsholm, Denmark. Founded in 1931, it currently has 85 members in 67 countries. The members of IGU are generally national associations of the gas industries or companies with assets in the gas industry.

The main objective of IGU is to promote the technical and economic progress of the gas industry worldwide mainly by facilitating the exchange of information of both a technological nature and of a more general, business-oriented nature.

To that end, IGU organises the World Gas Conference, which takes place every three years. The preparatory programme for the World Gas Conference is implemented by Working and Programme Committees, which study all aspects of the gas industry from the wellhead to the burner tip.

In preparation for the 2006 World Gas Conference, the IGU Dutch Presidency has launched three special projects: Gas to Power, Regulation and Sustainability. For all three, the aim is to engage governments, industry and other stakeholders in a dialogue on gas-related issues to achieve the best solutions for society at large.

The Gas to Power Project has been set up in view of the pivotal role that power is likely to play in the development of new gas markets and the realisation that it will take enormous effort to achieve the projected growth. It aims to identify possible obstacles and to address them by inviting the governments and the power industry to discuss them jointly with the gas industry. Clearly, the Regulation Project is closely related to the Gas to Power Project.

IGU organises a number of small regional workshops with a limited number of representatives from the three main stakeholder groups. This paper was written in preparation for the workshop on Gas to Power in Europe, which was held in Brussels on 4 October 2004.

The objectives of the workshop were to:

- assess the realistic prospects for future gas-fired power generation;
- recognise the need for co-operation between all three groups of stakeholders in order to succeed;
- identify potential obstacles and, where possible, jointly find remedies; and
- share success factors.

The discussions at the workshop were subject to the Chatham House Rule (which designates a meeting as one in which individual views can be expressed confidentially, without future attribution or risk to reputation when an individual has an "official position" as well as a personal opinion; information and ideas however can be referred to anonymously).

In order to focus the discussion, IGU has asked the Energy Delta Institute and the Clingendael International Energy Programme to conduct a survey across the power industry, the gas industry and the relevant government bodies. This final version of the paper incorporates the findings of the workshop. IGU thanks Christoph Tönjes from the Clingendael International Energy Programme for the preparation of this paper.

IGU also expresses its gratitude to Eurogas and Eurelectric for their kind support during the European part of the Gas to Power project and thanks all workshop participants and survey respondents for their active contribution to understanding the future role of natural gas in European power generation.

EXECUTIVE SUMMARY

The potential for gas-fired generation is significant

Energy analysts predict a strong increase in the use of natural gas for European power generation in the coming decades. The International Energy Agency (IEA) in its World Energy Outlook 2004 (WEO) projects an increase of 130 bcm/a in the use of natural gas for power generation in the European Union (25) under their "reference case" up to 2020 (with demand in 2002 at 118 bcm) whereas the remainder of the market would grow only some 70 bcm/a. Such forecasts are based on the assumption that combined cycle gas turbine (CCGT) power plants will be the most economic choice to meet growing electricity demand and to replace aging generation capacity.

But there is uncertainty as to whether the projected growth will be realised in the predicted timeframe. Various forecasting agencies, among them the IEA in their WEO 2004, have adjusted their earlier projections downwards.

Uncertainty about government policies affects the outlook

Investment decisions for power generation plants in Europe are complicated by a variety of uncertainties. The future of nuclear policies remains unclear for countries such as Germany, Belgium and Sweden, with actual decommissioning decisions depending on the political power balances in these countries. The effects of the European emission trading scheme are still difficult to evaluate; this plays a particular role in countries that dispose of large amounts of otherwise competitive domestic lignite and coal resources.

Most generators agree on the competitiveness of CCGT plants for base load generation

New investments in power generation are at the moment mainly directed toward base load power plants, as prices for peak and mid-load electricity are considered too low to justify investment aimed at those market segments. In markets with a relatively high amount of existing lignite, coal or nuclear capacity, new CCGT plants are unlikely to operate as base load plants due to the relatively high variable cost. France and Germany are examples of such countries. This makes it more difficult to opt for a gas-fired power plant as compared to countries where low variable cost power plants play a less prominent role and/or the electricity market shows rather large growth, like in Spain. Although generation costs studies comparing different power plants do not show large differences between the full costs of generation between CCGT power plants and coal plants, most survey respondents and workshop participants consider CCGTs as the most economic choice for base load generation. This implies that the future gas to coal price ratio is not expected to change significantly to the disadvantage of natural gas.

But there are some dissenting views

This view is not shared by large German power generators who contend that for Germany natural gas would be too expensive to withstand competition with lignite and coal. The French Ministry of Economic Affairs appears to strongly believe in nuclear power as the most economic option for base load power generation.

Differences over the gas price outlook

The IEA in their reference case assumes gas import prices of around 3.3 US$(2000)/MMBtu up to 2010, rising steadily to 4.3 US$(2000)/MMBtu in 2030. Although both gas and power industry actors are reserved about revealing their own specific price expectations, it appears that many power generators consider this price outlook as being too low.

The absence of a liquid spot market for gas on the continent is a problem

Power generators currently are less inclined to conclude long-term gas supply contracts than in a non-liberalised environment. However, in the absence of liquid spot markets for natural gas, long-term contracts for a large part of gas supplies are seen by most generators as necessary to secure supplies.

Outlook on pricing terms under long-term contracts is unclear

Many generators are concerned about the pricing terms for natural gas. Some power generators consider the oil price linkage of natural gas pricing as the main obstacle for natural gas in power generation. Price risks from the oil market are perceived as rather high with only limited options for hedging. Generators with a large diversified portfolio of generation assets are less concerned about conventional gas pricing terms. In their view, a diversified generation portfolio offers more opportunities to deal with fuel price risks.

To the extent that long-term contracts are concluded, the preference of generators goes clearly to indexation against electricity or spot gas prices. A substantial number of gas merchants acknowledge the possibility that contract structures in the future might include indexation to coal or even electricity prices. On the other hand, prices in liberalised markets tend to converge on spot prices. Already, new supply contracts with UK generators are indexed to spot gas prices, while gas supplies to power generators in Germany are regularly indexed to a small extent to coal prices. Gas merchants do have a limited ability to offer such indexation as long as their purchase contracts with producers are based on oil indexation. Gas producers might be better prepared to offer contracts indexed to gas and electricity prices directly to consumers; however, gas producers also assert that they do not intend to offer every indexation that consumers would like to see and maintain a preference for traditional pricing based on oil indexation. Clearly gas merchant companies, especially in Germany, are reluctant to sell gas to the power sector at margins that might at times be lower than those achievable in the heat market. The added possibility of arbitrage by generators between heat and power markets would increase competitive pressures on gas suppliers. Exclusive indexation against coal or electricity prices is expected to remain the exception rather than the rule.

Regulatory environment: gas grid access terms are another obstacle

Many power generators, especially in northwest Continental Europe, regard the current terms for gas transport and flexibility services as unfavourable and an impediment to the use of natural gas for power generation. They are seeking more transparent and efficient access conditions to the European gas network and storage facilities, and are joined by a number of comparably small gas merchants calling for effective legal unbundling of gas companies and the elimination of cross-subsidies. Larger gas companies with stakes in considerable transmission assets emphasis the need for granting third party access (TPA) exemptions in some cases, to enable the necessary new investments in infrastructure to support the growth in gas demand.

Security of gas supplies: importance is difficult to judge

Power generators agree that liberalised electricity markets leave little room to invest in anything but the least cost option for electricity generation. When markets perceive a certain technology as economically superior, the scope for a diversified portfolio of technologies and fuels will be limited, unless direct government intervention promotes or prescribes a certain diversification. Such government intervention with respect to the fuel mix exists in France and to a lesser extent in Germany (taxation) and Spain (restriction on individual share of origins of gas). In most European countries, the composition of the power generation park is left to the market. However, large power generators state that in such an environment they still would prefer to maintain a portfolio of generation technologies. Particularly German power generators state the importance of a balanced generation portfolio from both a company and country perspective for technical reasons as well as in order to manage security of supply risks.

Some European power generators are concerned about becoming too dependent on imported gas and also consider this as an obstacle to increased use of gas in power.

The implications of these concerns and their consequences for new investments in generation plant and adaptation of business policies remain rather unspecific and difficult to assess. Although security of supply issues have been highlighted against the backdrop of geopolitical changes, in recent discussions among policymakers, very few gas and electricity companies expect governments to come forward with additional measures to influence the fuel mix. If governments were to do so, gas and electricity companies would have to be compensated for the costs associated with such interferences.

Both gas and electricity companies call for clear and timely guidance from governments what kind of security of supply policies they can expect.

Market structure: generators seek direct deals with producers

Gas supplies within Europe are increasingly organised by integrated companies active in the gas as well as in the electricity sector. Some gas merchants invest in power generation but more significantly, power generators move into the gas business and contract their gas supplies directly with the producer. Gas merchants aim at increasing their profitability by capturing the full market value of gas, including the added value from power generation. Power generators, on the other hand, are confident they can strike better deals by negotiating directly with the producers. Given that more and more traditional gas merchants engage actively in power generation themselves, traditional power generators also feel a need to arrange gas supplies directly with gas producers to not be dependent on gas supplies from competitors. Nondiscriminatory and efficient access to transport capacity would support the electricity industry's goal of independence from traditional suppliers. Consequently, power generators plead for more transparent and efficient TPA regimes. Significant cost reductions for the liquefied natural gas (LNG) chain of the past decade and the small project size as compared to long-haul pipelines are other factors making it easier for power generators to engage in gas supply without being dependent on the traditional gas merchants.

Future technological developments do not affect investment decisions

Power generators are generally sceptical about growth prospects for combined heat and power generation (CHP). The demand for industrial heat, the main driver for this technology, is viewed as having very limited growth potential within Europe.

Small-scale distributed generation on the basis of natural gas or other fuels is not yet considered economical. The necessary technological advances to make such technologies attractive are regarded as being still far away.

Gas for European power: removing obstacles

The most pressing issues concern system access conditions and pricing terms. From a regulatory perspective this implies need for further attention to improving and harmonising grid access conditions, providing transparency in transportation and flexibility services; and facilitating investments in new infrastructure in support of new gas supplies.

If the gas industry intends to make further efforts to secure the potential of gas-fired generation in northern Europe, it is faced with the decision to either accommodate the power sector by means of differentiated pricing terms in new supply contracts; or to move actively towards an independent (spot) price for gas, which at least offers a transparent basis for decision-making by power generators.

This decision lies essentially with gas producers, but it is unclear which direction they will take.

Given market uncertainties and (business) policy choices ahead, the future development of the market for natural gas in the European power sector will certainly benefit from continued dialogue between all stakeholders.

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Tables and Figures:

Specific information gathered for this paper in general refers to selected Member States of the European Union (25). However, not all Member States of the European Union are covered in detail whereas some forecasts and data cited for illustrative reasons actually apply other regional distinctions when analysing European energy markets. The term 'Europe' is therefore used in this paper in a rather general way.

Volume data in this paper have been derived by assuming a gross calorific value of 41.4 MJ/m^3. This being a rather high value, actual volumes to be observed in the market tend to be higher.

Acronyms

/a	per annum
/t	per tonne
bcm	billion cubic metres
CCGT	combined cycle gas turbine (power plants)
CEC	Commission of the European Communities
CHP	combined heat and power generation
CIEP	Clingendael International Energy Programme
CO_2	carbon dioxide
EIA	Energy Information Administration
EU	European Union
EU-15	The first 15 member states of the European Union: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom
EU-25	EU-15 plus member states which joined the EU in 2004: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia
GW	Gigawatt
IEA	International Energy Agency
IEO	International Energy Outlook (by the EIA)
IGU	International Gas Union
kWh	kilowatt-hour
LNG	liquefied natural gas
MJ/m^3	MegaJoules per cubic metre
MMBtu	million British thermal units
mtoe	million tonnes oil equivalent
MWh	Megawatt hours
NAP	national allocation plan (for emissions)
NO_x	nitrogen oxides
OECD	Organisation for Economic Co-operation and Development
OME	Observatoire Méditerranéen de l'Energie
SO_x	sulphur oxides
TPA	third party access
TPS	Total primary energy supply
TWh	Terawatt hours
UK	United Kingdom
WEO	World Energy Outlook (IEA)

Gas to Power in Europe

Introduction

The main energy forecasts identify natural gas as the fastest growing primary energy source at a global level. As for most other regions of the world, the use of natural gas in power generation is seen as the main driver for this increase in Europe. The favourable economics of combined cycle gas turbine (CCGT) power plants, especially their relatively low capital intensity and high conversion efficiencies, make natural gas the fuel of choice for power generation. The International Energy Agency's (IEA) World Energy Outlook 2004 (WEO) "reference scenario" posits that power generation will account for about 130 of the 200 bcm/a projected increase in the consumption of natural gas for the European Union (25) during the period of 2002-2020. But this bright outlook – at least for the gas industry – also raises many questions. Increasing import dependency has reawakened concerns about security of supply. Another important issue is whether investments in new generating capacity are as high as forecasted. Until recently, prices in many wholesale electricity markets did not appear to justify any substantial new investments in generation plant. A further issue is how future nuclear policies will develop. Much of the projected medium-term growth in gas consumption stems from the planned retirement of nuclear power plants in Europe. However, these retirement plans appear to be only as stable as the political power relations in the respective countries.

Finally, liberalisation of European gas markets has caused additional risks for gas and electricity businesses. Gas importers are less inclined to commit to traditional long-term take-or-pay contracts. Will this hamper new supply for European gas markets? What will happen to gas prices?

These factors have already dampened the overwhelming optimism for gas market development shared by most forecasting organisations. The IEA's 2004 reference scenario for OECD Europe projects about 30% or 94 bcm less growth in annual consumption up to 2020 than the previous forecast issued in 2002.

This discussion paper reviews the most important factors driving investment decisions for power generation plant in European electricity markets. We consider the economics of different generation technologies and fuel price developments, and the current state of government policies with respect to fuel mixes and climate change.

The main objective of this paper is to assess the views and perceptions regarding the use of natural gas in power generation of the primary stakeholder groups, namely the gas and electricity industries and governments. The findings are based on material derived from studies and reports, and the results of a survey conducted by the International Gas Union (IGU) across the European gas and electricity industries.[1]

Natural gas in the European electricity market: very different roles in very different markets

Natural gas holds very different positions in the total energy supply as well as in electricity

[1] Survey questionnaires were sent to about 40 respondents, of which around 50% were filled-out (often in great detail) and returned. Clearly, the answers presented are not representative of each stakeholder group as a whole. However, the responses received did indicate high levels of consensus between various groups and certain patterns clearly evolved. Government bodies were reserved in replying to our survey. Therefore, statements about government policies are primarily based on official policy documents and various other reports.

generation across the European countries (see table 1). The position of natural gas in the respective countries is determined largely by two interrelated factors: the availability of domestic energy resources and past policy choices. The strong position of natural gas in the United Kingdom and the Netherlands is clearly influenced by the large domestic resources available, whereas the limited role of gas in French power generation is a direct result of the country's policy to promote nuclear energy. Italy and Turkey are the two European countries in which power is generated mainly from *imported* gas. Spain shows strong growth rates in electricity demand and newly built power plants are largely gas-fired, making Spain, for the future, another country strongly reliant on imported gas for power generation.

Table *1: Natural gas in selected European countries*

	Total Primary Energy Supply 2003 (mtoe)[1]	Share of Natural Gas in TPS[1]	Electricity Generation 2001 (TWh)[2]	Share of Natural Gas in Electricity Generation[2]	Largest Electricity Source
Czech Republic	43.4	19%	75	4%	Brown coal
France	260.6	15%	550	3%	Nuclear
Germany	332.2	23%	583	10%	Nuclear/Coal
Hungary	23.7	49%	36	24%	Nuclear
Italy	181.9	35%	279	37%	Natural Gas
Poland	91.3	12%	146	1%	Hard Coal
Spain	141.5	15%	238	10%	Nuclear
Sweden	46.4	2%	162	0%	Hydro
The Netherlands	90.0	39%	94	59%	Natural Gas
Turkey	74.3	25%	123	40%	Natural Gas
United Kingdom	223.2	38%	386	37%	Natural Gas
EU-15	1,498.0	24%	2,673	18%	Nuclear
EU-25[3]	1,690.0	23%	2,986	17%	Nuclear/Coal

(1) BP Statistical Review of World Energy 2004
(2) IEA Electricity Information 2003
(3) IEA World Energy Outlook 2004. 2002 data.

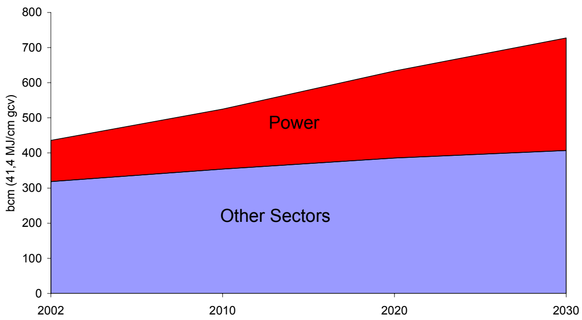
Demand projections vary

Many forecasts predict that the major share of new generation capacity in Europe will be gas-fired, due to the relative advantages of CCGT plants in comparison with coal fired plants – such as lower capital intensity, shorter construction time, modularity of capacity additions due to smaller economies of scale and higher conversion efficiencies. The emission properties of natural gas provide an insurance against possible future costs associated with CO_2-emissions.

Consequently, natural gas consumption in Europe is expected to grow substantially, with by far the largest share of incremental gas demand stemming from the power sector. However, different agencies' forecasts show rather strong variations (cf. table 2).

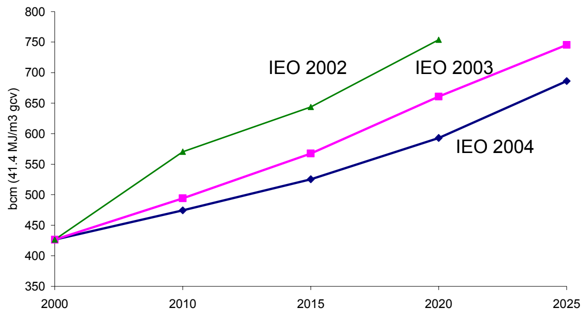
As indicated above, high oil prices (and in consequence natural gas prices) have recently worsened the economic position of gas-fired power plants. This and increasing concerns regarding future availability of competitively priced supplies in sufficient quantities to meet demand have triggered discussion on the soundness of current projections. The different factors driving investments for new generation capacity, including a discussion on uncertainties about the availability of gas supplies, are presented in the following section.

Figure *1: EU (25) gas demand forecast*



Source: IEA 2004

Figure *2: Western Europe gas demand forecasts by the Energy Information Administration*



Source: EIA 2002, 2003, 2004

Uncertainty around the need for new investment

Development of electricity demand?

Future of nuclear and renewable energy sources?

The choice of a specific generation technology and corresponding fuel is preceded by the decision to invest at all in power generation. Two of the main aspects that play a role when such a decision is taken by a generator are the future development of demand for electricity and the future availability of electricity supply. Whereas the development of power demand follows reasonably stable trends within Europe, the development of the electricity supply structure is subject to a wider range of uncertainties. The lifespan of power plants is a dynamic variable and the date of plant retirement is difficult to predict. Political agreements to phase out nuclear power have been concluded for instance in Germany, Belgium and Sweden but the timing of closures remain subject to discussion in some cases. Moreover, renewed interest in nuclear power given climate change and security of supply considerations even makes it possible that such agreements might be reconsidered as a whole, especially if political power relations in the respective countries change. The political sensitivity of programs promoting renewable energy sources and possible requirements for conventional back-up generation capacity add to the uncertainty around investment needs.

In a competitive market, power generators must take into account the investment plans of their competitors. Such information, however, is typically kept confidential.

Steadily growing electricity demand and an ageing generation park in Europe, however, will make new generation capacity investments necessary in the coming years. Eurelectric estimates that around 500-600 GW new capacity will be needed by 2020 to meet rising demand and to replace old capacity in the EU-15 alone.

Table 2: *Various projections of natural gas demand in Europe*, bcm

	Area covered	Year of forecast	2000	2010	2020	Average annual change 2000 - 2010	Average annual change 2010 - 2020
Gas in power generation							
IEA	EU-25	2004	*118	170	248	4.7%	3.8%
Eurogas[1]	EU-15	2004	*70	114	138	6.2%	1.9%
European Commission	EU-15	2003	120	193	249	4.9%	2.6%
Eurelectric	EU-13[2]	2004	**79	148	203	7.2%	3.2%
CEC	EU-25	2003	126	209	273	5.2%	2.7%
IGU	Western and Central Europe[4]	2003	112	189	331	5.4%	5.8%
Total gas market							
IEA	EU-25	2004	*436	524	633	2.3%	1.9%
Eurogas	EU-15	2004	*388	486	543	2.9%	1.1%
European Commission	EU-15	2003	380	511	593	3.0%	1.5%
EIA	Western Europe[5]	2004	**426	474	593	1.2%	2.3%
CEC	EU-25	2003	422	571	670	3.1%	1.6%
IGU	Western and Central Europe[4]	2003	457	622	718	3.1%	1.4%

* 2002 data

** 2001 data

[1] excluding cogeneration

[2] EU-13: EU-15 without Germany and France (no forecasts available).

[3] OECD Europe: EU-15 plus Iceland, Norway, Switzerland, Turkey, Czech Republic, Hungary, Poland, Slovakia.

[4] EU-15 plus Albania, Bulgaria, Croatia, Czech R., Hungary, Iceland, Liechtenstein, Malta, Norway, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Turkey, Yugoslavia.

[5] EU-15 plus Iceland, Norway, and Switzerland.

It should be noted that the different studies use different methodologies for determining which activities to include in the 'power generation' sector.

Economics of power generation

The kind of generation plant built to meet increasing demand and to replace retiring equipment in liberalised electricity markets should depend in the first place on the economics of the different plant types.

The factors that determine the unit cost of generation of a power plant are construction costs and time, lifespan, conversion efficiencies, operating costs and in particular, anticipated fuel prices. Cost studies for different generation technologies were compared, in particular, for coal fired power plants (various technologies) and CCGT power plants (see table 3). Although the results of the various studies are not strictly comparable, the overall picture with respect to fuel choices is quite uniform:

Coal / Gas: little cost differences for base load

- at expected gas prices, CCGTs in every assessment are the most economic option for mid-load and peak units;
- for base load plants most studies evidence little difference between costs for coal-fired power plants and CCGTs. However, average utilisation assumed in the studies for base load plants is rather high; many base load plants do not reach such high rates. Assuming a lower average utilisation would result again in slight economic advantages for CCGTs.

It should be noted that assumed prices for both coal and gas differ across studies but are all lower than those that currently prevail in European markets.

The studies generally report the averaged cost of electricity generation over the lifespan of the generation plant. If investors adopt the stance that their planning horizon in a liberalised electricity market should be much shorter, the relatively low capital intensity of CCGTs can compensate for the expected higher fuel costs. Most importantly, any cost for CO_2-emissions shifts the balance in favour of gas-fired power generation due to the emission properties of the different technologies.

Table 3 illustrates very different perceptions about the generation cost of nuclear power. As public opinion and government policies in most countries currently restrict construction of new nuclear power plants, we concentrate in the following on the relation between coal and gas-fired power generation technology, as the obvious options for private investment in large-scale power.

The economics according to the European power industry

All survey respondents acknowledged the well-known advantages of CCGT power plants such as relatively low capital intensity, short lead and construction times and low emissions. The relative competitiveness of natural gas in base load power generation is viewed in a differentiated way:

Regional differences

a) Power generators in the Polish and German market consider natural gas too expensive to compete with coal. The role of gas in power generation in these markets would probably be smaller than predicted by most official projections. Swedish generators also consider gas prices as too high. Capacity increases are currently under consideration at various existing Swedish nuclear power plants.
b) Southern European generators clearly regard natural gas as the most economic choice for all load ranges. The overwhelming majority of new investment in southern Europe consequently takes place in CCGTs.
c) UK generators consider gas as the most economic option for all load ranges and subscribe to an increasing role of gas for power generation.
d) Other generators from Continental Europe consider gas-fired generation as competitive with coal-fired generation.

Base load

New investments in power generation are mainly directed toward base load power plants, as prices for peak and mid-load electricity are considered too low to justify investment. In markets with relatively high amounts of existing lignite, coal or nuclear capacity, new CCGT plants are unlikely to be operated as base load plants due to the relatively high

only variable costs they incur. France and Germany provide examples of this. In this context, it is more difficult to opt for a gas-fired power plant as compared to countries where low variable cost power plants play a less prominent role and/or the electricity market shows rather large growth, such as in Spain.

One respondent from the gas industry and another from the power industry pointed out the specific requirements of coal-fired power plants. The need for well-developed supply conditions as well as sufficient cooling water requirements restrict the number of suitable sites for coal-fired plants. In the opinion of the two respondents, this could result in recourse to gas-fired technologies even in markets in which market participants would principally favour coal over gas because of the perceived high gas prices.

Power generators generally see the advantages of installing dual-firing capacity at gas-fired power stations as a means of addressing gas prices and availability risks. Although the additional cost is often seen as an obstacle, new power plants are regularly fitted for dual-firing.

CHP and distributed generation: limited growth perspectives

Power generators, in general, are sceptical about the growth potential of combined heat and power (CHP) generation. Demand for industrial heat is one of the main drivers for this technology. This demand is seen as limited for southern Europe, and one respondent even sees energy intensive industries as leaving Europe, which would further reduce the potential for combined heat and power generation. Lacking sufficient heat demand, CHP plants will not be competitive with large-scale centralised power generation.

Small-scale distributed generation based on natural gas or other fuels is not yet considered economical. The technological advances required to make such technologies attractive are regarded as being still far away.

Table 3: *Cost comparison of various generation technologies (base load)*

Coal fired power plants					
	MIT/EIA[1]	**MINIFI**[2]	**Univ. of Essen**	**ECN**	**PEL**
Interest rate / Discount factor	12% equity; 8% debt	8 %	10%	9 %	na
Net efficiency	36.7%	43 - 44 %	38.6%	45.4%	na
Operating hours	7446	8000	7500	7500	na
Investment cost per kW installed	1.300 US$	1.400 €	820 €	1.200 €	na
Lifetime (years)	40	35	35	30	na
Project lead time (month)	48	36	36	Na	na
Fuel price	1.2-1.5 US$ /MMBtu	30 €/t	48 €/t	40 US$/t	na
		(1.4 US$/MMBtu)	(2.1 US$/MMBtu)	(1.4 US$/MMBtu)	na
Generation cost per MWh	42 US$	35.1 €	34 €	35 €	39 €
CCGT plants					
Interest rate / Discount factor	12% equity; 8% debt	8%	10%	9%	na
Net efficiency[3]	53%	57.1%	55.0%	56.5%	na
Operating hours	7446	8000	7500	7500	na
Investment cost per kW installed	500 US$	526 €	420 €	540 €	na
Lifetime (years)	40	25	25	20	na
Project lead time (month)	24	26	24	Na	na
Fuel price	4.42 US$/MMBtu	4.13 US$/MMBtu	1.2 ct/kWh initially	3.5 US$/MMBtu	na
			(4.13 US$/MMBtu)		na
Generation cost per MWh	41 US$	35.7 €	35 €	39 €	34 €
Nuclear power plants					
Interest rate / Discount factor	15% equity; 8% debt	8%		9%	na
Net efficiency	32.8%	36.1%			na
Operating hours	7446	7500		7500	na
Investment cost per kW installed	2000 US$	1.663 €		1.850 €	na
Lifetime (years)	40	60		40	na
Project lead time (month)	60	78		Na	na
Fuel price		4.4€/MWh		Na	na
		('1.61 US$/MMBtu)			na
Generation cost per MWh	67 US$	30.4 €		41 €	53 €

[1]Moderate gas price scenario. 1 US$ = 0.8 €
[2]Base case scenario.
[3]On the basis of the lower heating value.
Note: It is apparent that the studies are not strictly comparable with one another. Different technologies for Combined Cycle Power Plants, coal-fired power plants and nuclear power plants have been looked at in the various studies. Capital costs are not stated on a basis that is consistent across studies. However, the overall picture of the relative economics of coal-fired power generation in comparison with CCGTs is constant across studies, with PEL being the exception.

Fuel price developments

The two most important fossil fuels for power generation are natural gas and hard coal. The relationship between their prices determines the short run dispatching of fossil fuel plants (the 'merit order') as well as the choice for which kind of generation technology to invest in. Price fluctuations do not only determine the long run demand for the respective fuels but can also lead to significant changes in volume consumed in the short run. Power generators with a portfolio of plants switch operational preference in their different power plants from gas to coal in times of high gas prices and vice versa.

Gas has lost ground vs. coal

Figures 4 and 5 show the relative prices of coal and natural gas in northwest Continental Europe over the last 14 years. Gas and coal prices determine the competitiveness of the various generation technologies. Prices that prevailed during the last decade would have justified investments in CCGTs rather than in coal-fired power generation given today's technology. It is only during this decade that gas prices have experienced an upward shift, making coal again attractive.

Natural gas prices

By far the biggest share of natural gas in Continental European markets is supplied under long-term contracts indexed to prices for oil products. Due to strong demand for oil in world markets and persisting unrest in the Middle East, augmented by concerns about the economic and political circumstances in many other important oil and gas producing countries such as Russia and Venezuela, forecasting organisations expect oil prices in the medium-term to remain well above 30 US$/bbl. This would translate into gas prices well above 3 US$/MMBtu.

European import prices in 2004 regularly exceeded 4 US$/MMBtu, with spot prices temporarily being significantly higher.[2]

Will gas prices fall?

Standard energy forecasts assume gas prices in Europe to come down from their currently high levels. The IEA in their 2004 reference case, for example, assumes gas prices of around 3.3 US$(2000)/MMBtu up to 2010, rising steadily to 4.3 US$(2000)/MMBtu in 2030.

However, widely used cost estimates for additional supplies to European markets by organisations such as Observatoire Méditerranéen de l'Energie (OME) and IEA suggest that most new sources of natural gas can reach the European market at costs of less than 4 US$/MMBtu.[3] Thus, cost does not appear to be a long-term economic obstacle for meeting future demand of gas for power generation.

Natural gas prices for the power sector, based on such costs or indexed against alternative fuels such as coal might create additional sales opportunities to gas resource holders. Such a change in pricing terms, however, entails various issues for both the gas supplier and the power generator. Gas suppliers might have to offer gas priced below current prices in order to sell additional gas to the power sector. Such gas supplies might be resold in the heat market and thus undercut their own existing deliveries when destination clauses can no long be included in new supply contracts.

Gas merchant companies without equity production will find it particularly difficult to hedge against the risk of selling gas against different indexations than against the fuel indexation under which they purchased their supplies.

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[2] cf. World Gas Intelligence, various issues.
[3] See appendix A.

Figure 3: Gas and coal prices

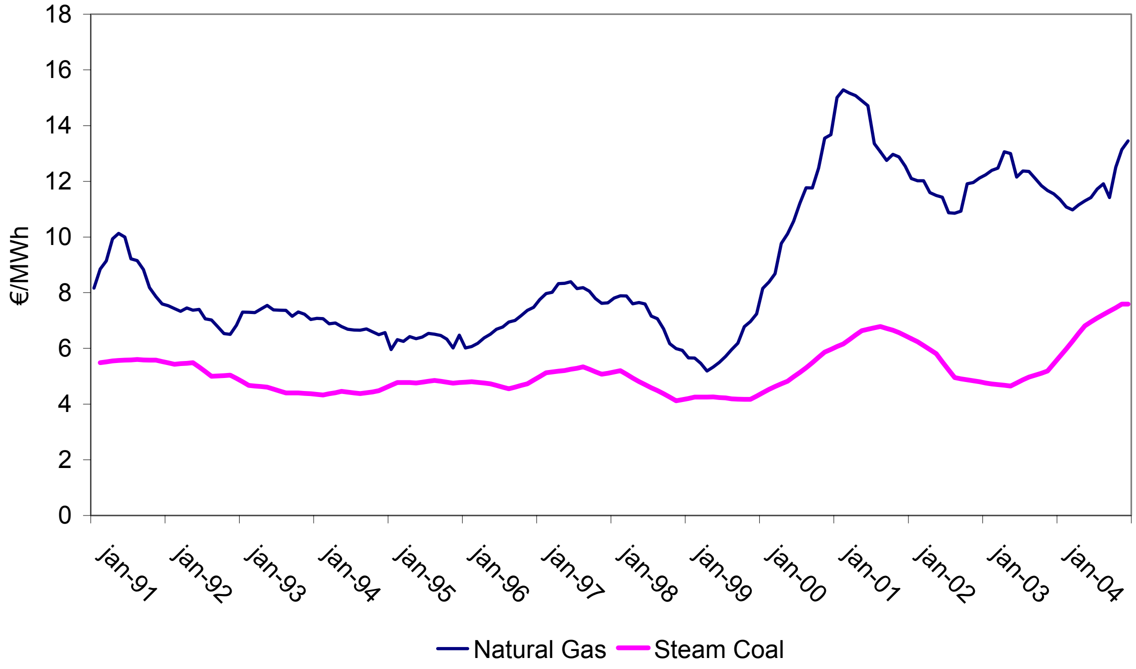
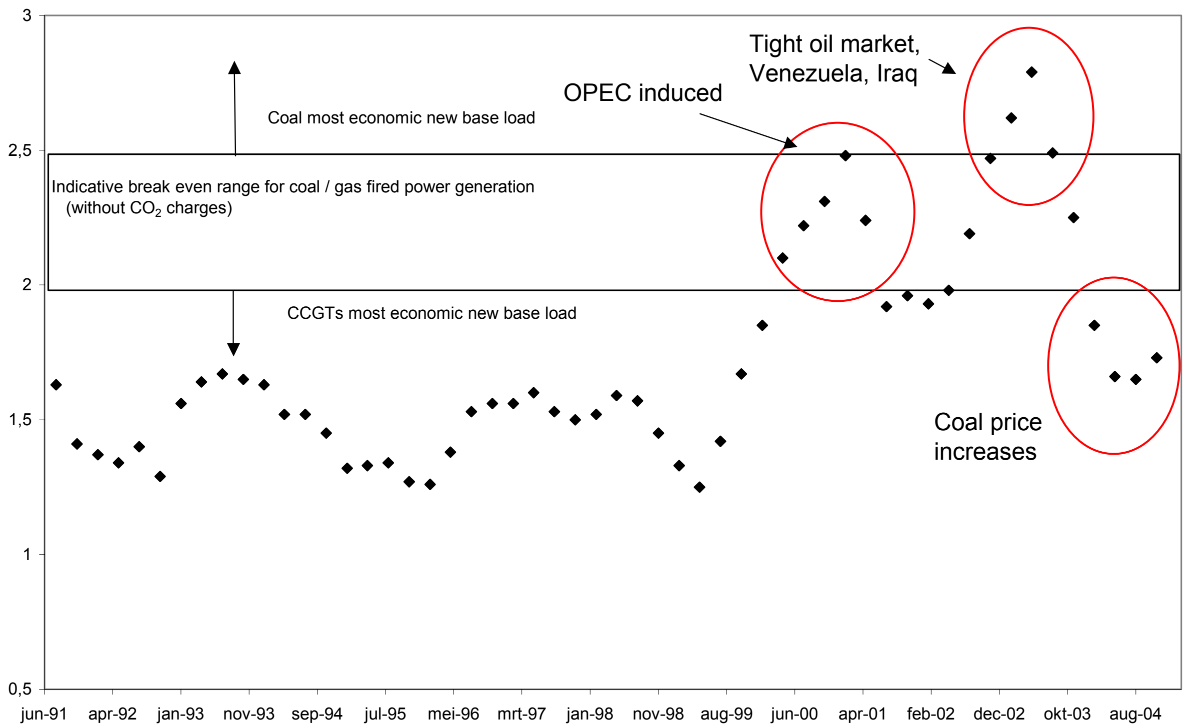


Figure 4: Ratio gas price / coal price on an energy equivalent basis



Calculated on basis of German import unit values (Source: BAFA, 2005).
Power plant economics on full cost basis.

Conversely, coal indexation is not risk free for power generators either. Power generators who manage to obtain coal indexation in their long-term contracts might actually face more expensive supplies than those who bought under oil price indexation if oil prices decline again. Not only under traditional long-term contracts but also on spot markets, natural gas prices still follow the substitute oil prices. Committing to long-term coal indexed or fixed prices might leave power generators with higher fuel costs than their competitors. This happened for instance with Norwegian gas supplies to Dutch power generators.

Coal prices

Coal resources are substantial and geographically well-distributed around the world. A wide variety of coal suppliers serve the competitive international market for steam coal. Prices are determined by supply and demand in world markets. Impressive increases in productivity have been achieved over the last decades, allowing world market prices to remain relatively stable over time. This trend is expected to persist. However, like many other bulk commodity industries, the coal industry has been subject to past investment and price cycles. Periods of sluggish demand in times of low economic growth led to decreased investment in new production capacity which in turn resulted in temporary supply shortages and higher prices when demand growth accelerated again. Such a situation occurred during 2003-2004 when unexpectedly strong demand led to much higher tariffs for coal supplies and, more importantly, transport capacity. The negative impact on European coal purchase prices was limited by the appreciation of the euro against the dollar, concurrent to the coal price increases. When coal prices will again fall closer to supply costs depends on the development of bulk shipping markets, the prices of alternative fuels (especially natural gas) and the extent to which new investments will increase production and transport capacity. The time horizon for coal price reductions is unclear. On the one hand, China is currently considering measures to prevent an overheating of their economy that could in general relieve stresses on shipping markets. On the other hand, investments in new coal production capacity have been limited in 2003 and oil and gas prices remain high.

Coal prices will fall, but when?

The International Energy Agency expects coal prices will remain at their rather high levels into 2005 and then to stabilise at around 40 US$(2002)/tonne until 2010. From 2010 to 2030, a linear rise up to 44 US$/tonne is anticipated.[4]

Should transport restrictions drive-up coal prices, the price impact will be limited for regions with competitive domestic coalmines, able to supply power generators without the need for long-range transport.

Most power generators do not comment on coal market developments. The few that do are confident that coal prices will decline from their current high levels.

Importance of power plant location and its influence on fuel prices

A power plant’s location can have a direct effect on its fuel costs. For a coal-fired power plant located at a major harbour, the coal border price virtually becomes its fuel price, whereas plants located at a distance from the open sea could face up to 30% higher fuel costs due to costly transport.

Similar considerations can apply to gas-fired power plants, particularly for power plants

[4] IEA 2004a: 179.

built alongside an LNG terminal. The combination of an LNG terminal with a gas-fired power plant can also increase the efficiency of the power plant due to technical reasons.

The European power and gas industry's views on contracting terms

With respect to gas supply contracts, power generators are generally less inclined to conclude long-term commitments than in a non-liberalised environment.

Preference for spot markets

Still, long-term contracts necessary

In the absence of liquid gas spot markets, generators consider long-term contracts as necessary to secure supplies. The preference is clearly for indexation against electricity, coal or spot gas prices. The gas industry is struggling with this demand from the power industry. A substantial number of respondents from the gas supply industry acknowledge the possibility that contract structures in the future might include indexation to coal or even electricity prices. New supply contracts to the UK already are indexed against spot gas prices and gas supplies to power generators in Germany are regularly indexed – at least in part – to the coal price. Conversely, gas merchant companies, especially in Germany, are reluctant to sell gas to the power sector at margins that might at times be lower than those achievable in the heat market, based on oil price indexation. Possible arbitrage by generators between heat and power markets would increase competitive pressures on gas suppliers; apparently they would like to prevent this. Some gas suppliers are clear that they do not intend to offer indexation against electricity prices.[5]

Oil price linkage is an obstacle

Two respondents from the power industry explicitly stated that the oil price linkage for natural gas pricing would be the main obstacle for natural gas in power generation. Price risks from the oil market are perceived as being rather high with only limited options for hedging. Generators with large diversified portfolios of generation assets are less concerned about conventional gas pricing terms. In their view, a diversified generation portfolio offers opportunities to deal with various fuel price risks.

Other concerns regarding natural gas pricing can be found in the limited number of producing countries. However, only few power generators – from northern Europe – express worries about higher prices due to market power. Concerns about security of supply are also rather vague in this respect (see below).

Availability of natural gas supplies and investments in infrastructure

Very large investments in gas production and transport infrastructure will be necessary in the years to come to meet projected increases in demand, even for more conservative scenarios. Long-term take-or-pay supply contracts have been the backbone of the Continental European gas market for the past decades. It has been argued that the liberalisation of EU gas markets has increased the risks involved for this kind of contract for gas merchant companies. The volume of gas sales for individual companies is more difficult to predict as gas merchants might lose market share to competitors, the transparency of the market decline and an anticipated higher number of shippers render coordination of the supply chain from wellhead to burner tip altogether more difficult. Gas merchant companies would be more reluctant to conclude long-term take-or-pay contracts with gas producers. Lacking the security of volumes sold, otherwise provided by this kind

[5] A respondent from the power industry remarked that in the past gas suppliers in the whole of Europe have reacted to customers' needs, also with respect to contract forms. Therefore he would be confident that alternative pricing terms other than oil indexation would be available in the future.

of contract, the necessary large-scale investments in production and transport infrastructure might be much more difficult to finance and delays incurred.

Limited concerns about gas investment

These concerns were raised only to a limited extent in the survey responses. The perception of power generators regarding the availability of sufficient gas supplies at competitive prices varies greatly. Some expect no problems at all, while others express concerns about a lack of timely investment, increasing demand and concurrently increasing prices. The concern of insufficient investments to meet future potential is not confirmed by the survey responses from the gas industry. Gas suppliers are generally confident about the future secure availability of natural gas; but they do carefully express concern about lack of investment in infrastructure.

Regulation and market structure

Transparent system access needed

Many power generators, especially from northwest Continental Europe, complain about unfavourable access terms for gas transport and flexibility services, which they consider as impediments to the use of natural gas for power generation. They are pushing for more transparent and efficient access conditions to the European gas network and storage facilities, and are joined by a number of smaller merchant gas companies calling for effective legal unbundling of gas companies and the elimination of cross-subsidies. Larger gas companies with stakes in considerable transmission assets place more emphasis on the need to grant TPA exemptions in some instances, to enable investments.

Gas / Power Integration

Generally, gas suppliers, as well as power generators, predict that the current trend towards stronger integration between power and gas industries will continue. Both industries are considering one form or another of vertical integration to manage risks and to capture the full value of the fuel. Integration can take the form of mergers and takeovers, but also further reaching cooperation between power generators and gas producers. Given that traditional gas merchants increasingly engage in power generation, traditional power generators also feel a need to arrange gas supplies directly with gas producers in order not to be dependent on direct competitors.

Some gas and power companies perceive synergies to be gained from the joint marketing of electricity and gas.

Some power companies voiced concerns about the limited number of natural gas suppliers. However, the main concern regarding competitive gas markets appears to centre around network access conditions rather than limited choices between alternative producers. A substantial number of gas supply companies complain about national differences in the liberalisation process and the presence of oligopoly and monopoly power in gas as well as in electricity markets. These factors are seen as obstacles to the increased used of gas in power generation.

Impact of CO_2 policies and outlook

The European Union as a whole is one of the most committed parties working to limit greenhouse gas emissions. The European Emission Trading Scheme began in January 2005, requiring a large part of CO_2-emitting activities to hold tradable permits covering their emissions. The price of emission permits depends on the cap national governments will set for the issuing of these permits, fixed in the so-called national allocation plans (NAPs). In general, emission permits for the first allocation round (2005-2007) were expected to be relatively generous. Surprisingly, emission permits are currently traded at around 15 €/t (April 2005). This significantly exceeds earlier price expectations. Even a few months ago, the range of 5 to 10 €/t was regularly quoted as likely for the first allocation round. Uncertainty around the final shape of several national allocation plans has contributed to these rather high prices. Trade volumes are still very limited, however, as developments on this score are still unfolding.

Emission permit costs can have a significant impact on the use of various fossil fuels in power generation. Different emission characteristics of various fossil fuels affect the variable cost component of power plants to different extents. In the short run, the merit order of dispatching may change, pushing coal-fired power plants lower in the merit order, reducing their running hours, whereas gas-fired power plants might be dispatched earlier, actually increasing their running hours. Thus, the short-term demand for gas increases when CO_2-permit prices reach certain levels, while short-term demand for coal is reduced.

Due to the direct impact on variable costs, investment decisions for new generation equipment also are affected. Thus, long run demand for natural gas relative to coal demand is supported by CO_2-reducing policies. This does not necessarily imply, however, that CO_2-policies lead to an absolute increase in gas consumption in power generation. Permit prices make all fossil fuel generation more expensive. Electricity prices will rise and trigger further electricity savings, whereas investments in even more efficient generation plant become more attractive, both limiting demand for natural gas.[6]

Future of emission trading uncertain

However, the future of emission trading schemes is subject to quite a wide range of uncertainties. Although many individual governments within the European Union state that climate change is one of the most important contemporary threats to society, concerns that climate change mitigation measures will unduly disadvantage the Union's economic competitiveness at a global level have not abated in recent years. Climate change is a global problem and one-sided measures of the European Union and a few other countries might not make a big difference to solving the problem as long as other important states, such as the United States – but also developing economies such as India and China – do not restrict their emissions in a similar way. The cost to the European Union's manufacturing industry, however, could be substantial.[7]

Thus far, European reductions in greenhouse gas emissions at large can be characterised as windfalls from special circumstances, such as the breakdown and subsequent modernisation of the East German industry sector or the massive infusion of natural gas into the UK power generation sector. Further reductions as mandated in the Kyoto commitments will almost certainly require more costly measures and could therefore lead to relatively high prices for emission permits.

The National Allocation Plans for the first allocation round are considered as rather generous. It is up to policymakers to determine the total amount of emission permits to be issued in the subsequent allocation period (2008-2012). Whether there will be reductions in line with the European Union's Kyoto commitments or any further reaching measures after 2012 will likely depend on a variety of factors:

- *Prices for CO_2-permits in the first allocation period* – If these are so high that they are perceived as seriously impeding economic growth and reducing the competitive position of the EU on world markets, the likelihood of stringently

[6] cf. for instance IEA World Energy Outlook 2004, alternative policy scenario.
[7] *Substantial,* of course, is a very relative term. The cost involved might be in the order of magnitude of 1% of annual GDP. However, the cost will not be distributed evenly across sectors and the sectors affected the most will exert political pressure to reduce cost increasing policies. If climate change mitigation measures are undertaken only regionally, the effect will be limited and political justification will become difficult.

formulating policies in line with the Kyoto targets decreases;

- *Signals received by other important emitting states such as the US, India and China* – if strong international consensus develops that all countries will curb emissions substantially, European policies will be reinforced;
- *The weather* – an increasing number of natural disasters caused by abnormal weather conditions increases the sense of urgency for climate change mitigation measures as well as the political pressure for enforcement. This will have a stronger impact if the more important emitting industrialised and developing states are directly affected by adverse weather circumstances.

All of these factors are virtually impossible to predict. However, it is likely that any price of emission permits will be perceived by a variety of industrial groups as too high, and especially developing countries will find it difficult to subscribe to policies which at first glance could hamper their own economic development.

Figure 5: CO_2-emissions per MWh fuel input

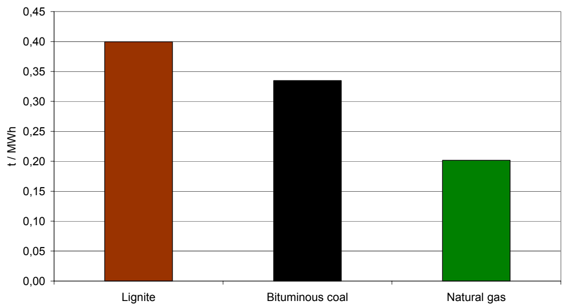


Figure 6: CO_2-emissions per MWh electricity generated

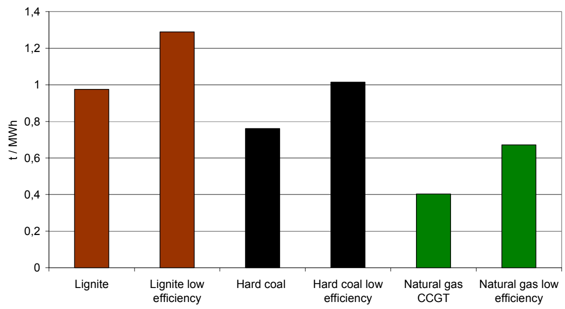
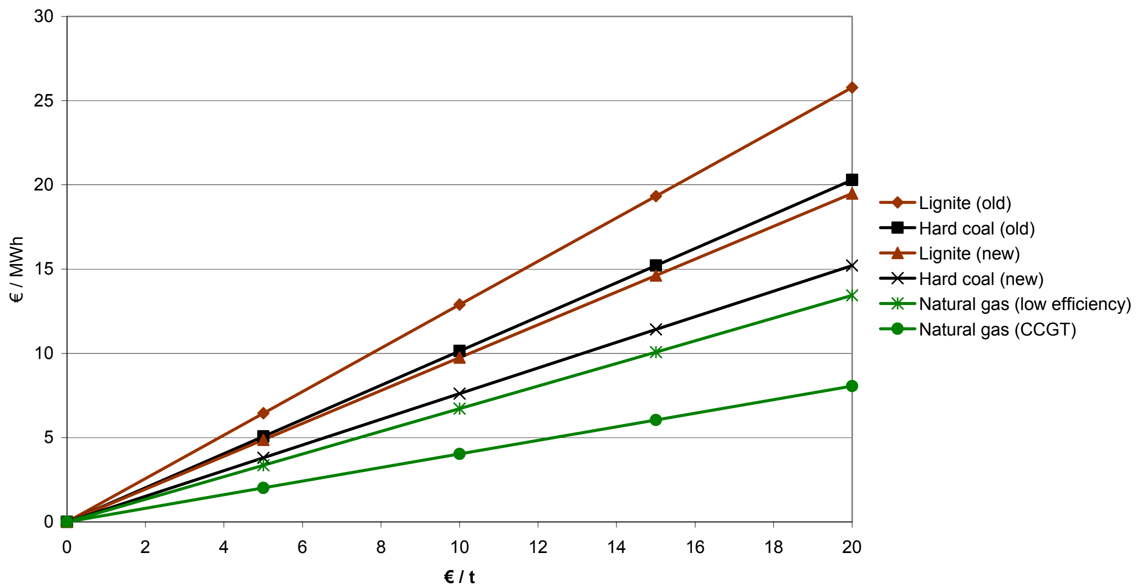


Figure 7: Impact of CO_2-permit prices on generation cost



CO_2 in the eyes of the European power and gas industry

Emission policies and trading schemes are clearly prominent in survey respondents' answers as very important if not the most important factors determining the future demand for natural gas in power generation. According to virtually all survey respondents, the European Union's emission trading scheme and the prospects of assigning costs to CO_2 emissions will strongly support the use of natural gas in power generation. Power generators who already consider gas-fired power generation as being economical see additional drivers for gas-fired power generation. Those who consider coal a less costly option acknowledge that emission permit prices could tip the balance towards natural gas. The gas industry as a whole sees the competitive position of natural gas as being backed-up by permit prices.

All parties are uncertain about the order of magnitude of permit prices as well as the further course of climate change policies. Clarity would be helpful, but will be difficult to achieve, as noted above.

Government influences on fuel choices

Governments in the past have adopted a variety of policies to influence fuel choices of power generators; some still do so today. Among the drivers were security of supply and, more recently, environmental concerns.

Environmental policies

Burning fossil fuels leads to emissions of nitrogen oxides (NO_x) and sulphur oxides (SO_x), both harmful to human health and the environment.[8] Emissions can be technically controlled, however, at a cost. In many European countries emission standards are applied to industrial installations, altering the relative economics of various fuel choices. Natural gas for instance emits much less NO_x and SO_x than coal, which makes meeting emissions standards much easier and thus cheaper.

Large combustion plant directive might increase need for capacity

Controlling SO_2, NO_x and dust emissions from plants with a thermal input of larger than 50 MW is the objective of the Large Combustion Plant Directive (European Communities 2001). The provisions of the Directive can seriously impact the operation of older plants by setting emission standards, which in some cases can only be achieved by new investments in existing plants. This investment might prove to be uneconomic, and could lead to a decrease in operating hours or even in closure of certain plants. According to survey results and discussion in the IGU workshop, this poses a problem to older British coal plants at the time that emission reduction needs to be achieved, from 2008 onwards with more stringent targets coming into effect in 2015.

Other concerns around emissions focus on greenhouse gases, which are strongly suspected to contribute to global warming. Almost all European governments subscribe to the abatement of climate change as a key point in their energy policies. The main measure undertaken to reduce greenhouse gas emissions is the European emission trading system (see above). Another direct measure is taxation of fossil fuels. Such taxation is hardly applied to natural gas and coal, with the notable exceptions of natural gas in France and Germany (see below). Market observers have suggested that political

[8] 'Acid rain' caused by sulfur oxides originating mainly from coal based power generation led in the 1970s and 1980s to a massive forest damage in Europe. Strong pressure from environmental groups forced governments to obligate power generators to equip their plants with costly exhaust gas cleaning equipment.

considerations with respect to climate change make obtaining construction permits for power plants with relatively high emission factors more difficult. To what extent this is true is difficult to evaluate.

Security of Supply

A second set of governmental concerns includes issues around strategic security of supply. Specifically, for countries significantly dependent on imported energy supplies, governments are wary of the respective state's energy supplies relying too heavily on a specific fuel or a specific supply country. Over dependence on a specific fuel makes the country's economy vulnerable to price fluctuations and dependence on a specific supplying country could raise political interdependence to undesirable levels. This situation especially applies to natural gas, in which pipelines connect specific markets with specific sources and options are very limited for acquiring alternative short-term supplies in the event of interruptions to these supplies. In non-liberalised markets governments explicitly, as well as informally, gave incentives to energy companies to provide a balanced mix of fuels and suppliers for electricity generation. In a liberalised market, with companies exposed to competitive pressure, the extra costs of such diversification can only be recovered if all companies are subject to similar explicit regulations with respect to fuel and supplier choices. The trade-off between a balanced mix of fuels and suppliers and the promotion of efficient competition is a difficult one for governments. In the European Union there are thus far only few firm regulations with respect to fuel and supplier choice. French gas supply companies must present a diversified gas supply portfolio to the government for approval. In Spain, regulation prescribes that the single largest supply source of the total Spanish gas supply not exceed a 60% share.[9] The many regulations supporting an increase in the share of renewables for energy supply are primarily motivated by environmental rather than security of supply concerns.

In the following, relevant government measures in selected countries will be summarised.

France

France pursues the objective of producing 50% of the primary energy consumed domestically. This has resulted in the strong role of nuclear power in the French generation mix. An energy efficiency programme has been launched with support for renewables to increase their quantity by 50% by 2015. This would result in a 21% share of renewables in electricity generation and installed capacity of wind power plants of around 10 GW.

Capacity planning in France

Gas suppliers in France must present a diversified supply portfolio to the government.

The government can suspend construction permits for certain generation technologies if they do not fit into the governments target range with respect to that technology.

Germany

Within the wider framework of achieving a more sustainable energy system, the German government is striving for a 12.5% share for renewable energy sources in electricity generation and 4.2% in primary energy supply by 2010. Support schemes for renewable energies and combined heat and power plants (existing large scale and newly built micro scale) exist. The use of natural gas for power generation is taxed (cf. table 4). A temporary tax exemption can be obtained for highly efficient CCGTs or CHP units.

In its 2001 strategy document, the German government underlined the importance of

[9] Although this is an indicative target only, it is applied rather strictly.

long-term gas supply contracts for security of gas supplies. Moreover, there is a strong commitment to coal. Security of supply is very much related to the price risks associated with different energy carriers, among which coal is regarded as providing most price stability for the future. Security of supply is also the main argument proffered for the ongoing subsidisation of domestic hard coal. Vattenfall Europe is committed to producing 50 TWh/a electricity from lignite in the New Länder until 2011. Yet the government maintains that the fuel mix in power generation and security of gas supply is largely left to the market. The German government sees increases in the efficiency of existing and new power plants as a very effective means for curbing greenhouse gas emissions.

Italy

Diversification away from oil in Italy

Italy has depended on oil for power generation to a large extent with natural gas showing significant increases in recent years. The Italian government would like to achieve a more balanced fuel mix in electricity generation, especially to bring the share of coal in line with other European countries. However, data on new power plants and plants that have been converted from one fuel to another or are being converted right now, indicate a clear trend towards gas-fired power generation. Only a few plants will use coal or orimulsion as fuel. The Italian government promotes the diversification of gas imports with new supplies envisaged from, for example, Azerbaijan, Kazakhstan and Indonesia. Substantial grants have been awarded for the construction of an LNG terminal (Brindisi) and pipeline extensions.

United Kingdom

The Department of Trade and Industry's Energy White Paper (2003) stated a strong commitment to curbing greenhouse gas emissions. Energy savings and promotion of renewable energy sources should achieve this. Coal should play a role in the fuel mix for diversification reasons, provided CO_2 emissions can be controlled. However, except for renewables, ultimately the fuel mix is left to the market.

Table 4: *Excise taxes on gas and coal for power generation in selected countries*

	Natural gas	Steam coal
United Kingdom	0	0
Spain	0	0
France	1.32 €/MWh	0
Germany*	2.04 €/MWh	0
Italy	0.05 €/MWh	0.36 €/MWh
Sweden	0	2.18 €/MWh

* Tax exemption can be temporarily obtained for newly built power plants achieving a net efficiency of 57.5% or higher.

Source: Eurogas 2004b. All other countries covered in the Eurogas report (basically all Member States of the EU [15]) apply no or negligible excise taxes on natural gas and coal in power generation.

Government policies from the perspective of gas and power companies

Liberalised electricity markets leave little room for power generators to invest in anything beyond the least cost option for electricity generation. When markets perceive a certain technology as economically superior, the scope for a diversified portfolio of technologies and fuels will be limited, unless direct government intervention promotes or prescribes a certain diversification. In most European countries the composition of the generation park is left to the market. However, large power generators state that in such an environment they still would prefer to maintain a portfolio of generation technologies. Particularly German power generators state the importance of a balanced generation portfolio from both a company and country perspective for technical reasons as well as to manage security of supply risks.

Little additional government interference expected

Very few gas and electricity companies expect governments to provide additional measures to influence the fuel mix. If governments were to do so, gas and electricity companies would have to be compensated for the costs associated with such interference.

Both gas and electricity companies call for clear guidance from governments as to what kind of security of supply policies they can expect.

Permit procedures important

One of the main impediments to investment in power plants and gas infrastructure are permit procedures for these investments. Especially power generators would appreciate a simplification and acceleration of such procedures, as well as some public support for overcoming local opposition to large-scale projects.

The increased share of wind power in European electricity generation is seen by some survey respondents, from the power sector in northwest Europe and the UK, as a possible stimulus for investment in peak generation capacity as back-up for fluctuating wind power supply. This could be mostly gas-fired.

Conclusion

There is little argument around the significant prospects for gas-fired generation in Europe. The most important factors determining the realisation of this prospect are the perceptions and expectations held by power generators regarding relative prices for coal and natural gas. Other factors contributing to the uncertainty of the future of gas-fired generation include the role of nuclear energy and the way in which the European CO_2-emission trading scheme will develop.

With the exception of policies around nuclear power generation, in Europe the choice of fuel for new power generation is, in principle, left to the market. Nevertheless, some governments appear to be more supportive of new gas-fired generation than others.

As regards the preferences of power generators, there is a geographical distinction between:

- Northern Europe, where gas-fired power generation is not considered economic for newly built base load power plants, given the gas price expectations of local power producers; and
- Southern Europe and the UK, where almost all newly built power plants are CCGTs.

Part of the reason for this distinction, but not entirely, concerns the structure of the existing generation portfolio (highly dependent on coal and nuclear in parts of northern Europe) and the availability of low-cost coal and lignite in some countries.

In terms of potential obstacles to gas-fired generation, power generators stress the need for effective gas market opening and transparent and efficient third party access to transportation and flexibility services. Gas companies also point to the need to ensure adequate investments in new infrastructure to bring in new gas supplies. The main impediment to gas-fired power generation appears to lie in the pricing structure applied in Continental European gas markets, which exposes the power sector to the risks of price movements in international oil markets.

From a regulatory perspective this highlights the need for a focus on:

- Improving and harmonising grid access conditions, providing transparency in transportation and flexibility services; and
- Facilitating investments in new infrastructure in support of new gas supplies.

If the gas industry intends to make further efforts to secure the potential of gas-fired generation in northern Europe, it seems faced with the decision of either:

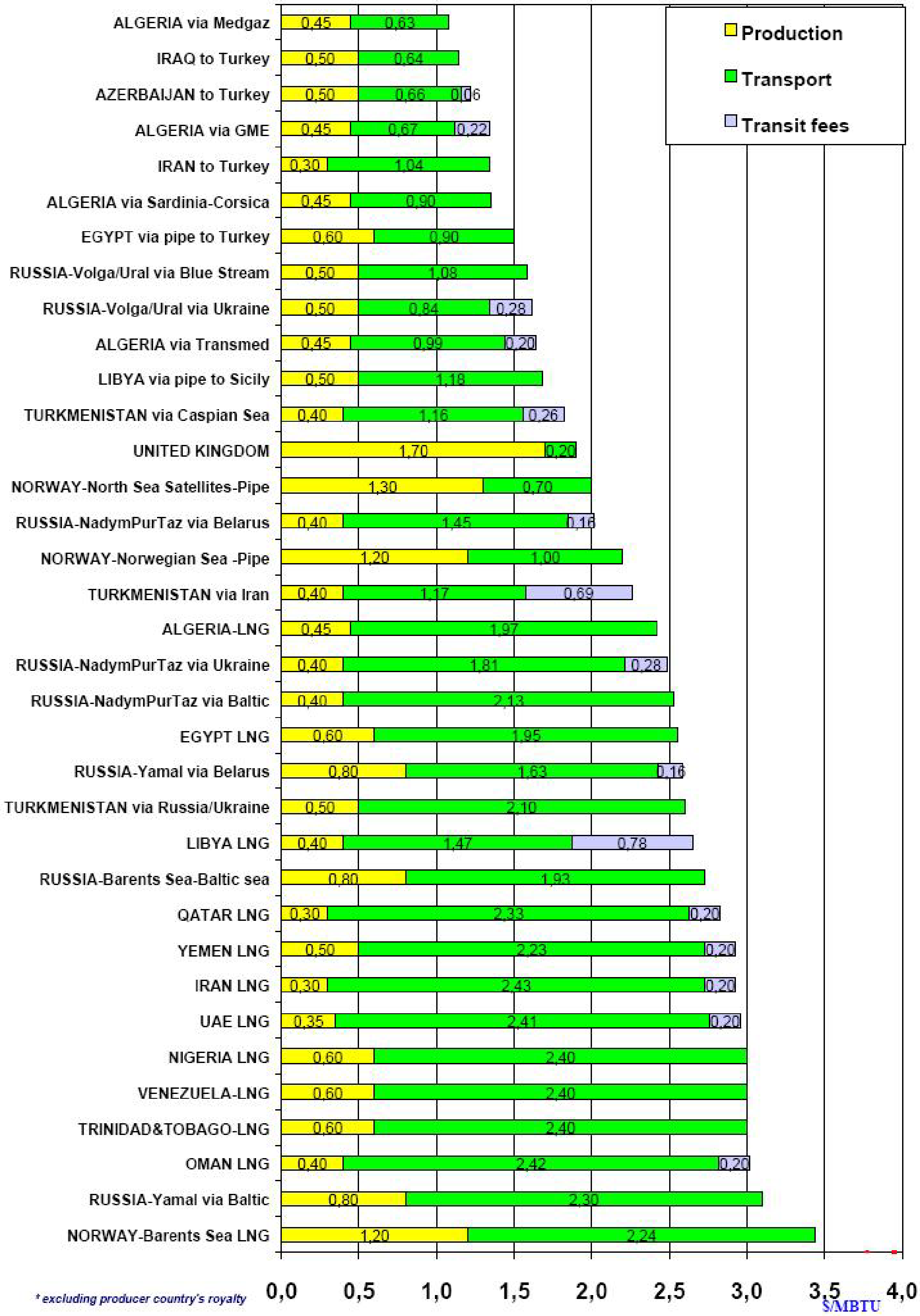
- Accommodating the power sector by means of differentiated pricing terms in new supply contracts; or
- More actively moving towards an independent (spot) price, which at least offers a transparent basis for decision-making by power generators.

This decision lies essentially with gas producers, but it is unclear which direction will be chosen.

Given market uncertainties and (business) policy choices ahead, future development of the market for natural gas in the European power sector would certainly be helped by a continuing dialogue between all stakeholders.

Stronger competition between gas and electricity companies, both becoming active in each others' traditional markets, is a key driver for the formation of vertically integrated companies able to capture the full value of natural gas for power generation from wellhead to the power plant. Bringing new gas supplies to European markets will be increasingly in the hands of these integrated undertakings.

Appendix A: Indicative costs of new gas supplies (excluding royalties) at the EU-30 border [10]



Source: OME, 2001

[10] EU-30: In addition to the EU-15, the EU-30 includes Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Romania, Bulgaria, Turkey, Cyprus, Malta, Switzerland and Norway. However, Norway is considered as an external supplier in the OME study, thus Norwegian supply costs are to the border of the EU-30 excluding Norway.

Appendix B: Overview of the European Union's Emission Trading Scheme (Directive 2003/87/EC)

- The following activities require a CO_2 emission permit from 1 January 2005 onwards:
    - Combustion with thermal input > 20 MW
    - Mineral oil refineries
    - Coke ovens
    - Metal, cement, glass, ceramics, pulp, paper industry above defined thresholds
    - e.g. GER: trading regime covers 98% of electricity generation emissions, 60 % of industry emissions, 40 – 50 % of all emissions
- Permits can be traded EU-wide
- National Allocation Plans (NAPs) to be submitted to the EC by 31 March 2004
- Original allocations must take place widely free of charge
- Periodisation of permits (2005-2007; 2008-2012)
- Penalties for emissions without holding a permit (does not remove obligation to still require permits):
    - 2005-2007: 40 € per tonne CO_2
    - 2008-2012: 100 € per tonne CO_2

Appendix C: Contributors to Survey and Workshop

Centrica
Distrigas
EdF
EdP
Electrabel
EnBW
Enel
EnergieNed
E.On Energie
E.On Ruhrgas
Essent
EWE
Gas Natural
Gasunie
Norsk Hydro
POGC
RWE
Scottish Power
Shell Energy Europe
SNAM Retegas
Vattenfall

European Commission
Federal Ministry of Economics and Labour (Ger)
Ministry of Economy and Labour (PL)

Eurelectric
Eurogas
Gas Strategies
International Energy Agency
Oxford Institute for Energy Studies

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