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IMPACTS OF MARKET LIBERALISATION ON THE EU GAS INDUSTRY

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Abstract

This final report presents the results of the analyses at relevant trends and features in the EU gas market enabling or limiting more competition. The study focuses in particular on the possible impacts of the implementation of the EU Gas Directive and subsequently of the expected effects of increasing competition and further integration of gas markets in Europe. The study is conducted in the framework of the Shared Analysis project entitled 'Economic Foundations for Energy Policy, coordinated by FhG-ISI and prepared for the European Commission Directorate General for Energy.

The report contains an analysis of the recent changes in the structure of gas demand and the supply and its consequences for enhancement of competition in the EU gas market. It discusses the role of growing gas demand, changing structure of the supply industry and access to the network. Next, the implementation EU Gas Directive is discussed. In order to deal with the uncertainty in the results of the implementation process, two extreme institutional scenarios for future development of the liberalisation process in the EU gas markets are formulated. Finally the consequences of these two gas market liberalisation scenarios are analysed. Note that part of the conclusions of the expected effects of the Directive, i.e. the expected changes in gas prices and market structures, are based on a model analysis. However, it should be clear that at this stage our conclusions presented in this report are still of a tentative nature.

Note that the final report is based on an extensive collection of EU gas market data both on country and company level, which was described in the first interim report entitled 'The natural gas market in the European Union' (R. Aalbers and M. Uyterlinde, June 1998). A second interim report was drafted with an energy policy interpretation of the analyses of data and developments over the past ten years (F. van Oostvoorn and M. Boots, December 1998).

Furthermore, at this moment, facts, opinions and available data are rapidly changing in the beginning of the transition period and the bulk of the work was conducted in the second half of 1998. Therefore it was impossible to include all the latest details of the EU gas market in sufficient detail, particularly given the limited scope of this subtask of the Shared Analysis.

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EXECUTIVE SUMMARY

The current study analyses the consequences of the implementation of the EU Gas Directive and other factors relevant for more competition in the EU gas markets. In summary we can conclude that the following factors are driving the EU gas markets towards more competition:

- growing gas share in energy demand and diversification of supplies and imports,
- emergence of large non-EU suppliers and overcapacity in gas supplies to the EU consumer markets,
- changing role of governments in the economy, and consequently another view on intervention in the gas markets,
- opening up of the German gas market by Wingas and Gazprom,
- construction of the Interconnector between UK and Belgium,
- implementation of the EU Gas Directive to accomplish an internal market for gas.

The EU Gas Directive aims to create a full competitive market in natural gas through common rules for transmission, distribution, supply and storage. Central to this aim is the requirement to open up the transmission network and storage facilities to third party access, so that eligible customers can buy gas directly from producers if they wish. The Directive establishes minimum degrees of market opening. The initial market opening covers all power generators and all other consumers of more than 25 million cubic metres/year and a minimum of 20% of each national market. The market opening rises to 15 mcm/year and 28% of the market after five years of the directive's taking effect in 2000 and to 5 mcm/year and 33% after ten years. The Directive also allows new entrants to build pipelines.

However, with a view on the future developments of the EU gas markets the implementation of the Directive raises several questions:

- How will the different Member States (MS) implement the Gas Directive and at what pace? Given the large differences between MS with respect to available domestic gas production, dependency on imports and other economic and political features, differences in implementation can be expected. Will the implementation of the Directive indeed lead to an internal market for gas in the EU or, in other words, will the Directive be implemented by the Member States beyond its minimal requirements?
- What are the responses of the different gas companies to the Directive and its implementation by the Member States? For example, can we expect a defensive or offensive response of the companies? How will the Member States and how will the Commission react to mergers or vertical integration of companies and to requests for derogations or/and violations of the rules by the Member States?

Clearly the outcome of the progressive liberalisation of the EU gas market and particularly the role of the Directive and the responses of the large companies in this process are highly unclear and very uncertain.

In order to cope with the currently large uncertainties of this process of the enforced liberalisation, the most relevant institutional driving factors influencing the emergence of more competition in EU gas markets are put into a scenario framework to enable a more systematic analysis and assessment the effects of this liberalisation process in the next decade. To that aim two 'extreme' scenarios for the possible development of the 'new' institutional framework (implementation of the Directive) and other key factors influencing (limiting and/or promoting) the development of more competition in the EU gas market is defined. The results of our impact analysis of these two scenarios are as follows.

Full competition scenario

Achievement of an internal gas market in 2010 will have the following effects:

a) Substantial lowering of natural gas prices in most of the mature EU countries except for the UK.
b) Convergence of gas prices across countries and between the different consumers due to arbitrage facilitated by emerging spot and future trading.
c) Profits of gas companies will strongly erode.
d) Substantial increase of gas consumption in most of the continental EU countries and particularly in the power sector.
e) Trade via the pipeline network for transmission will relatively decline and be substituted by swap deals and other 'paper trade', thereby reducing the transmission costs for consumers. This is because these and other auxiliary (storage, quality, etc.) costs are becoming relatively more important in a full competitive market.
f) Consequently EU producers/suppliers such as Shell, Exxon, Agip/ENI, Wintershall etc., which are closer to their markets than most of the non-EU producers, are the winners in the next decade of attaining full competition. Their production and sales will relatively increase.
g) Growing number of multi-utilities and convergence of gas and electricity markets.

Semi-open Competition scenario

Given the assumption of a minimalistic implementation of the Directive, of course the key objectives of the European Commission will not be obtained, because Member States focus primarily on protecting their stake in national gas transmission and trade. Therefore we expect the following effects:

a) Only small reductions of gas prices in the mature gas markets in the EU.
b) Moderate increasing gas consumption in most of continental EU countries.
c) Structural changes in the EU gas industry are limited.
d) Unjustifiable price differences between countries and markets continue, particularly for small household consumers.
e) Profits are constant or expected to increase slightly.
f) Public support for liberalisation process will decline.

Consequently we can conclude that in order to bring about a fully liberalised gas market in the EU and thereby harvest all the expected benefits, in particular a more efficient gas industry and particularly secure a fair lowering of gas prices, the Commission and the Member States have to secure the following conditions:

- Harmonisation of the implementation of the Gas Directive, beyond the bottom-line requirements in all EU Member States.
- Effective and thus legal unbundling of accounts and separation of management of the different functions of the gas market such as trade and network transmission, storage, etc. Otherwise large vertical integrated and/or national gas companies will continue to dominate the gas pricing, trade etc. in the EU.
- Secure effective and non-discriminatory access to entire network and particularly its auxiliary functions by realising regulated TPA for the entire network.
- Secure non-discriminatory access pricing, i.e. enforcing publication of tariffs and commercial conditions in advance.
- Establish strong empowered regulation authorities on EU and Member State level, which have to co-ordinate their pro-active regulatory work effectively.
- Minimise derogations for mature markets, particularly for take-or-pay contracts, public services, obligations and capacity reasons.

Clearly the developments in the next transition period of the EU gas markets are of great importance to all actors involved. Therefore a close monitoring of events and movements for policy makers at both EU and member state level is expected.

1. BACKGROUND

The penetration of gas in the EU energy balance effectively started in the 60's, particularly in The Netherlands and the UK, because of the large domestic resources. Until the end of the 80's, EU gas policy was focused mainly on limiting the use of natural gas for electricity generation and promoting extraction of gas in the Community. This was to secure the availability of sufficient natural gas to 'high valued' (small) consumers.

The high oil prices (and thus relatively high gas prices for consumers) at that time supported the careful gas using policy by both national governments and the EU. This policy was also widely supported as being in the interest of governments, their state-owned national gas production companies (Gasunie, Statoil, etc.) as well as transport/distribution companies like Distrigaz, SNAM and Gaz de France. Up till the end of the 80's, the result was a moderately increasing share for gas in energy balances of most EU countries. Nevertheless, it gave concern in the Commission as regards to rising EU dependence on gas supply from countries outside the EU in the future.

Until 1990, the issue of gas market liberalisation did not feature significantly on the policy agenda of the European Commission. Its concerns were focused primarily on issues of security of supply. The gas industry was allowed to operate according to the individual wishes of each Member State government. Perhaps because of the strategic importance of energy supply, no serious attempts were made to establish a free market in either gas or electricity, in spite of the EU objective of the establishment of a free market for other goods and services. The gas industry in general was not dissatisfied with this state of affairs, since the major participants usually worked out trade and transit provisions bilaterally and without serious problems. However, the lack of harmonisation and the diversity of energy prices were becoming increasingly anomalous within the scope of the EU to achieve a single market. In 1988, the Commission published the white paper entitled 'The Internal Energy Market' with the aim of EU Member States establishing a single market by 1992. Clearly, the realisation of a single market for energy presented more serious obstacles than for other commodities. From that point on, liberalisation of gas and electricity markets has occupied an important place on the Commission agenda. The promotion of Trans-European Networks (TENs), e.g. for gas pipelines, as put forward in the white paper 'Growth, Competitiveness and Employment', added momentum to the political drive of liberalisation of energy markets in the EU.

Since the Commission turned its attention towards the functioning of the gas industry, several directives have been passed and liberalisation has been kept at the top of the energy policy agenda of the EU.

The first relevant directive was passed in 1990 and was related to price transparency for industrial gas prices. Member States are required to inform the Commission about gas prices under clearly defined categories. The price transparency directive and the gas and electricity transit directive of 1990 can be regarded as the first, preliminary steps to the opening-up of the European energy markets to competition. During 1991, the Commission started to work on its main proposal for the realisation of a true internal energy market, which was stimulated by developments in the UK where the liberalisation of gas markets was started. Also the Directive (1975) on limiting the use of gas for power generation was abolished at that time.

Gas consumer prices and import prices at that time were, and in most EU countries still are, linked to oil product prices. Upstream prices are determined by long term contracts between producers and transporters. This protected national transmission companies from price fluctuations and secured their profits, but also kept prices relatively high for consumers in comparison with a situation of gas-to-gas competition.

The Transit Directive, which was passed in 1991, allows nominated gas companies the right to use the pipelines of other nominated gas companies, provided that gas crosses an internal European border. This was undoubtedly an incentive to the UK-Interconnector project, which will secure that a substantial amount of uncontracted gas becomes available to and from UK after 1998. Gas exports from the UK can travel through the British Gas network at the standard regulated rates and will then be rated according to an agreed tariff through the UK-Interconnector. However, recently, transportation of volumes have been delivered from the EU continent to the UK consumers to satisfy peak demand and thereby mitigating extreme price increases during the winter season in the UK. Noteworthy is also the emergence of new gas companies such as Wintershall and Wingas, which leads to a complete opening-up of the German gas market.

The discussion on liberalisation of the gas markets in the EU continued and after several years of debate a political agreement on a new EU Gas Directive was finally reached in December 1997. After being adopted by the Energy Council with a unanimous common position, the EU Gas Directive was finally approved by the European Parliament in June 1998 and entered into force on August 1998. Appendix A gives an overview of the main elements of the Gas Directive. The current report will analyse the main features for more competition in the EU gas market and the role and impacts of the implementation of the Gas Directive.

This report is structured as follows. Chapter 2 reviews the demand side of the EU gas market. Chapter 3 covers the supply side developments and will illuminate the role of upstream competition and transmission. Furthermore Chapter 4 reviews the current role of the network for transport and trade of gas and discusses the importance of access to the networks. In Chapter 5 we discuss the EU Gas Directive and formulate two implementation scenarios. Finally, in Chapter 6, the conclusions with respect to the expected impacts of the implementation of the EU Gas Directive are presented.

2. GAS DEMAND

2.1 Growing gas demand

After a period of sluggish growth in the 1980's the demand for natural gas within the European Union is projected to rise substantially over the coming decades. Natural gas demand is said to be 'booming' all over Europe. The all-around optimism is fed by a number of structural economic and political developments. The main factors that have been restraining the use of natural gas are either no longer present or will be lifted within the foreseeable future. First, it has become clear that natural gas reserves, both on a European as on a world scale, are abundant. To cite one figure, the worlds proved reserves more than doubled over the last twenty years from 65,240 bcm in 1976 to 143,947 bcm in 1997. Hence, it appears no longer necessary to restrict the use of natural gas for 'high value' purposes only. For example, in 1990 the European Union removed its earlier ban on burning natural gas in order to generate electricity. Second, since 1985 natural gas prices have decreased. The fall in oil prices combined with the depreciation of the US$ has resulted in considerably lower end-user prices within all European countries. This has made natural gas more attractive versus alternative fuels like coal and lignite. Third, the low sulphur and carbon content of natural gas compared to other fossil fuels makes it an attractive fuel from an environmental perspective. Fourth, the availability of the highly efficient Combined-Cycle Gas Turbines (CCGT) and the liberalisation of the UK electricity market did stimulate the use of gas in the power sector. It seems likely that the ongoing liberalisation of the continental European electricity market will have a similar effect on the demand for CCGT and, hence, for natural gas. Fifth, the European economies have recovered from the economic depression in the early eighties. Current growth rates are at a higher level than a decade ago and therefore the demand for electricity and thus gas will rise accordingly.

Table 2.1 shows annual consumption of natural gas for the seven most important gas-consuming countries in the European Union (Austria, Belgium, France, Germany, Italy, The Netherlands, the United Kingdom). In 1995 these seven countries accounted for 93 per cent of total consumption within the European Union. For an overview of the gas market situation, in brief, in all EU countries, see Appendix B.

Table 2.1 *Natural gas demand [bcm] and demand forecasts*

Country	Sector	Demand			Demand growth [%]
		1995	2000	2010	1995-2010
Austria	households	2.140	2.381	2.423	13.2
	industries	1.743	1.860	1.914	9.8
	power	3.053	3.027	3.361	10.1
	total	6.936	7.268	7.698	11.0
Belgium	households	4.981	5.518	6.061	21.7
	industries	4.522	5.190	5.476	21.1
	power	2.931	5.408	6.726	129.5
	total	12.434	16.116	18.263	46.9
France	households	17.322	18.556	18.960	9.5
	industries	10.713	11.342	12.196	13.8
	power	5.016	10.613	16.373	226.4
	total	33.051	40.511	47.529	43.8
Germany	households	33.016	34.784	33.684	2.0
	industries	17.879	18.462	18.879	5.6
	power	18.559	22.746	31.060	67.4
	total	69.454	75.992	83.623	20.4
Italy	households	20.914	22.382	24.108	15.3
	industries	12.109	12.834	13.980	15.5
	power	16.790	31.567	35.285	110.2
	total	49.813	66.783	73.373	47.3
The Netherlands	households	17.641	19.546	20.808	18.0
	industries	6.808	8.036	10.146	49.0
	power	13.289	15.692	18.944	42.6
	total	37.738	43.274	49.898	32.2
UK	households	37.814	43.522	45.243	19.6
	industries	11.564	12.677	15.130	30.8
	power	16.933	29.600	45.444	168.4
	total	66.311	85.799	105.817	59.6
Total		*275.737*	*335.743*	*386.201*	*40.1*

Source: Baseline projections, Shared Analysis (Capros, 1998).

Given these observations, projections for the coming decades are that demand for natural gas within the European Union will grow rapidly. Based on submissions from member countries the IEA foresaw in 1995 that total demand for natural gas within the seven countries would rise to 370 bcm in 2010 (IEA, 1995a). This is somewhat less than the baseline results of Capros (1998) for the same year, i.e. 386 bcm (see Table 2.1). This corresponds to an annual growth rate of 2.7 per cent. Growth rates for the individual countries over the same period vary from 0.7 per cent for Austria to 4 per cent for the UK.

The IEA provides the following projections for the developments in Europe:

- Growth of electricity demand is expected to average 2.1 per cent between 1992 and 2010. However, in the same period, gas-fired electricity production will grow at an annual rate of 7.3 per cent.
- Gas penetration in the residential sector is approaching saturation in some of the mature markets.
- Gas demand in the industrial sector will grow more strongly during the pre-2000 period compared to the post-2000 period.
- The electricity sector accounts for over 50 per cent of the projected rise in demand for natural gas.
- The market share of natural gas as a primary input increases from 17.1 per cent in 1992 to 23.7 per cent in 2010.

Based on these projections natural gas seems to have a bright future within Europe. Its cost and environmental advantages seem to give it a competitive advantage over alternative fuels, especially for power generation. However, a number of observations are in order. First, although stricter environmental legislation will increase the attractiveness of natural gas compared to other fuels, it will also lead to an increase of energy efficiency (Stoppard, 1996). Second, the penetration of gas into the power sector may stimulate the use of gas in other sectors of the economy as well, especially if new pipelines are constructed with sufficient spare capacity. In this case the additional costs and risk of new supply to households would be reduced considerably. Third, although power generators seem prepared to pay relatively high prices for natural gas, the liberalisation of the electricity market may change this. A prime example of this is a contract signed by the Italian electricity producer, Enel, in 1992. At that time Enel agreed to take 3.5 bcm per year of Nigerian gas, at a price some 30% above the price paid by other buyers. However, by the end of 1996 Enel had failed to obtain a permit for expanding its regasification capacity. It then decided to cancel its contract claiming *force majeure*. The other, and perhaps even more important, reason for cancelling the contract is that the new management of Enel does not want the costly Nigerian LNG anymore. Clearly the prospect of liberalisation changed the nature of the contract from an asset into a liability, which is also the situation in The Netherlands with a gas contract, based on coal prices, between SEP and Hydro Norske. Fourth, counterbalancing the previous effect, gas producers are considering participation in downstream operations including electricity production. Gazprom, Sonatrach and Shell have expressed their interests in doing so. For them the advantage is that it allows them to capture a part of the upstream rent. At the same time downstream integration decreases risk, since profits become less dependent on movements in upstream gas prices. Fifth, projections for natural gas demand are extremely sensitive for changes within the electricity sector, i.e. lower growth rates for electricity demand will have a big impact on the demand for gas.

Although these factors are important for the development of the gas market, the primary question is whether gas can remain competitive compared to its main alternatives. Until today most contracts in Western Europe have been concluded on the basis of inter-fuel pricing. The price of natural gas is linked to its nearest alternative. Broadly speaking, natural gas prices on the industrial and electricity market have been linked to fuel-oil, whereas prices on the residential market have been linked to the much higher priced gas-oil. From the point of view of a transmission company inter-fuel pricing has two advantages. One, it reduces risk as well as average costs. Natural gas remains competitive vis-à-vis alternative fuels whatever the price of the alternatives in question. Since both natural gas production and transmission are highly capital intensive, average costs are decreasing with output. A high and stable throughput will keep average costs down and profits positive. Two, the absence of arbitrage possibilities between different markets and market segments allows the gas companies to set discriminating prices on different market segments. In this way they are able to extract substantial monopoly rents from markets which have a higher priced alternative, see also Chapters 3 and 4.

The above observations become particularly relevant when liberalisation of the natural gas market removes the possibility to discriminate prices between different types of customers. A more uniform price for natural gas may mean lower prices for some consumers and higher prices for others. This means that in theory on some market segments demand may decline whereas in others it may rise. Given that in most European countries the electricity market has not been served, total demand for natural gas is likely to increase substantially in the power sector and to a lesser extent on other market segments.

Whether the rise in demand can be satisfied, and at which price it can be satisfied, crucially depends on the supply side of the market. If the projections come true, an additional 110 bcm has to be produced and supplied to the West-European market by 2010. Although additional capacity is on the way (e.g. Maghreb, Yamal-Europe and Troll related pipelines), the infrastructure of distributing a substantial part of the projected demand increase, remains to be built. Questions such as; *who will supply the additional volumes to the market and where are the additional supplies located* will be addressed in the next chapters.

2.2 Gas market maturity

Third party access is a key element in market liberalisation, promoting competition and allowing customers to choose between suppliers. However, TPA can only be introduced in a mature market, where an excess of gas can be sold to alternative buyers, and a shortage of gas can be bought from alternative sellers, this is less likely to happen. Which markets in the EU are mature enough for liberalisation from both the buyer's and seller's point of view? We classify the gas markets in the different EU countries according to their maturity, which in turn gives an indication of the scope and possibilities for successfully introducing liberalisation of these gas markets.

For the classification, we have selected two main indicators, i.e. the share of natural gas in total primary energy requirements (TPER), and the number of years elapsed since the introduction of natural gas. The share of natural gas in TPER can give a rough indication of the number of buyers in a country and the importance of natural gas in a country's fuel mix compared to other fuels. The share of gas in TPER at the time of liberalisation was 22.9 per cent for the United Kingdom (in 1986) and 23.2 per cent for the United States (in 1985). This suggests that when the value of this indicator approaches 23 per cent, the natural gas market is mature enough for liberalisation, at least from a buyer's point of view. The number of years passed since the introduction of natural gas in a country gives an indication of the maturity of the gas infrastructure. In addition, it gives a rough indication of the investment costs to be recouped from the market, the expertise of the gas companies and policy makers.

In Figure 2.1 all countries have been classified along the two main indicators. We will consider markets where natural gas was introduced over 25 years ago as mature, and markets younger than 10 years as emerging. For the category in between, the share in TPER is more decisive. Obviously, there are also other factors determining the maturity of a market, for instance the share of residential/commercial gas consumption, the importance of gas for electricity generation, price transparency, and the regulatory system. Table B.1 and Table B.2 in Appendix B summarise a number of additional indicators also used for the classification.

The following gas markets have been identified as mature: Austria, Belgium, France, Germany, Italy, Luxembourg, The Netherlands and the United Kingdom. In addition, Ireland is considered to be close to maturity, and Denmark, Spain and Finland are expected to mature within the next decade. Portugal and Greece are new, but rapidly emerging markets.

From the point of view of market penetration, i.e. the share in TPER, combined with the existence of some (preparatory) institutional framework, the market seems to be ready for liberalisation in The Netherlands, Germany and Italy. In Austria, Belgium and Luxembourg, there are no provisions for liberalisation yet, but the market share of natural gas is already close to or over 23 per cent, so the number of buyers should not be a barrier to liberalisation. In France, liberalisation is not likely in the short term, given the low share of gas in the country's energy supplies. If the markets in Austria, Belgium and Luxembourg would be liberalised as well, there would be an interconnected gas market running from the United Kingdom to Italy. Emerging gas markets close to maturity, such as in Ireland, Denmark and Spain could join in later.

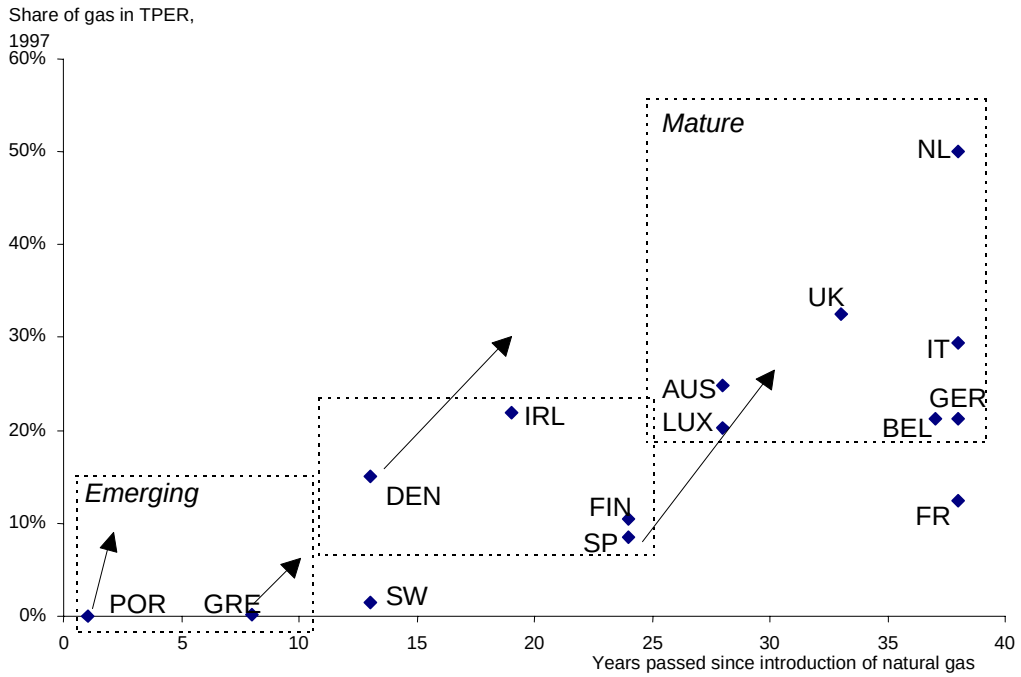

Figure 2.1 *Classification of the maturity of gas markets in EU countries along the two main indicators[1]. The arrows indicate substantial growth expectations that might change the classification in the future [%]*

Clearly a large part of the EU gas market is ready for a step by step liberalisation in accordance with the EU Gas Directive. However, there is a need for a number of facilitating measures to allow for the establishment of an effective institutional framework. For example, stimulating the development of hubs, encourage trading at hubs and promoting the investments in interconnectors between existing gas networks and between the EU countries and non-EU gas producers.

2.3 End-use prices

Given the objectives of this paper, namely an analysis of the effects of implementing the EU Gas Directive, an assessment of the impacts on end-use gas prices for consumers in the EU is a key issue. Therefore we start with a review of what has happened with end-use prices in the past decade in the EU right after the sharp fall of world oil prices (period 1985-1994). Companies on the European gas market have seen a fall in European import prices for natural gas since the mid-eighties. Measured in US dollars gas prices have fallen by 38 per cent between 1985 and 1994 (IEA, 1998a). Measured in local European currencies the fall of the natural gas price has been much larger. Depending on the currency in question, European import prices have dropped between 66 and 72 per cent in real terms between 1985 and 1994. Not surprisingly, producer revenues have been hit hard. The gas industry responded by slashing costs. For example, the Dutch mineral extraction industry has been capable of reducing costs with some 52 per cent between 1985 and 1994 (CBS, several editions).

[1] Note that for most countries, particularly for the mature markets, the precise number of years since the introduction of natural gas was not available and had to be estimated. Therefore no conclusions should be drawn from the exact location of countries along the x-axis.

Table 2.2 *Reduction end-user prices for natural gas between 1985 and 1994 in local currencies, real terms and excluding taxes [%]*

	Industrial prices	Household prices
Belgium	-68	-45
France	-62	-41
Germany	-62	-40
Italy	-55	-27
The Netherlands	-67	-41
Spain	-68	-47
United Kingdom	-47	-24
Average	-61	-38

Source: Aalbers, 1998.

Table 2.2 shows the percentage fall for both industrial and household end-user prices between 1985 and 1994. All end-user prices are measured in local currencies, in real terms and excluding taxes. Two observations can be made from Table 2.2. First, the fall in end-user prices has varied considerably among the seven countries, with the smallest fall occurring in Italy and the United Kingdom. Apparently, British Gas and SNAM have not passed on the reduction in border prices to a similar degree as the other utilities. Second, on average the 1994 industrial end-user prices in seven major consuming countries was 61 per cent lower than in 1985, while the 1994 household end-user price was only 38 per cent lower than in 1985. This suggests that contrary to households, industrial customers have been able to reap the benefits of the fall in natural gas prices. The different development between household and industrial end-user price might be due to the fact that the share of distribution costs in the household end-user price is much larger than in the industrial end-user price. However, since the distribution costs are made in local currency, their development is in principle unconnected to the development of the European border price.

Table 2.3 shows that the relatively higher distribution costs cannot explain why the household end-user price has dropped far less than the industrial end-user price. The left column contains the price that households actually paid in 1994 measured in local currencies and excluding taxes. The middle column contains the price households should have paid, again in local currencies and excluding taxes, if the distribution costs in 1994 had stayed at their 1985 level. These prices have been calculated by taking the 1994 industrial end-user price and adding the 1985 difference between the industrial and household end-user price. After correction for inflation this difference should reflect the additional distribution costs to households, the profit margin of the distribution company and possible differences in load patterns between households and industry[2]. Table 2.3 shows that all European households were paying too much in 1994, but also that considerable variations exist between countries. In 1994 Spanish households were paying 1 per cent too much, while Dutch households were paying 27 per cent too much for their natural gas.

[2] All information on prices has been taken from IEA, Energy Prices and Taxes, several editions. Producer price indices have been taken from CBS, several editions.

Table 2.3 *Household end-user prices in local currencies per toe excluding taxes*

	Currency	1994	1994 at 1985 costs	Needed drop [%]
Belgium	[BF]	11390	10210	-10.4
France	[FF]	2151	2043	-5.0
Germany	[DM]	574	507	-11.5
Italy	[Lira]	616902	512346	-16.9
The Netherlands	[*f*]	472	346	-26.8
Spain	[Ptas.]	62116	61502	-1.0
United Kingdom	[£]	190	165	-13.0

Source: Aalbers, 1998.

Key question is: why are households paying relatively more for their gas than they did in 1985? A number of possible explanations exist. First, the producer price index may not reflect the price development of distribution costs. Second, transmission or distribution companies may have absorbed the extra rent. On the first possibility there seems to be no reason why distribution companies have been much less successful in realising efficiency gains than the rest of the industry. Neither does there exist any evidence that the profits of distributions companies have gone up systematically between 1985 and 1994. Hence, the only explanation that remains is that the transmission companies have been able to absorb the extra rent on household related sales.

The experience in The Netherlands seems to support this view. Confronted with the decline of natural gas revenues after the second oil crises the Dutch government decided to link the household end-user price to the much higher priced gas-oil instead of the crude and heavy sulphur oil. Since the profit of Gasunie is regulated at 80 million guilders a year, the extra rent from household related gas sales has gone to the Dutch state and the gas producers, not to the distribution companies. Yet another reason for the Dutch government to keep the household end-user price at a high level is that higher end-user prices within The Netherlands mean higher export revenues. Since 1982 prices for some export contracts are linked to the average end-user price in The Netherlands, the so-called Spierenburg agreements. Hence, a higher domestic end-user price means higher gas rents both domestically and abroad.

However, more recently the British experiment with liberalisation, as Heren (1999) accurately points out, induced the old pricing system for natural gas to collapse. A spot market has arisen which is now recognised as the indicator of value for gas. By early 1995, the growth of competition and the arrival on the market of new sources of gas began to expose overcapacity, and prices fell by 50 per cent. This led to a rapid expansion of the spot market. IEA statistics (IEA, 1998) show that prices in all market segments in the UK show a downward trend since 1985, although prices to power generators increased for the first time in 1997. Prices to industry have fallen most dramatically, see also Table 2.4.

Prior to the approval of the EU Gas Directive, in some countries on the Continent, such as Austria, Germany and The Netherlands, gas to gas competition already emerged on a limited scale. Price reviews in long term contracts have already been triggered on the basis of gas to gas competition and they are also expected in the future. However, the emergence of a British spot market resulted in a significant divergence of gas prices in the UK from the oil-indexed gas prices on the continent. The consumers on the continent not yet benefit lower prices. For example, during 1996, average German industrial prices increased by nearly 20 per cent, despite the easy supply and the relative high level of serious gas to gas competition, particularly between Ruhrgas and Wingas (Heren, 1999).

However, the dramatic fall in oil prices in 1998 is rapidly cutting the border prices of gas on the continent. As a result, the gap between British and continental gas prices is closing. Here, the opening of the UK-Interconnector in 1998 already proved that price differentials between the continent and the UK are not sustainable. This physical link between the two separate markets

will gradually lead to a convergence in gas prices as well as to convergence in indexation, price re-openers, take-or-pay contracts and contract duration (Thomas, 1999). Moreover, the exceptional low gas prices makes it easy for governments to introduce new taxes or increase tax levels (Frisch, 1999).

Besides the commodity prices, the more complex peak prices are of importance. The problem is that existing prices for peak demand and supply in Europe are practically invisible and no market prices exist for this peak. Even in the UK, peak prices are far from clear. In the UK all market segments require peak services because all segments are open to competition. Storage and interruptions have become more available and prices in the spot market have shown a seasonal profile. Thus, price volatility has increased in the UK since the liberalisation. However, the winter peak prices tend to moderate in the UK. In continental Europe, only high load factor customers are open to supply and peak services, which are still controlled by incumbent gas suppliers. The reversed gas flow during the 1998/99 winter as a result of higher UK prices proved the usefulness of the UK-Interconnector for arbitrage and load balancing purposes.

Table 2.4 *Prices [US$/1000 m^3] of natural gas*

		Households	Industries	Power generation
Austria	1995	459.7	194.5	n.a.
	1997	430.8	186	n.a.
Belgium	1995	487.1	141.5	109.7
	1997	413.3	131.3	132.5
France	1995	500.5	161	n.a.
	1997	426.6	152.8	n.a.
Germany	1995	476.8	207.1	174.6
	1997	416.6	189.9	158.1
Italy	1995	667.2	173.7	130.2
	1997	n.a.	191.7	n.a.
Netherlands	1995	360.9	148.7	144.2
	1997	360	132.8	129.3
UK	1995	328.8	127.1	117.9
	1997	338.2	99.6	123.2

Source: IEA (1998a), p.355-357. Gas prices for power generators in Austria and France are not available, for Italy prices are not yet known.

2.4 Outlook for demand and prices

It is extremely difficult to predict how increasing liberalisation pushed by the EU Gas Directive will affect the end-users gas market in terms of prices, volumes and services to the consumer in the next decade. However, some observations are possible. For this we have to make a distinction between the short-term period in which the gas markets are in transition to full liberalisation and the long-term period beyond 2010. This is the period in which the liberalisation is expected to be completed.

First experiences with gas and power liberalisation in the UK show clearly an increasing gas use for power generation by a huge expansion of the generation capacities of CCGT power stations ('dash for gas'). It is our expectation that gas demand will increase in the next decades in the EU at the same pace too. This is mainly due to the increasing use of gas for centralised and decentralised power generating (replacing decommissioned coal, oil and nuclear power plants). Particularly the gas use by the power sector will be boosted in EU countries such as Germany, Belgium, Italy and Spain.

Second, we expect an increasing downstream competition and a substantial fall in average industrial gas prices due to gas market liberalisation. Also, given the fact that large volumes of new non-EU gas supplies are available in the next decade for a majority of continental EU countries, see next chapter, upstream competition can be expected to increase further, which will lead to lower average border and also end-use prices, if the lower upstream gas prices are passed on to the end users and not pushing-up transmission profits, see chapter four.

On the other hand, the traditional national gas companies such as Gasunie, SNAM and Gaz de France will try to minimise the pressure on their profits and thus minimise effects of upstream competition and the implementation of the EU Gas Directive in their countries in order to maintain their quasi-monopoly in transmission and downstream markets and thus their profits level. They will offer more favourable national tariffs (see British Gas in the UK, Chesshire, 1999) and find a way to get rid of the 'stranded costs', which some of them may have in the form of unfavourable 'old contracts', which are mainly based on a 'take or pay' basis without 're-openers' or other flexible mechanisms. However, this issue seems less relevant for the EU than it was for the UK, because of the planned gradual establishment of the opening up for competition of the gas market in the EU.

3. GAS SUPPLY

3.1 Gas supply and market structure

The ownership structure on the supply side of the European gas market can be characterised as an extremely complex oligopoly. In order to limit market risk, the search for and exploration of (new) gas fields is often executed in joint ventures with other gas companies. Although the operatorship of a single gas field usually rests with one company, all partners in the joint venture are entitled to a part of the profit (loss) of the gas field in question. Additionally, many upstream companies have extensive interests in the downstream part of the market. The prime example is Shell, which holds an interest in at least 15 different transmission companies. The ownership structure of individual transmission companies can be very complex as well. For example, Germany's Ruhrgas is owned by a consortium of four so-called 'pools'. Behind each of these pools stands a consortium of upstream gas companies, some of which have shares in more than one pool. In order to give some structure to the analysis first a description of the upstream market is given, then the downstream part of the natural gas market and the level of vertical integration is discussed. In other words how much does a company produce and how much does it, direct or through its interests in other companies, transmit?

The upstream market is the most competitive part of the natural gas chain. About twenty major companies are involved in the exploration and production of natural gas for supply to the seven major consumer countries in the EU (Austria, Belgium, France, Germany, Italy, Netherlands, and UK), see Table 3.1.

In 1996, the biggest of those companies, Russia's Gazprom, had a market share of about 20 per cent of the West European market. In that same year, the top five companies, Gazprom, Sonatrach, Exxon, Shell and EBN, supplied just over 60 per cent of this market. Although this points to a relatively competitive market[3], it must be noted that these figures are European averages. Taking a look at each of the countries separately we obtain a somewhat different picture. In some of these countries one company or a consortium of companies holds a dominant market share. In The Netherlands, a consortium of Shell, Exxon and EBN supplies virtually the entire market. In Spain, Algerian Sonatrach supplies over half of the market. Moreover, many of the companies listed in Table 3.1 do not compete with each other because of geographically separated markets. Seven out of the twenty companies listed are active only, or mainly, in the United Kingdom, whereas the two largest companies, Gazprom and Sonatrach, only compete with each other in Italy due to unconnected pipeline systems.

The changes in market volume and share of supply of the companies are also illustrating the growing importance of non-EU producers for the EU gas consumption, see Table 3.1.

[3] This is confirmed by some of the measures used in the literature, e.g. the Herfindahl index. For the top five companies the Herfindahl index on the natural gas market in 1996 was 0.078, compared to 1.0 for a pure monopoly, 0.013 for twenty firms of equal size and 0.2 for a five firm market. (The Herfindahl index is calculated as the sum of squares of the market shares of the biggest companies).

Table 3.1 *Gas supply (bcm) by individual companies to the seven main consumer countries[c] in the EU*

	1992	1993	1994	1995	1996
Gazprom	58.8	54.2	55.1	64.1	64.2
Sonatrach	35.7	34.0	30.1	36.6	38.9
Exxon	32.1	31.5	29.4	29.0	34.8
EBN	31.0	31.3	29.2	29.2	33.4
Shell	30.0	29.9	28.5	28.1	33.3
Agip (ENI)	18.6	19.3	20.5	20.5	20.5
Statoil	10.0	11.0	12.0	12.0	18.0
British Gas	9.0	11.0	10.9	13.4	14.2
Elf	11.5	12.2	12.9	13.0	13.4
Mobil	7.8	9.2	9.8	11.4	12.3
BP[a]	7.1	8.9	9.0	9.0	11.6
TOTAL	3.8	4.2	4.9	5.0	5.4
Amoco	2.8	2.7	3.5	3.8	4.0
Amerada Hess	1.9	2.2	2.4	2.8	2.9
Norsk Hydro	-	2.0	2.4	2.2	2.9
Wintershall	1.8	1.9	2.3	2.1	2.5
Lasmo	0.6	1.2	1.2	1.3	1.7
Saga	0.5	0.5	0.5	0.5	0.7
Others[b] (e.g. Arco, Conoco)	35.4	48.5	53.0	56.2	n.a.
Total	*298.4*	*315.7*	*317.6*	*340.2*	*n.a.*

Source: Annual reports of listed companies. Note that total production and sales are usually given in the annual reports. However, production and sales for specific (groups of) countries have to be estimated.

[a] Figure for 1993 obtained through interpolation.

[b] Calculated as total supply minus deliveries by major companies.

[c] Austria, Belgium, France, Germany, Italy, Netherlands and the UK.

3.2 Transmission of gas

The downstream part of the EU gas market shows a completely different picture than the upstream part. In nearly every country the transmission market is dominated by one company supplying virtually the entire market (see Table 3.2).

Table 3.2 *Dominant transmission companies and their supply in 1995*

Country	Dominant company	Transmission[a] [bcm]	consumption[b] [%]
Austria	ÖMV	6.8	92
Belgium	Distrigaz	14.7	104
France	Gaz de France	44.0	112
Germany	Ruhrgas	59.4	69
Italy	SNAM	52.6	89
Netherlands	Gasunie	44.7	98
United Kingdom	BG/Transco	76.3	89

Source: Aalbers, 1998.

[a] Transit volumes are not accounted.

[b] Due to (unreported) differences in definition of a bcm the amount supplied by the dominant transmission company may be larger than total consumption in that country.

The only exception is the German market where the share of the largest transmission company, Ruhrgas, is limited to 69 per cent. Until mid 1998, the German transmission companies, which signed so-called 'demarcation contracts', promised to refrain from competing in the supply of piped gas outside their respective areas. The German landscape was characterised by a patchwork of regional monopolies instead of a nation wide monopoly. Since the late eighties how-

ever, the position of the German utilities has already been challenged by the BASF/Gazprom joint venture Wingas, which is now building its own nation-wide transmission network. In 1998 the German market was also opened-up by liberalising the transmission of natural gas in Europe's main market thereby replacing the existing *de facto* or legal monopoly in Germany.

3.3 Vertical integration

So far, the analysis has shown a reasonably competitive upstream market together with a nearly monopolistic downstream market. Hence, the conclusion seems warranted that any problems with market power will be confined to the downstream market only. However, the situation on the market for natural gas is more complicated than the analysis suggests. First, a number of the companies active in the upstream market are working closely together. The main motive is that it allows cost savings and reduces risk. Horizontal integration[4] also reduces the number of competitors on the market and, hence, reduces competition. Second, many of the upstream companies have interests in downstream companies, which is called vertical integration[5]. Although vertical integration reduces risk and increases value added for a company, it also allows the upstream firm to 'shift' the battlefield to the less competitive downstream market and, hence, to evade competition.

Stoppard (1996) divides the upstream companies into the 'old order' and the 'new order'. The distinction is made on the basis of a company's downstream involvement. Shell, Exxon, EBN and ENI belong to the old order, whereas Gazprom, Sonatrach and the Norwegian producers belong to the new order. The transmission companies Gaz de France and Distrigaz also belong to the old order. Stoppard argues that, as a result of the monopolistic buyer system, the old order has been able to shift most of the rent on natural gas to the downstream market. The fall in natural gas prices since the mid-eighties has been fully absorbed by the producers, while at the same time, the profits of the transmission companies have remained almost unaffected. Since the new companies Gazprom, Sonatrach and GFU have virtually no downstream interests, they have been hit much harder by the fall in natural gas prices than Shell, Exxon, EBN and ENI.

Stoppard's analysis suggests that in order to understand what has been going on in the European market for natural gas, one must have a clear picture of the level of vertical and horizontal integration. One way to measure the amount of vertical integration is to determine the downstream interests of upstream companies on a bcm basis. This is done as follows. Suppose that upstream company A holds a 50 per cent interest in downstream company B who sells 25 bcm/year and that it has no other downstream interests. Company A's downstream interest is then given by 0.5 times 25 bcm is 12.5 bcm/year.

[4] Horizontal integration is defined as the co-operation of two or more firms active in the same market to jointly produce and/or market their products. It can take place either by means of a merger of the companies or the creation of a joint venture for certain activities or the participation in each other's capital stock. Besides giving advantages in terms of costs by exploiting returns to scale, horizontal integration also increases the grip of the joint firms on the market, since it eliminates competition between the firms themselves and allows for the co-ordination of their activities towards their remaining competitors. A recent example of horizontal integration is the proposed merger between Boeing and Lockheed. The European Commission has objected to the merger because the newly founded company would have too firm a grip on the American and European aircraft market.

[5] Vertical integration is defined as the co-operation of two or more firms active on different stages of the industrial column (upstream and downstream). As with horizontal integration it can take place by means of a merger, a participation in each other's capital stock or the creation of a joint venture. Vertical integration gives opportunities for exploiting economies of scope and reduces risk. But it also allows a firm to evade competition in the more competitive market. It can do this by lowering the price in the more competitive market and increasing the price to a similar degree in the less competitive market. In the natural gas market this takes the form of lower prices in the upstream market and higher prices on the (near) monopolistic downstream market. It is especially effective if there are substantial entry barriers on the less competitive market, like huge sunk costs, customer inertia, predatory pricing or denying possible competitors access to an essential network.

Table 3.3 *Vertical integration downstream on a bcm basis in 1996 (individual companies)*

	Production	Transmission (low estimate)	Transmission (high estimate)
Gazprom	64.2	4.8	4.8
Exxon	34.8	22.6	46.6
Shell	33.3	25.3	52.6
Sonatrach	38.9	0	0
EBN	33.4	19.2	37.5
Agip (ENI)	20.5	53.3	53.3
Statoil	18.0	0.8	0.8
British Gas	14.2	85.7	85.7
Elf	13.4	0.8	0.8
Mobil	12.3	3.9	6.6
BP	11.6	8.7	19.5
TOTAL	5.4	0	0
Amoco	4.0	0	0
Norsk Hydro	2.9	0	0
Wintershall	2.5	19.3	19.3
Lasmo	1.7	0	0
Saga	0.7	0	0

Source: Aalbers, 1998.

Table 3.3 lists the downstream interests for the companies active on the West European market. The low estimate in the table is based on the sales of the transmission company to final customers only. This excludes throughput, which are the sales to industry, electricity producers and distribution companies. The high estimate in the table also includes throughput. The figures show that major differences exist between the downstream involvement of upstream companies. This downstream involvement, for Agip, a subsidiary of Italy's ENI, is 260 per cent, which means that it transports 2.6 bcm for every bcm it produces. Other companies that have high matches are Shell (76 per cent), Mobil (75 per cent), Exxon (65 per cent) and EBN (57 per cent). On the top of the list are, of course, the 'transmission' companies Wintershall and British Gas with matches of 772 and 852 per cent respectively. The two biggest producers of natural gas, Gazprom and Sonatrach, catch the eye by their low downstream involvement[6]. A third major absentee is Norwegian Statoil. Notice that because it is bound to increase its production sharply under the Troll Sales Agreement, its already poor match will worsen considerable in the near future[7].

Finally a number of companies active on the European market have from a historical point of view been working closely together. The prime example of such a strategic alliance is the co-operation between Shell, Exxon, and EBN, since the early sixties. Recently a number of other alliances have emerged on the European market. These are Gazprom/Wintershall, Sonatrach/BP and the Norwegian Joint Gas Negotiations Committee (GFU) led by Statoil. Besides, the recent mergers of Exxon with Mobil and of BP with Amoco are important. Below in Table 3.4 the relative 'strength' of these alliances is illustrated. These alliances might play an increasingly important role in the further expansion of sales towards more risky, but promising emerging markets such as CEECs.

[6] Gazprom holds a five per cent share of the East German transmission company Verbundnetz Gas as well as a five per cent share in the UK Interconnector.

[7] Statoil has a five per cent stake in East-German VNG. It also holds a 18.75 per cent stake in the Netra pipeline. This pipeline will supply the German market with gas from the Norwegian continental shelf. Other shareholders are Ruhrgas (37.5 per cent), BEB (37.5 per cent) and Norsk Hydro (6.25 per cent). It is the first voluntary co-operation between members of the old order (Ruhrgas and BEB) and the new order (Statoil and Norsk Hydro).

Table 3.4 *Vertical integration downstream on a bcm basis for alliances*

	Reserves [bcm]	Production [bcm]	R/P ratio [years]	Transmission (low estimate)	Transmission (high estimate)
Exxon/Shell/EBN	2080	101.5	20.5	67.1	136.7
Gazprom/Wintershall	> 40000	66.7	> 69.0	24.1	24.1
Sonatrach/BP	3754	44.7	45.3	8.7	19.5
GFU	1693	21.6	78.4	0.8	0.8
ENI	323	20.5	15.8	53.3	53.3
British Gas	154	14.2	10.8	85.7	85.7
Elf	125	13.4	9.3	0.8	0.8
Mobil	119	12.3	9.7	3.9	6.6
TOTAL	51	5.4	9.4	0	0
Amoco	36	4.0	9.0	0	0

Source: Aalbers, 1998.

3.4 Outlook for changes in the supply structure

In summary, the following observations seems realistic:

- There is a drive for large production companies, particularly from outside the EU, to become increasingly involved in downstream markets of the EU. Hereby, they challenge the national transmission monopolies, such as Gasunie, Gaz de France, ÖMV, Distrigaz, etc. This to compensate for the expected squeezing of profits, due to the fierce and increasing upstream competition between the large producers and suppliers.
- New alliances or/and mergers between non-EU and EU suppliers or/and 'national' transmission companies can be expected, particularly in support of reaching downstream markets, limiting competition upstream and reducing costs of long distance transmission between producers and consumers.
- Large vertical integrated companies will emerge and probably dominate the European gas market in the next decade more than before.

4. GAS NETWORK

4.1 European network

Trans-European network

The bright prospects for natural gas since 1990 have resulted in an accelerated increase of transport capacity in the EU. From 1993-1997 the total network length increased by 54 per cent to 18,834 km in 1997. New areas of supply have now been connected to the continental European grid or have seen a substantial increase in their transport capacity. As of 1998, the Norwegian continental shelf is connected to the European main land by four major pipelines. These pipelines are Norpipe, Zeepipe, Europipe 1 and Norfra (see Table 4.1). By the end of 1999 a decision on the Yamal-Europe pipeline, a second connection between Gazprom's Western Siberian gas fields and its export markets in Western Europe might be taken. At the same time, gas has started flowing through the UK-Interconnector, intending to flow from the oversupplied UK market to the continent, but this winter 1998/1999 also used to supply peak demand in the UK. Another interconnector, completed in 1993, has linked the Spanish and French transportation systems. Negotiations have started between the Gaz de France and SNAM to build the first physical link between Italy and France. SNAM intends to use this interconnector to transport Norwegian gas from Dunkirk to Italy. Finally, since 1996, the Algerian gas fields are connected to the European continent by three major pipelines, two of which run to Italy (Transmed I, II) and one to Spain (Maghreb). Additionally, at relatively low cost capacity on many of the mentioned pipelines is available by increasing the pressure by which the gas is transported.

Table 4.1 *Norwegian export pipelines*

	Completion	Length [km]	Diameter [inch]	Capacity [bcm/year]	Terminal	Cost [10^9 US$]	Cost [US$/in/km]
Norpipe	1977	440	30	19	Emden	3.8	288
Frigg	1978	350	30	6.6	St Fergus	2.9	276
Zeepipe	1993	814	40	12	Zeebrugge	2.5	58
Europipe 1	1995	660	40	13	Emden	2.0	57
Norfra	1998	840	42	15	Dunkirk	1.06	23
Europipe 2	1999	650	42	18	Emden	0.9	25

Source: European Gas Markets, 16 Nov. 1998.

The Norwegian capacity to supply will experience a similarly impressive upward jump (throughput will increase from 44 bcm at present to about 77 bcm at the end of 1999), allowing the Norwegian producers to start competing with each other and with other supply sources.

Russian supplies to Germany

Large industrial customers, such as BASF, came to question the monopolistic price discrimination exercised by the national transmission companies. However, few had the means to challenge the system as long as the pipelines remained exclusively reserved for national transmission companies and local distributors. Some of these pressures have led to commercial actions that are altering the gas market structure at increasing speed. Wintershall, the oil subsidiary of BASF, build the Midal pipeline in Germany, from Emden to Ludwigshafen, to assure BASF's gas needs without reliance on Ruhrgas.

Additionally, Wintershall's challenge of Ruhrgas comprised a joint venture with Gazprom to build a new pipeline (Stegal) through Slovakia and the Czech Republic, to connect with Midal in Germany, for the purpose of selling Russian gas in Germany (Radetzki, 1999). Another challenge has involved both price and legal wars with Ruhrgas over the gas market in Eastern

Germany. Wingas, 65 per cent owned by Wintershall and 35 per cent by Gazprom, has been in the forefront of all these actions. More recently, the fighting for markets has also spread into the Western part of Germany, with the challenger gaining significant footholds with some of the regional transmission companies (Bayerngas and Westfalisches Ferngas agreed to take 10-15 per cent of their long term needs from Wingas), as well as in the industrial and the emerging power market (Radetzki, 1999).

Wingas has been involved in an extraordinary pipeline construction program to import gas to Germany. The program is reported to have cost a total of close to US $ 3 billion (Stoppard, 1996). The results, at the end of 1996, are summarised in Table 4.2. The operating lines have a capacity of 54 bcm, but capacity utilisation for 1997 was assessed at less than 20 per cent. For comparison the total gas consumption in 1996 in the EU is about 350 bcm.

Wingas' capacity will rise to 90 bcm when the pipelines under construction and planning become operational. This is marginally more than overall German gas consumption in 1996 (84 bcm), and represents 135 per cent of German imports (67 bcm) in that year.

Table 4.2 *Wingas' import pipelines into Germany*

Entry point	Name	Capacity [bcm/year]	Status in 1996
North Sea	Midal	10	Operating
Czech Republic	Stegal	12	Operating
Austria	Bavaria	6	Operating
Poland	Jagal 1	26	Operating
Belgium	Wedal	10	Building
Poland	Jagal 2	26	Planned

Source: European Gas Markets, Nov. 1996.

Conditions in the German gas market will be fundamentally altered in consequence of this construction. Prices will have to decline, as Wingas competes with Ruhrgas for market share, and will remain low for a long time to induce a rise in consumption sufficient to assure reasonable levels of capacity utilisation. Wingas and its owners, BASF and Gazprom, must apparently believe that the pipeline investments will prove profitable in the long run, despite a lowered price level. The changes in Germany are clearly driven more by market dynamics than by shifts in the regulatory regime.

The investments by Wingas are bound to have spillover effects outside Germany. A gas price fall cannot be isolated to Germany in an increasingly integrated European gas market. Spillovers will be accentuated by Wingas' own international ambitions, which are likely to undermine the market power of national transmission companies in other countries, e.g. Austria. Wingas' recent interest in the UK-Interconnector (see below) is an indicator of these ambitions.

Interconnector

Construction of the UK-Interconnector, with an initial throughout capacity of 20 bcm per year[8], was started in 1996 and completed in 1998. The first right to use the capacity was vested with the shareholders in relation to their participation. The shareholder group comprise of British Gas, 35 per cent; British Petroleum, Elf, Gazprom and Conoco 10 per cent each; and Amerada Hess, Distrigaz, National Power, SNAM and Ruhrgas, with 5 per cent each.

Table 4.3 shows that by the end of 1997, a total of almost 11 bcm of the capacity had been contracted for under long term agreements. Further contracts are anticipated, but some 5 bcm of annual capacity is expected to be left available for short-term or spot sales. Before the UK-Interconnector has started operating, plans have been advanced to make Zeebrugge into a Euro-

[8] The reverse capacity of the UK-Interconnector, i.e. gas flow from the continent to the UK, is 8.5 bcm per year.

pean hub, comprising both physical and paper trade. Enron, the global and prolific gas trading company from the United States, is waiting for the right opportunity to jump into this market from its subsidiary base in the UK.

Table 4.3 *Interconnector sales of UK gas*

Parties	Deal signed	Volume [bcm/year]	Duration years	Delivery point
Conoco/Wingas	Feb. '96	1.0	10	Aachen
BG/Wingas	July '96	2.0	10	Aachen/Zeebrugge
Centrica/Thyssengas	May '97	0.5	7	Zeebrugge
Mobil/Norsk Hydro	May '97	0.8	15	Zeebrugge
BP/Ruhrgas	Jan. '97	1.0	15	Bacton/Zeebrugge
Centrica/Elsta	July '97	1.0	8	Zeebrugge
Centrica/Entrade	Oct. '97	0.7	8	Zeebrugge
Conoco/Gasunie	Nov. '97	1.0	8.5	Belgian/Dutch border
Elf/Texaco/Hardy/Ruhrgas	n.a.	2.8	10	n.a.

Source: Thomas, 1999.

The content of Table 4.3 raises several observations of importance. It appears that very substantial exportable surpluses of UK gas will be available for the foreseeable future[9]. Despite the very rapid growth of the UK gas demand in recent years, particularly via the strong CCGT capacity expansion as part of the 'dash for gas' competition among producers in the UK has clearly released a profitable production potential that few observers perceived before the UK-Interconnector outlet became a reality. Now that the gas market in the UK is being tied to the rest of Europe, the example of what has been accomplished by competition in the UK is bound to have a strong influence on continental developments. The Norwegian capacity to supply will experience a similarly impressive upward jump (throughput will increase from 44 bcm at present to about 77 bcm at the end of 1999), allowing the Norwegian producers to start competing with each other and with other supply sources.

Furthermore, part of the UK-Interconnector deliveries are destined for Wingas, in Germany or elsewhere, thus diversifying this company's sources and improving the supply security image of its deliveries. This should add to Wingas' competitive edge when it seeks to take additional market shares from Ruhrgas and others.

4.2 Transmission profits

The fall in European border prices has not eroded the profits of Europe's main transmission companies, which becomes clear from Table 4.4. All companies, with the exception of Germany's Ruhrgas, have been able to keep their profits stable in real terms. The dent in Ruhrgas' profits coincides with the emergence of Wintershall as a competitor on the German market, which forced Ruhrgas to lower its prices. Of the European transmission companies, SNAM has been the only company, which reported a substantial increase in real profits. During 1985-1994 SNAM also succeeded in increasing its profit margin per m^3 by 15 per cent. While its profits in real terms grew by 73 per cent, its sales volume measured in m^3 increased by only 50 per cent. This view is supported by the observation that Italian end-user prices for both households and industry have fallen far less than in the rest of Europe (see Table 4.4). Finally, the drop in profits of British Gas since 1990 has mainly been caused by regulatory intervention in the UK. In order to promote competition in its home market British Gas agreed with Ofgas to lose 60 per cent of its industrial and commercial sector contract market between 1992 and 1995.

[9] During the winter of 1998/99, gas flow was reversed because of the low continental gas prices.

Table 4.4 *Profits of principal transmission gas companies in local 1985 currencies*

	British Gas [10^6]	Distrigaz [10^6]	ÖMV [10^6]	Gaz de France [10^3]	Gasunie [10^6]	Ruhrgas [10^6]	SNAM [10^9]
1985	706	2974		3786	80	n.a.	1132
1986	968	982		5001	80	943	1124
1987	978	1446		4308	80	726	1160
1988	991	3269		3006	79	748	566
1989	906	3650		2641	79	922	947
1990	1239	3073		2939	77	938	1615
1991	1182	3277		3835	74	1210	2024
1992	753	2759		4642	71	1062	2093
1993	901	2815		5428	70	850	2020
1994	717	2991		3792	68	619	1958
1995	364	3567	2191	6875	80	1198	
1996	705	3708	2921	6920	80	1207	
1997	1148	3507	5763	n.a.	80	1207	

Sources: Aalbers, 1998 for 1985-1994 figures. The figures for 1995-1997 are in nominal terms and based on the companies' annual reports.

The combined fall in oil prices and the US dollar have resulted in a drop in both households and industrial end-user prices in the European market. Much of the price fall has been absorbed by the gas producers who have seen European import prices fall between 66 and 72 per cent from their 1985 level. Table 4.4 clearly shows that during the same time the profits (measured in real terms) of Europe's main transmission companies have not been effected by the fall in European border prices. In a market where prices are supposed to be under pressure, this would be a remarkable achievement.

The most plausible explanation (see Stoppard, 1996 for a similar view) for the ability to keep their profits up is that the transmission companies have been able to shift the rent on the natural gas market from gas production to gas transmission[10]. Earlier it has been shown that the alliances on the natural gas market have widely diverging interests downstream. Back in 1985, when Wintershall had not yet made its appearance on the German market, the Shell/Exxon/EBN alliance was the only alliance with extensive interests in upstream and downstream companies. Since profits in the upstream sector have been affected much more than profits in the downstream sector, the profits of Shell/Exxon/EBN have gone down much less than the profits of Gazprom, Sonatrach and the GFU. From the point of view of Shell/Exxon/EBN, shifting the rent to downstream activities has two advantages. First, due to the *de facto* monopoly position of Europe's principal transmission companies it is both difficult and time-consuming to enter the highly profitable downstream market. The Wintershall experience is a clear example of this. Second, at equal end-user prices high profits for transmission companies mean lower border prices. Under those circumstances producers will get less for their natural gas. This will push high cost natural gas, for example gas not produced by Shell/Exxon/EBN out of the market. Again this reduces competition in favour of the alliance.

As for the future the changing prospects of natural gas in the early nineties have attracted new volumes to the market from more 'expensive' (long distance) producers like Gazprom, Sonatrach and the GFU. Since the downstream market has become more attractive vis-à-vis the upstream market, these producers are looking for opportunities to extent their downstream interests. On the other side of the market end users like BASF and Edison are willing to invest heavily in their own transportation capacity.

[10] Another explanation would be that the transmission companies have been able to slash costs dramatically. However, nowhere in their annual accounts have we found evidence that either market conditions were considered to be very harsh or that slashing costs has been a priority for them.

Apparently they are convinced that substantial cost savings can be made. Yet again this points to the fact that profit margins within the transmission sector are relatively large. Consequently for the development of competition in the EU the conditions against which parties can get access to the gas transportation network plays a crucial role.

4.3 Third party access

In liberalised markets access to pipelines can be arranged in many ways. First, there may be no legal rules for obtaining access. Even if companies have sufficient spare capacity available, they can simply deny access to possible competitors and/or customers. However, according to the EU Gas Directive, access can be obtained on the basis of negotiated Third Party Access (nTPA) or regulated Third Party Access (rTPA). With nTPA, prices for the transportation of natural gas have to be negotiated on an individual basis between the parties. However, the negotiations have to comply with a certain code. For example, the transmission company cannot simply refuse to transport independent volumes of gas, when sufficient capacity is available. Neither can it ask an exorbitantly high price for its transportation service. In both cases the party, who is seeking access to a network, can file a complaint with a regulatory body. The regulator will then decide whether or not the transmission company must transport the gas and at what price. In the case of regulated TPA, the transmission company has to publish binding prices for the transportation of natural gas over its network. The published prices are such that the transmission company does not make an exorbitant profit. Compared to nTPA, regulated TPA requires a much larger involvement form the regulator. The advantage of regulated TPA is that customers can negotiate directly with natural gas producers without at the same time having to negotiate with a transmission company.

Although the European gas transportation network has expanded considerably over the past few years, substantial differences between countries remain. The development stage of the network in a country is important, because it has a major influence on the possible market structure. Non-mature markets may be unsuitable for the introduction of either nTPA or rTPA for two reasons. First, opening up the market only works when buyers and sellers have alternative routes to transport and alternative buyers to buy their gas. Obviously, finding alternative buyers and alternative transport capacity will be very difficult in non-mature markets, since too few alternatives exist. Second, in non-mature markets competition may lead to a reduction of investments in new pipelines and thereby prevent the further build-up of the market. Long distance pipelines or LNG facilities for that matter require huge investments that span many years and are, by nature, very risky. Non-mature markets with their unstable demand conditions do not provide the kind of stable environment that is required to undertake these projects. Whether a similar argument holds as well for mature markets, is open for debate. Proponents of a free market in Europe say that the experiences in the United States and United Kingdom have shown that investments in pipelines do not need to suffer from a free market regime.

Looking at the number of sellers in a country, it appears that most of the countries with mature gas markets have been pursuing a diversification policy to increase their security of supply, and have multiple suppliers already. The perceived political stability of suppliers is also a factor to consider. For instance, Germany, Italy and France are heavily dependent on imports from Russia. Italy and France also depend on Algeria for their gas supplies. However, most of the emerging markets are still totally dependent on one or two suppliers. With the introduction of TPA the number of suppliers is likely to increase, and the extensions of the international infrastructure currently under construction will greatly facilitate this. Therefore, the number of suppliers does not seem to be a major barrier for liberalisation in the mature gas markets of the EU.

Apart from the effects on the price of natural gas, there is the effect that the introduction of TPA will eliminate price discrimination on the continental European markets. In a liberalised market all consumers will pay the same price for the same product. Arbitrage possibilities will make it

impossible, or at least more difficult, for companies to discriminate between customers. So even if the average price for all customers goes up, prices for households are very likely to go down. To give an example, if Gasunie had charged the same price to all end-users in 1996, the price of natural gas for households would have gone down by an estimated $0.64/MBtu (= 15.8 ct/$m^3$)[11]. Hence, the main reason for introducing TPA may not be efficiency considerations, but equity considerations: all customers should pay the same price for the same product, whatever that price may be.

A second benefit of a liberalised market is its flexibility. Even if the critics are right and the introduction of TPA does not lead to a price decrease for natural gas, short-term flexibility would increase in a fully liberalised market. Flexible prices would be able to absorb part of the (supply) disruptions that markets could face. As the IEA concludes for the US gas market: 'Where competition in end user markets has been created, adequate mechanisms to ensure security of supply have been created. It could therefore be concluded that there is no evidence that deregulation and the introduction of competition have jeopardised security of supply. There is, on the contrary, reason to believe that security of supply has been enhanced after deregulation'. Similar experiences have been recorded on oil markets, where the spot market has increased the flexibility of the market to cope with supply disruptions.

However, regulated TPA with full unbundling may create problems on its own. Under the old system were all functions along the chain like transmission, storage and marketing, were vertically integrated within the same company, this company made sure that the allocation of gas in its supply area was done in a cost-efficient way. In a market, where these functions are to be separated, it is prices that have to make sure that the allocation is efficient. This allocation problem arises because gas and infrastructure are joint products. Without the infrastructure to transport it, the alternative (short-term) value of gas will be close to zero. Without gas to be transported, the (short-term) value of the infrastructure will be zero. The complementary nature of all functions on the natural gas market means that prices for transmission, storage and marketing have to be determined jointly in order to reach an efficient allocation. In a decentralised market this may create problems, since individuals may not have all the information they need to complete their gas deals.

To overcome these problems it is necessary to introduce a system of hubs at which gas can be traded at spot markets. A precondition for a hub is that natural gas supplies coming from different sources meet each other at the hub. Within continental Europe the primary candidate for such a hub would be Zeebrugge, where supplies from Norway, the United Kingdom and LNG meet each other. Other future 'would be hubs' could be located anywhere in Europe, provided that several independent supplies and pipelines meet at one point. The joint valuation problem in a hub-based system is solved by jointly allocating property rights of gas and transport capacity. Sellers transport gas to the hub, buyers from the hub. Gas trade occurs at the hub. The main advantage of a hub-based system is that it decreases the complementary nature of gas and its transportation: it solves the matching problem between gas and transportation. In a hub-based system, gas without the capacity to transport it does not exist, since prices would go up. This would reduce the demand for gas and hence the need for transportation capacity.

[11] Average price of gas sold by Gasunie in 1996 was 20 ct/m^3. The price paid by distribution companies to Gasunie for household sales was 35.8 ct/m^3.

Further advantages of a hub based system are that (Funk, 1992):

- As in a centrally operated system, different load profiles may be balanced against each other (be it in a smaller volume).
- Buyers can find quick replacements if producers fail to deliver.
- Hubs increase the alternative value of the gas. Buyers can find alternative sellers and sellers can find alternative buyers. This reduces risk of committing to a firm capacity.
- Hubs are natural spot-pricing points reflecting the regional price of gas (and hence any differentials between different hubs). Hubs are also the ideal place for futures markets.
- Hubs increase the diversity of contracts. A variety of contracts (e.g. separate peak-load contracts, inventory holdings and replacements contracts) are only possible in a hub-based trade system.
- Prices between different hubs should, due to arbitrage possibilities, not exceed transportation costs between them.

Experiences with a hub based system in the United States indicate that such a system significantly reduces the disadvantages of regulated TPA combined with full unbundling, while at the same time retaining the advantages of competition.

5. IMPLEMENTATION OF EU GAS DIRECTIVE

5.1 EU Gas Directive

In summary we can conclude that the following factors are driving the EU gas markets towards more competition:

- Growing gas share in energy demand and diversification of supplies and imports.
- Emergence of large non-EU suppliers and overcapacity in gas supplies to the EU consumer markets.
- Changing role of governments in the economy, and consequently their intervention in the gas markets.
- Opening up of the German gas market by Wingas and Gazprom.
- Liberalisation of the UK gas market.
- Construction of the Interconnector between UK and Belgium.

Clearly the implementation of the EU Gas Directive can be viewed as a final step by the EU to accomplish an internal market for gas. The EU Gas Directive aims to create a full competitive market in natural gas through formulating common rules for transmission, distribution, supply and storage. Central to this aim is the requirement to open up the transmission network and storage facilities to third party access, so that eligible customers can buy gas directly from producers if they wish. The Directive establishes minimum degrees of market opening. The initial market opening covers all power generators and all other consumers of more than 25 million cubic metres/year and a minimum of 20% of each national market. The market opening rises to 15 mcm/year and 28% of the market after five years of the directive's taking effect in 2000; and to 5 mcm/year and 33% after ten years. The Directive also allows new entrants to build pipelines. See Appendix Afor a slightly more elaborated overview of the Directive. Other key elements of the directive include:

- *Access to networks*
  The directive provides for Member States to choose between negotiated and regulated access to networks. Under a negotiated access regime, eligible customers can negotiate access with the operator of the network. Member States must require gas utilities to publish their main commercial conditions for use of their system. Regulated third-party access implies a right of access on the basis of published tariffs for use of the system, guaranteeing access on predictable terms.
- *Unbundling*
  The directive requires that integrated gas utilities keep separate internal accounts for their transmission, distribution, storage and, where appropriate, non-gas activities. In the case of regulated access and where access to the network is based on a single charge for transmission and distribution, accounts for these two activities may be combined. The authorities would have access to the accounts for the natural gas utilities.
- *Take-or-pay derogations*
  A gas utility is entitled to apply to a Member State for a derogation from the network access requirements, if it considers that it would encounter serious economic or financial difficulties because of its take-or-pay commitments in one or more gas purchase contracts. Applications are to be presented to the Member State on a case-by-case basis, either before or after refusal of access. The Commission may request that the Member State amend or withdraw a decision to grant a derogation.

- *Derogations for emergent markets*
  Member States which can demonstrate that the implementation of the Directive would result in substantial problems for the development of the gas market in an emergent region can apply for a derogation from the requirements for eligibility and licensing for construction of new lines. Such a derogation, which also requires Commission approval, may only be granted for a given area of the first ten years after the first supply to that area.
- *Public service obligations*
  Member States are allowed to impose on gas utilities, in the general economic interest, public service obligations, which may relate to security of supply, regularity, quality and price of supplies and to environmental protection.

However, with a view on the future developments of the EU gas markets the implementation of the Directive raises several questions:

- How will the different Member States implement the Gas Directive and at what pace? Given the large differences between the Member States with respect to available domestic gas production, dependency on imports and other economic and political features, substantial differences in implementation can be expected. Will the implementation of the Directive indeed lead to an internal market for gas in the EU or in other words, will the Directive be implemented by the Member States beyond its minimal requirements?
- What are the responses of the different gas companies to the Directive and its implementation by the Member States? For example, can we expect a defensive or offensive response of the companies? How will the Member States and how will the Commission react to mergers or vertical integration of companies and to requests for derogations or/and violations of the rules by the Member States?

Clearly the outcome of the progressive liberalisation of the EU gas market and particularly the role of the Directive and the responses of the large gas companies in this process are highly unclear and very uncertain at this stage.

In order to cope with the many uncertainties of this process of enforced liberalisation, the most relevant institutional driving factors influencing the emergence of more competition in EU gas markets are put into a scenario framework to enable a more systematic analysis and assess the effects of this liberalisation process for the next decade. To that aim two ‘extreme’ scenarios for the possible development of the relevant institutional framework (implementation of the Directive) and other key factors influencing (limiting and/or promoting) the development of more competition in the EU gas market are defined. This enables us to conduct a more systematic analysis and assessment of the impacts of the EU Gas Directive.

5.2 Definition of two institutional scenarios

For the sake of transparency and clarity we assume two ‘extreme’ different outcomes of the implementation of the Gas Directive. The first implementation scenario is called the Full Competition (FC) scenario and reflects the development of market conditions in accordance with the EU objective of the Directive, namely the achievement of an internal EU gas market in 2010.

The second implementation scenario is called the Semi-open Competition (SC) scenario, which reflects a defensive attitude and approach to the implementation of the Directive by the main players (governments and large gas companies) in the EU.

The key assumptions for both extreme implementation scenarios are as follows.

Full competition (FC) scenario

- Fierce upstream competition between large gas suppliers, such as GFU, Gazprom, Shell, etc. continues in the next decade.
- Convergence of Member State regulation is achieved before 2010.
- Legal and effective unbundling of accounts and separation of management for trade, transmission, distribution etc. functions.
- Effective access (rTPA) to the entire network, storage, distribution etc. functions.
- Pro-active operating regulators on the EU and Member State level are not allowing any abuse of derogations, discriminatory access to the network, etc. in the Member States.
- Transparent access pricing is established.
- Sufficient number and capacity of hubs, pipelines, storage at hubs/interconnector links (necessary for establishing an effective system of spot trading) facilities are available in EU and these are optimally dispersed and located across the EU.
- Spot trading will dominate the price setting of gas.

Semi-open Competition (SC) scenario

Different key assumptions characterize the Semi-open Competition scenario, namely:

- Upstream suppliers form alliances and large vertical integrated companies are dominating the market (company response to implementation of the Directive) and thereby limiting competition.
- Administrative unbundling of trade, transmission etc. accounts of the vertical integrated companies.
- Discriminatory and limited (weak form nTPA or less) access to network, storage, etc.
- Ineffective and slowly reacting regulators to settlements of tariff, access and other disputes.
- Large differences in deregulation between Member States due to differences in circumstances and different implementation of the Directive in the Member States.
- Insufficient number, quality and capacity of interconnectors/hubs, pipelines, etc. for facilitating spot trade and thus spot trade will not really emerge.
- Long run take-or-pay contracts still dominating the gas trade in Europe.

Finally for both 'institutional' Directive implementation scenarios, we assume that competition in the next ten years is only achievable in mature gas markets in the EU. The following, see also Chapter 2, gas markets have been identified as mature: Austria, Belgium, France, Germany, Italy, Luxembourg, The Netherlands and the United Kingdom. In addition, Ireland is considered to be close to maturity, and Denmark and Spain are expected to mature after a decade. Portugal and Greece are new, emerging markets. Also, the oligopolistic character of the EU gas market will continue in the next ten years in both scenarios.

5.3 Model assumptions on the opening-up of gas market in the FC scenario

The gas model is only used for the analysis of price and other effects in the FC scenario. Therefore we have to define the precise opening-up of the gas market in the mature countries as assumed in the gas model for the Full Competition scenario. The Gas Directive gives guidelines for the degree of market opening and the customers that will be considered eligible. In the FC scenario it is assumed that Member States open-up their markets according to the minimum percentages described in the EU Gas Directive, see Table 5.1 below. However, in the final step of the FC Scenario the opening-up is completed and the institutional changes go beyond the regulations of the Gas Directive, thereby realizing full competition in 2010.

Table 5.1 *EU Gas Directive, market opening and eligibility*

Year	Min. market opening [%]	Eligibility [million m^3/year]
2000	20	25
2005	28	15
2010	33	5

For simulating the FC scenario in the model the step by step opening-up of the market is assumed as follows:

- *Step I*
  This scenario represents the current developments within the European Union. The institutional (= legal) framework laid down in the EU Gas Directive is taken to be the starting point for the developments on the natural gas market. In line with the requirements of the EU Directive, in the first step, all gas-fired power stations will be considered eligible customers in 2000. Since there are hardly any gas-fired power stations in France, large industries will also be considered eligible in this country (in order to reach 20 per cent market opening).
- *Step II*
  For the year 2005 a further liberalisation step is assumed. In step II, industries and power generation in all seven EU countries are eligible. However, for facilitating the comparison of effects, in the model this opening was calculated for the year 2010.
- *Step III*
  This step is designed to investigate the effects of a fully liberalised market on gas prices, gas demand and gas supply. Its results can be used as a benchmark to compare the results of the preceding steps. In a fully liberalised market efficiency gains will be maximised, be it at a certain cost. Examples of the latter are that price volatility will increase as will the ratio of peak to base load prices. The scenario will make it possible to gain insight into the questions who will reap most of the long-term benefits of liberalisation and who will pay the cost. See Table 5.2 below for an overview of calculation steps.

Note that only the Member States, whose gas market classifies as a mature market, open up their market completely. All customers are eligible in 2010. The gas market of Member States, whose gas market is classified as an emerging market, will for the time being remain closed.

Furthermore, it is assumed that since eligible customers will be able to change suppliers, or in some cases to build their own pipeline systems, it may be expected that the price of this part of the market will be market driven. Given that the transmission of gas in a fully liberalised market will be regulated on a rate-of-return basis with published tariffs, natural gas producers will have the opportunity to sell their gas directly to end-users. Competition will therefore take place between gas producers. Crucial in this respect is the question how intense the competition will be on the suppliers' side. In the calculated FC scenario for opening-up of the market it is assumed that the main suppliers will compete with each other and that monopoly power is effectively prevented by national monopoly and mergers commissions. This means that, for example, the alliances between Gazprom and Wintershall will not distort the intensity of competition within Europe.

Table 5.2 *Overview of key steps in the opening-up towards the full competition*

Step	Year	Eligible customers
I	2000	all power generation; industries in France
II	2010	all power generation and industries
III	2010	all mature markets full competition

Other assumptions in the model for the FC scenario

Regarding Third Party Access (TPA) it is assumed that all EU countries, whose gas market classifies as a mature market will implement a system of regulated Third Party Access. All tariffs have to be published in advance and are supervised by an appropriate independent body. Network tariffs are regulated on a rate-of-return basis. Note here that in reality some Member States are not going as far as implementing regulated TPA, rather, they choose for nTPA or even a single buyer system. In addition to the assumption of regulated TPA all gas companies are required to unbundle their natural gas transmission, distribution, storage and non-gas activities. Companies that are active in transmission may no longer have interests in either storage or marketing activities.

Regarding price convergence, the Directive also provides for non-discriminatory regulation. Price differences between the households and industrial sector should only reflect the additional distribution costs to households, the profit margin of the distribution company and possible differences in load pattern. The idea is that larger price differences are absorbed by gas traders that exploit the arbitrage possibilities. As a result, price differences between countries and sectors cannot be too high. Note that in the past end-user prices for households in most continental countries have been too high relative to prices for industries and gas-fired power stations. Therefore in theory it is also expected that the decline in industrial end-user prices of gas in mature countries is expected to be less than for households, because all kinds of specific (cross) subsidies will have to be abolished. Consequently, in the longer run, small gas users (households) are expected to profit relatively more from the liberalisation than large industrial customers.

For the calculations it means that arbitrage, between mature countries per sector and between sectors, when appropriate according to the implementation schedule of the Gas Directive, is specified in the model. This results in convergence of gas prices given the other assumption that take-or-pay and other liabilities of national gas companies from the past are neglected in this static model. See appendix III for a brief description of the ECN gas model GASTALE.

6. OUTLOOK FOR EU GAS MARKETS

6.1 Impacts of the Gas Directive

As discussed in Chapter 5 we suppose that the Directive can follow two different routes of implementation of the market conditions and thus might result in two 'extreme' impact scenarios. For both FC and SC scenarios we will give a tentative assessment of the possible impacts on the structure of the EU gas industry and gas prices for industry, power and household consumers in the seven mature EU countries. The estimated price impacts are derived from our calculations with the at ECN developed gas market model for the EU[12].

First we start with an overview of possible impacts from the step by step implementation of the EU Gas Directive, thereby ending at full competition (the FC scenario) for the mature gas markets of the seven EU countries in 2010. Second we only briefly discuss the implications of the alternative scenario, namely the case that the Directive leads to a minimal opening up of the gas market, the so-called Semi-open Competition scenario.

The outlook for several important gas market phenomena is not easy to assess in more detail, because of the many factors, relations and behavioural aspects involved. Below we will formulate some tentative expectations, first with respect to the demand side impacts and thereafter for the supply side of the gas industry. Note that these expectations are partly based on our model calculations.

Demand side effects

At the demand side, prices and volumes of natural gas consumption are the important indicators for the effects of liberalisation. In general, our calculations indicate that prices of gas will decline (and consumption will increase) as a result of market opening. In the first stage, when only the gas-fired power generating sector is opened in 2000 (step I), prices in the model decrease 5 to 24 per cent compared with 1995, see Figure 6.1. However, gas-fired power generation in Belgium, Italy and the UK face a counterintuitive small price increase (2.2 to 4.4 per cent per year in period 1995-2000). Apparently, initial prices in these countries already are low compared to the gas prices for gas-fired power generators in the other countries and to costs of the sales.

[12] The gas market model developed at ECN is an extended version of a model developed by R. Golombek, E. Gjeltvik and K.E. Rosendahl (1995 and 1998). For its analysis of structural changes and gas price effects the ECN model incorporated sixteen producers according to the ownership (Gazprom, Sonatrach, GFU, Shell… Lasmo) assuming oligopolistic behaviour (with Cournot competition) between these companies. Furthermore, for the gas demand of the seven mature EU countries in the model three different consumer groups (industries, households etc. and power generation) were distinguished. See appendix III for a brief description of the ECN gas model GASTALE.

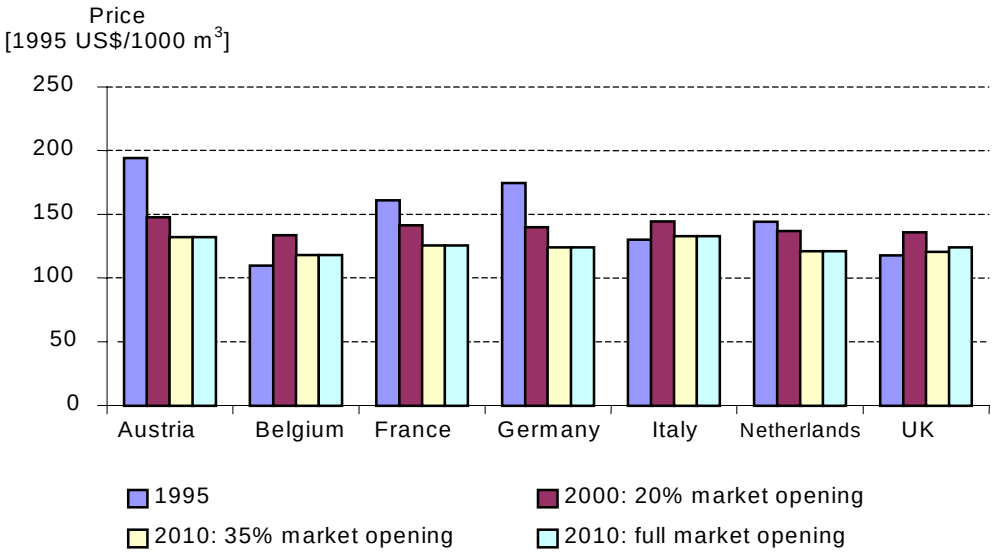

Figure 6.1 *Calculated gas price in the power sector, Full Competition scenario*

When gas markets are further opened in 2010, i.e. all large consumers are free to choose their gas supplier (step II), gas price decreases for the industrial sector range from 0.3 per cent per year in the UK to 2.7 per cent per year in Germany over the period 1995-2010. Price decrease in the UK industry is small because they already benefited from market opening in an earlier stage, see Figure 6.2.

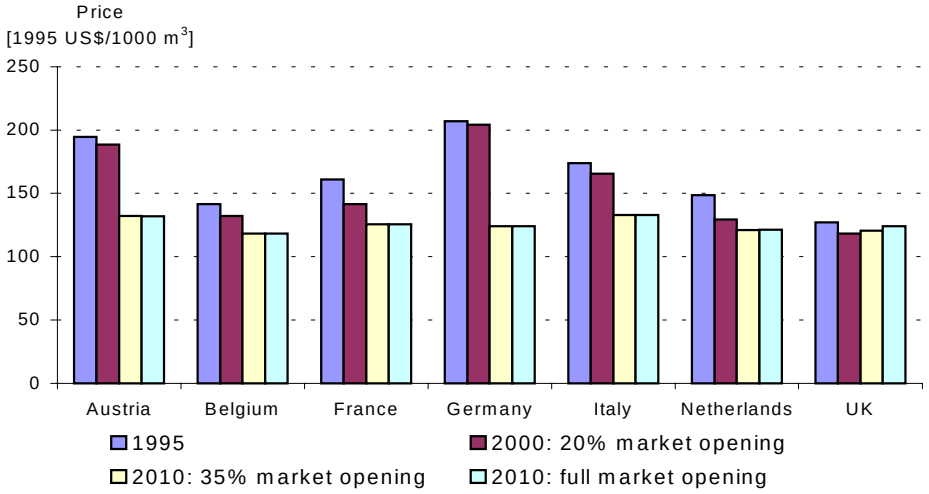

Figure 6.2 *Calculated gas price in industries, Full Competition Scenario*

Alternative calculations with a somewhat faster market opening, assumed for Germany, The Netherlands and the UK, (variants to step I respectively II) show no significant effects on the price changes in the markets that were already opened.

However, if all consumers are assumed eligible in 2010 (step III), calculated gas price declines are largest for the household consumers (2 to 4.8 per cent per year in period 1995-2010, see also Figure 6.3), whereas prices for the gas-fired power generation in Belgium, Italy and the UK increase slightly (see Figure 6.1).

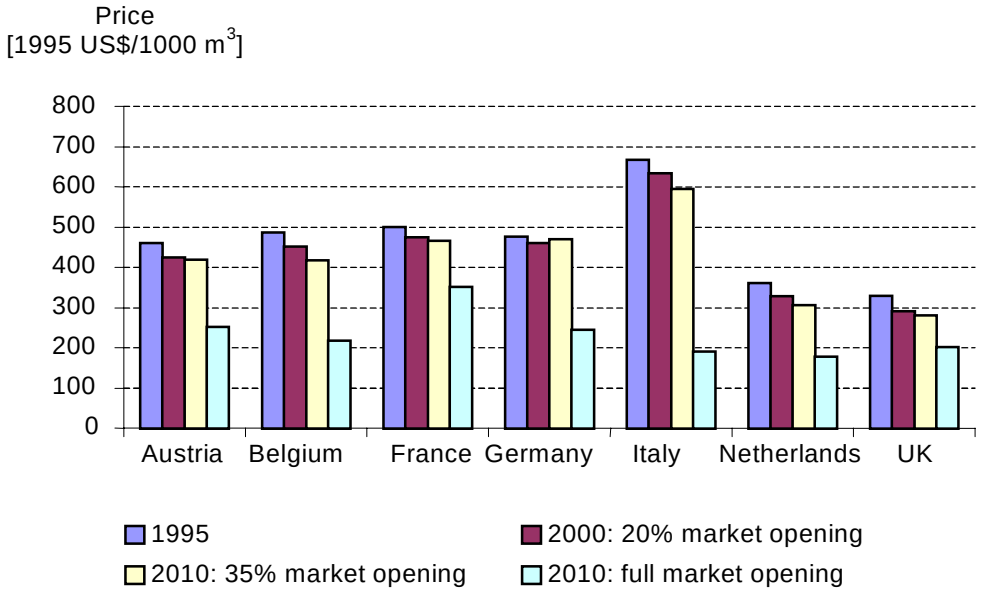

Figure 6.3 *Calculated gas price in 'households' Full Competition scenario*

Once more, it must be emphasized that the calculated price reductions are based on static model calculation, which neglects 'costs of contracts and other liabilities from the past', i.e. take-or-pay commitments, taxes, etc. So the price reductions are purely based on a static analysis and arbitrage etc. in the model and must therefore be considered to be a theoretical attainable decline of prices in absence of the past liabilities. Consequently, if we try to include a crude guess of the costs of the different liabilities we might arrive however at more moderated, but still impressive price reductions, see Table 6.1.

Table 6.1 *Expected[13] gas price reductions in the FC scenario, between 1995-2010 [%]*

Country	Industry	Power sector	Households
Austria	20	20	25
Belgium	8	-	30
France	15	15	20
Germany	30	20	30
Italy	20	-	40
Netherlands	10	10	15
UK	-	-	15

Note: assumed reference prices are real gas prices of 1995, without taxes, etc.

Changes in the structure of the EU gas industry

According to our model analysis the first stages of liberalisation (steps I and II) result in a more diversified gas supply. Only when markets are opened further (step III), supply is re-allocated gradually. As a consequence the diversification of supply decreases as a result of the full market opening. Especially customers in France, Italy, Belgium and Austria end up with a smaller number of regional suppliers. This is caused by the increasing role of the transport cost in the competition for end-use gas markets.

[13] Expected means that the gas price reductions calculated with the gas model are crudely corrected for long term (TOP) contracts and other in 2010 prevailing costs of the companies. Of course this will limit the attainable price reductions under FC conditions.

Furthermore due to more liberalisation there is a shift in market shares. In the first stages of liberalisation (step I and II), overall production and sales to the mature EU countries are slightly reduced. Only when the gas market is fully opened, total production will increase again with respect to the 1995 situation. Striking is the reduction in gas sales from the non-EU producers (Gazprom, Sonatrach and GFU) as a result of liberalisation. However, Algerian gas sales are benefiting from a fully liberalised market, although its main customer will be Italy. According to our assumptions it seems that production and transportation costs are too high for Russian and Norwegian gas supplies to compete with the EU producers to maintain their sales volume[14]. Also, British Gas' production costs, as we assume them (in 1995), are such that they might be pushed away from the gas market if they do not severely cut their costs. By the way, given their present position in the UK market, they apparently succeeded in these cost reductions. However, the Dutch and Italian producers, as well as some of the smaller producers (Total, Amerada, Wintershall and Lasmo) might increase their production and sales if the gas markets become more liberalised.

In the first stages of liberalisation (steps I and II), some producers are diversifying their sales to other countries. However, if markets are fully opened-up, producers tend to specialise (regionalise) into certain (countries) markets in order to reduce their transport costs etc. In fact the contracts based on long distance pipeline transports of gas is becoming a liability to several companies and therefore paper trade, i.e. swaps will increase in the future. For example, Sonatrach concentrates its sales on Italy, while the Norwegian producers, as well as some of the smaller producers, only supply the UK. The Dutch producers are concentrated on their nearest domestic and German markets. However, Agip/ENI, Wintershall, Elf and Total make major shifts to new markets. Consequently, in the future producers will looking for their sales to more closer (in terms of distance) located customers, because transport costs matter more than before.

In brief the EU gas market in 2010 can be characterized as follows:

Full competition scenario

From an achievement of an internal gas market in 2010 we expect the following effects:

a) Substantial lowering of natural gas prices in most of the seven mature EU countries except for the UK, see Figure 6.1, 6.2 and 6.3 below.
b) Convergence of gas prices across countries and between the different consumers due to arbitrage facilitated by spot and future trading.
c) Profit margins of the gas companies will erode.
d) Substantial increase of gas consumption in the bulk of the continental EU countries and particularly in the power sector.
e) Growing number of multi-utilities and convergence of gas and electricity markets.

Semi-open Competition scenario

Given the assumption of a minimalistic implementation of the Directive, of course the key objectives of the European Commission, namely an internal gas market will not be achieved, because Member States focus primarily on protecting their stake in the national gas transmission and trade. Of course assessing the price and volume effects are much more difficult in this scenario than the FC scenario. Briefly and tentatively we expect the following effects:

a) Much smaller reductions of gas prices in the continental mature gas markets of the EU, can be expected than in the FC scenario.
b) Moderate increase in gas consumption in bulk of continental EU countries.
c) Structural changes in the EU gas industry are limited.
d) Unjustifiable price differences between countries and markets continue, particularly for small household consumers (dominance of national vertically integrated companies persists).
e) Profits are constant or expected to increase slightly.
f) Public support for liberalization process will decline, if the benefits expected from liberalisation are disappointing.

6.2 Discussion of the impacts

The major objective of the implementation of the EU Gas Directive is to promote increasing competition in the natural gas market, and to reduce gas prices for all customers and thereby to increase the competitiveness of (energy-intensive) European industries and economies. At the same time, substitution of natural gas for coal and petroleum-based fuels will improve overall energy efficiency and reduce CO_2 and other energy related emissions to the atmosphere. In summary, the key goals of the EU energy policy are increasing competitiveness of the economy, supply security and environmental protection. Both the USA and the UK have provided a prototype of gas market liberalisation. Whether or not the continental European gas market can be further liberalised according to these examples stipulated by the EU Gas Directive is questionable. There are potential losers from this enhancement of competition, mainly in the coal mining industry and the less competitive companies in the deregulated gas and electricity sectors, causing unemployment. A fully liberalised gas market might discourage long-term and risky gas purchasing contracts and therefore provide an increased risk for the investors in huge investments needed for major pipeline projects. The following outcomes might be a challenge to the EU regulators.

- In a future market for natural gas, the balance of power will shift from the monopoly buyers (the EU transmission companies and utilities) to large vertical integrated gas companies (response by companies).
- In a deregulated market the risks of investments will increase, which means a higher cost of capital, lower investments in (capital intensive) infrastructure, and at the end lower gas supplies and thus higher end-user prices and price volatility in the longer run.
- Existing take or pay contracts and other obligations from the past market structure will lead to lower gas prices reductions (20% or 40%) than can be expected in full liberalised markets with fully competitive spot market conditions for price formation.

Note that given the present over-capacity of pipelines from the non-EU suppliers, such as GFU, Gazprom and Sonatrach, to the EU borders, it is unlikely for the next ten years that border prices will increase. On the other hand the gas infrastructure requires huge expenditure outlays, this might lead to an upward pressure on end-user prices in the long run. However, in a deregulated market, sellers and buyers can use all kinds of contractual arrangements to limit their risk. Moreover, experience in already deregulated gas markets indicates that about fifty per cent of natural gas is still traded under medium to long-term contracts, which is also relevant to the last point of higher prices, the ‘stranded cost’ of long term take-or-pay contracts. These costs will certainly become incurred via restructuring of the gas contract portfolio or be written off by gas companies (look for example to British Gas in the UK).

However, full deregulation might imply a change in the nature of the risk and thereby increase the level of risk of investments in large distance high risks new pipeline and interconnector investments which have to be sure of sufficient profitable gas trade compared to current levels. Note that an exception has to be made for emerging markets. In that case both buyers and sellers have no alternative options for their current supplier or buyer. Deregulation in these markets (Greece, Portugal, Ireland?) would certainly lead to an increase in risk and therefore derogation is allowed for these circumstances in the EU Gas Directive.

Finally, for the transition period of implementing the EU Gas Directive we expect more difficulties and disputes than anticipated now. Particularly on the negative impacts of liberalisation for the temporarily captive customer can lead to court actions.

In order to harvest the similar benefits of lower gas prices for all consumers, the EU must therefore secure the following:

- Protection of the non-eligible and captive customer against unjustified higher gas prices compared with the larger consumers which have a stronger bargaining power, and earlier access (during the period of the opening-up process) to more competitive gas suppliers. The emergence of unjustifiably large tariff differentials between large consumers with and small consumers without sufficient negotiating power and access to new competitive suppliers in the transition period. Because that will hamper the public support for further deregulation of the EU gas markets.
- Securing similar operational security and safety of supplies to all domestic consumers of gas particularly which is distributed and supplied by 'new suppliers from outside the EU'.
- Design and implementation of governmental market based policies and instruments to attain the environmental objectives of EU and the individual Member States in a progressively deregulated gas market.

In our opinion the effective solution of these challenges, particularly in the 'transition period' of implementing the EU Gas Directives asks for effective timely monitoring and particularly regulation by an independently operating 'regulatory office' in the Member States and on EU level to secure a fair outcome of the liberalisation process to all customers. For attaining the governmental and EU environmental policy targets, market based instruments should be timely put in place.

6.3 Summary of final conclusions

The qualitative and quantitative analyses lead us to the following conclusions:

- One of the crucial issues for a successful liberalisation of the natural gas market is, if and in what way, the EU Gas Directive will change the rules of price formation. At least for two cases there is little reason to expect that the way in which prices on the natural gas market are formed will change, namely for emerging markets (all EU countries except Austria, Belgium, France, Germany, Italy, Netherlands, UK) and non-eligible customers.
- In accordance with the results of our model analysis and other observations we expect that in general, end-use prices of gas will decline and consumption volumes will increase as a result of market deregulation according to the EU Gas Directive. Furthermore the gas end-user prices for households, which in several EU countries in the past have been fixed at a too high level relative to prices for industries and gas-fired power stations, will lower substantially in the long run (after completion of the implementation of the EU Gas Directive). In a then (we assume) fully liberalised market with gas-to-gas competition in the seven EU Member States, we can expect that large price differences are absorbed by gas traders exploiting all arbitrage possibilities. As a result, the decline in industrial end-user prices of gas in mature countries is relatively less than expected, mainly because all kinds of specific cross-subsidies will be abolished as well. However, if these gas-to-gas competition conditions are not met, which is also possible, small consumers will probably benefit to a much smaller extent from the EU liberalisation as results from our analysis.
- However, note that during the 'transition or implementation period' towards full liberalisation in the next decade only large gas consumers can and will fully benefit from the opening up of EU gas markets and the assumed competition between large gas suppliers. This might lead to the establishment of unfavourable conditions for the then captive (smaller) gas consumers, which is a situation that cannot become easily reversed later on, without a strong regulation authority in place.
- In order to realise full competition in the EU gas market it is necessary that all countries comply with the EU Gas Directive and introduce regulated TPA for the entire network and realise effective unbundling of accounts of integrated gas companies engaged in both trade, production and transport of gas.

- Furthermore, to facilitate the emergence of gas-to-gas competition in the so-called mature gas markets of the EU, it is also necessary that spot trading emerges, which needs to be facilitated by a number of well located and optimally operating (thus including storage facilities) hubs in the EU, see for example the interconnector at Zeebrugge and experiences in the USA.
- For consumer services in mature gas market countries, facing more competition in their downstream markets, one can expect that 'product differentiation' will increase. The exact form of this differentiation is still an open question. However, recent mergers of utilities indicate a trend towards the emergence of so-called multi-utilities, which are supplying a package consisting of electricity, gas, water and cable services to the consumers.
- With respect to interruptible contracts, it is expected that the share of this type of gas contracts, which today is relatively high in the UK (was already high before the liberalisation) will also increase in the Continental gas markets. Unless, however the traditional and very reliable gas delivery of gas distribution companies to their customers will deteriorate. Then interruptible contracts will increase substantially as well.
- Trade via the pipeline network for transmission will relatively decline and be substituted by swap deals and other 'paper trade', thereby reducing the transmission costs for consumers. This is because these and other auxiliary (storage, quality, etc.) costs are becoming relatively more important in a full competitive market.
- Consequently EU producers/suppliers such as Shell, Exxon, Agip/ENI, Wintershall etc., which are closer to their markets than most of the non-EU producers, are the winners in the next decade of attaining full competition. Their production and sales will relatively increase compared with the non-EU suppliers. The gas market will show regularisation tendencies.
- It is expected that within the next years the current gas oversupply situation will aggravate, because more (pipeline) capacity from Norway and North Africa will become operational in the next years. However, after about 10 to 15 years, more expensive so-called non-EU 'long distance' gas supplies might be necessary to meet the growing EU gas demand, which might lead to small price rises at the EU border and perhaps also to small increases of end-user prices
- The relative market positions of Russia and Norway will only gradually change in the long run, in favour of lowest cost and most reliable producer of these two. Particularly in the EU, Russia's Gazprom will try to expand its market share at the expense of Statoil, if the political situation in Eastern Europe does not change dramatically, and given their strong needs for hard currency export revenues. However, changing alliances and development of 'new collusions' between non-EU producers and EU transmission companies (vertical integration to reach profitable consumer markets) might change this perspective substantially.
- In fact, in general it is expected that a more vertical integration of former pure production with pure transmission companies for realising selling of gas directly to large consumers will take place in the next decade in the EU gas market. For example, the establishment of alliances between several producers (e.g. Gasunie and Gazprom) might be a first step towards the establishment of joint stock companies for combining trade with customers and production. UK and Dutch companies might be interested to make deals with Gazprom, because of a certain degree of complementarity of interest, capabilities, and market strategies. Moreover, horizontal integration (e.g. establishment of multi-utilities) can also be expected to develop in order to maintain present profits levels in an increasing competitive gas market environment.
- With respect to the differences in gas quality we observe that British H-gas is now flowing into ammonia/fertiliser plant of Hydro Agri Sluiskil in The Netherlands without any problems. In fact, if qualities are not compatible, a demand for extra services, e.g. blending of different qualities can be created rather easily and i.e. fulfilled by transmission companies.

6.4 Recommendations

Clearly the progressive implementation of the Directive in the EU Member States can develop in quite different ways with respect to the legislation and institutional setting of the EU gas market in the next decade. This is particularly the case if we assume that company and government responses and the dynamics of the liberalisation process are insufficient to bring about conditions necessary for the emergence of full competition in the next ten years. This development might seriously hamper the achievement of EU objectives, namely the accomplishment of an internal market for gas.

Let us therefore briefly summarize the most important barriers for the development of an integrated full competitive EU gas market. Most important barriers are:

- Lack the emergence of a transparent and non-discriminatory access to the network, storage, distribution and other auxiliary facilities.
- Ineffective unbundling of accounts and/or separation of different functions such as transmission, trade, distribution, storage. So far several countries choose a weak form of negotiated TPA.
- Ineffective regulatory agencies, particularly with respect to settle effectively disputes (i.e. on the abuse of transmission monopolies) and requests for derogations.
- Insufficient capacity and quality of the gas market infrastructure to bring about effective trade (spot and future trading), particularly because so far an insufficient number of well located hubs/interconnectors is available across the EU.

Consequently we can conclude that in order to bring about a fully liberalized gas market in the EU and thereby harvest all the expected benefits, in particular a more efficient gas industry and particularly secure a fair lowering of gas prices, the Commission and the Member States have to secure the following conditions:

- Harmonisation of the implementation of the Gas Directive, beyond the bottom-line requirements in all EU memberstates.
- Effective and thus legal unbundling of accounts and separation of management of the different functions of the gas market such as trade and network transmission, storage, etc. Otherwise large vertical integrated and/or national gas companies will continue to dominate the gas pricing, trade etc. in the EU.
- Secure effective and non-discriminatory access to entire network and particularly its auxiliary functions by realizing regulated TPA for the entire network.
- Secure non-discriminatory access pricing, i.e. enforcing publication of tariffs and commercial conditions in advance.
- Establish strong empowered regulation authorities on EU and member state level, which have to coordinate their pro-active regulatory work effectively.
- Minimize derogations for mature markets, particularly for Take-or-pay contracts, public services, obligations and capacity reasons.
- Support and promote the development of (investments in) a well-allocated network of hubs/interconnectors with sufficient matching storage capacity in order to promote the development of spot trading of gas across Europe.

Clearly the developments in the transition period of the EU gas markets are of great importance to all actors involved. Therefore a close monitoring of the implementation of the EU Gas Directive and timely actions, including additional legislation (i.e. for access to storage) is urgently recommended for policy makers at both EU and Member State level.

APPENDIX A EU GAS DIRECTIVE - A BRIEF OVERVIEW

The single most important aspect in nowadays gas market policies in EU is the liberalisation of the gas markets. During the discussions for the preparation of the EU Gas Directive (Directive 98/30/EC), which was adopted by the European Parliament and the Council in June 1998, individual countries already begAn to take steps towards liberalisation of their national gas markets and are expected to do so in the next years. The main provisions of the directive are as follows.

Scope
The Directive establishes common rules for the transmission, distribution, supply and storage of natural gas. It lays down the rules relating to the organisation and functioning of the natural gas sector, including liquefied natural gas, access to the market, the operation of systems, and the criteria and procedures applicable to the granting of authorisations for transmission, distribution, supply and storage of natural gas.

General rules for the organisation of the sector's public service obligations
Member States must ensure that natural gas undertakings are operated in accordance with the principles of the Directive, with a view to achieving a competitive market in natural gas. They must not discriminate between these undertakings as regards either rights or obligations.

The two approaches to system access laid down in the Directive must lead to equivalent economic results in the Member States and hence to a directly comparable level of opening up of markets and to a directly comparable degree of access to natural gas markets.

Member States may impose on undertakings operating in the natural gas sector, in the general economic interest, public service obligations which may relate to security, including security of supply, regularity, quality and price of supplies and to environmental protection. These obligations must be clearly defined, transparent, non-discriminatory and verifiable.

Member States may refrain from applying certain provisions of the Directive with regard to distribution insofar as these provisions would obstruct natural gas utilities in the fulfilment of the obligations imposed on them in the general economic interest. However, non-application of these provisions must not affect the development of trade between Member States to a degree that would be contrary to the Community's interest.

Opening-up of the market
Member States will specify eligible customers, meaning those customers inside their territory, which have the legal capacity to contract for natural gas.

Member States will take the necessary measures to ensure that at least the following customers are designated as eligible customers:

- Gas-fired power generators, irrespective of their annual consumption level; however, in order to safeguard the balance of their electricity market, the Member States may introduce a threshold, which may not exceed the level envisaged for other final customers, for the eligibility of combined heat and power producers. Such thresholds will be notified to the Commission.
- Other final customers consuming more than 25 million cubic metres of gas per year on a consumption site basis.

Member States will ensure that the definition of eligible customers will result in an opening of the market equal to at least 20 per cent of the total annual gas consumption of the national gas market. The percentage will increase to 28 percent of the total annual gas consumption of the

national gas market five years after the entry into force of the Directive, and to 33 per cent of the total annual gas consumption of the national gas market ten years after its entry into force. The threshold for eligible customers, other than gas-fired power generators, will be reduced to 15 million cubic metres per year on a consumption site basis five years after the entry into force of the Directive, and to 5 million cubic metres per year on a consumption site basis ten years after the entry into force of the Directive.

Organisation of access to the system

For the organisation of access to the system Member States may choose between two procedures (negotiated access or regulated access) which must operate in accordance with objective, transparent and non-discriminatory criteria.

- In the case of negotiated access, Member States must take the necessary measures to enable natural gas undertakings and eligible customers either inside or outside the territory covered by the interconnected system to negotiate access to the system so as to conclude supply contRacts with each other on the basis of voluntary commercial agreements. The contracts for access to the system must be negotiated with the relevant natural gas undertakings. Member States will require natural gas undertakings to publish their terms for use of the system within the first year following implementation of the Directive and on an annual basis every year thereafter.
- Member States opting for a procedure of regulated access, will take the necessary measures to give natural gas undertakings and eligible customers either inside or outside the territory covered by the interconnected system a right of access to the system, on the basis of published tariffs and/or other terms and obligations for use of that system. This right of access for eligible customers may be given by enabling them to enter into supply contracts with competing natural gas undertakings other than the owner and/or operator of the system or a related undertaking.

Unbundling

The accounts of all integrated undertakings in the sector must be as transparent as possible in particular in order to detect any abuse of a dominant position such as abnormally low or high tariffs or discriminatory practices for equivalent services. To this end, separate accounts must be kept for their natural gas transmission, distribution and storage activities, and, where appropriate, consolidated accounts for non-gas activities, as they would be required to do if the activities in question were carried out by separate undertakings. These internal accounts will include a balance sheet and a profit and loss account for each activity.

Derogations

- Take-or-pay contracts:
  If a natural gas undertaking encounters or considers it would encounter serious economic and financial difficulties because of its take-or-pay commitments accepted in one or more gas purchase contracts, an application for a temporary derogation from the requirement to grant access to the system may be sent to the Member State concerned or the designated competent authority. Where a natural gas undertaking has refused access, the application will be submitted without delay. The applications will be accompanied by all relevant information on the nature and extent of the problem and on the efforts undertaken by the gas undertaking to solve the problem.

The Member State or the designated competent authority may decide to grant a derogation and must notify the Commission of its decision without delay. The Commission may request that the Member State or the designated competent authority concerned amend or withdraw that decision.

When deciding on derogations, the Member State, or the designated competent authority, and the Commission will take into account, in particular, the following criteria:

a) The objective to achieve a competitive gas market.
b) The need to fulfil public service obligations and to ensure security of supply.
c) The position of the natural gas undertaking in the gas market and the actual state of competition in this market.
d) The seriousness of the economic and financial difficulties encountered by natural gas and transmission undertakings or eligible customers.
e) The dates of signature and terms of the contract or contracts in question, including the extent to which they allow for market changes.
f) The efforts made to find a solution to the problem.
g) The extent to which, when accepting the take-or-pay commitments in question, the undertaking could reasonably have foreseen, having regard to the provisions of the Directive, that serious difficulties were likely to arise.
h) The level of connection of the system with other systems and the degree of interoperability of these systems.
i) The effects the granting of a derogation would have on the correct application of the Directive as regards the proper functioning of the natural gas market.

Serious difficulties will in any case be deemed not to exist when the sales of natural gas do not fall below the level of minimum off-take guarantees contained in gas purchase take-or-pay contracts or insofar as the relevant gas purchase take-or-pay contract can be adapted or the natural gas undertaking is able to find alternative outlets.

A decision on a request for a derogation concerning take-or-pay contracts concluded before the entry into force of the Directive should not lead to a situation in which it is impossible to find economically viable alternative outlets.

- *Only one external supplier*
  Member States not directly connected to the interconnected system of any other Member State and having only one main external supplier may derogate from the Directive. A supplier having a market share of more than 75 per cent will be considered to be a main supplier. This derogation will automatically expire from the moment at least one of these conditions no longer applies. Any such derogation must be notified to the Commission.
- *Emergent markets and geographical areas*
  A Member State qualifying as an emergent market (Greece and Portugal) which, because of the implementation of the Directive, would experience substantial problems not associated with the contractual take-or-pay commitments may derogate from certain provisions of the Directive.

Where implementation of the Directive would cause substantial problems in a geographically limited area of a Member State and with a view to encouraging investments, the Member State may apply to the Commission for a temporary derogation for developments within this area.

The Commission may grant the derogation, taking account of certain criteria defined in the Directive. The derogation may be granted only if no gas infrastructure has been established in this area, or has been established for less than 10 years. The temporary derogation may not exceed ten years after the first supply of gas in the area.

The derogation may also be granted in case of capacity constraints of network - and with respect to take-or-pay issues. The Member States are obliged to establish a dispute settlement entity in their country, to which one can turn for appeal on these derogations.

APPENDIX B EU MEMBER STATES GAS MARKET IN BRIEF

Please note that this brief review was finished mid 1998.

B.1 Emerging markets

Greece

The Greek gas market is still very immature, with gas accounting for only 1 per cent of primary energy requirements in 1997. Rapid growth is expected, however, since a pipeline from Russia started operating end 1996. Currently the reserves are estimated at 8 bcm. Greece's energy policy aims to increase the share of natural gas in Total Primary Energy Requirements (TPER) to 7 per cent, as gas represents an important new source of energy supply diversity for Greece. Gas will be used mainly in electricity generation. The residential gas market still has to be established. Currently the reserves are estimated at 8 bcm. Greece will be totally dependent on Russian imports and on Algerian LNG for peak shaving purposes. The market is dominated by DEPA, which has a *legal* monopoly on imports and a *de facto* monopoly on transmission and supply.

Portugal

In Portugal, natural gas has only been introduced in 1997, when the Europe-Maghreb pipeline was opened. The first gas fired power station started operating in 1998. Portugal is completely dependent on imports from Algeria. The initial volume of 0.4 bcm is expected to grow to 2.5 bcm from 2005 on, or 9.6 per cent of TPER. Residential gas consumption is not foreseen, given the mild climate and low population density, which makes the infrastructure not viable. The main entity in the Portuguese market for natural gas is the company Transgas, which has a legal monopoly on both imports and transmission.

Sweden

Although natural gas was introduced in 1985 in Sweden, it still plays a minor role, accounting for 1.4 per cent of total primary energy requirements in 1997. Rapid growth is not expected, but future developments greatly depend on two factors:

- Consequences of a 1980 referendum to phase out all nuclear power plants by 2010. As nuclear power accounts for half of Sweden's electricity supply, the uncertainty about the consequences of this referendum has hampered the further development of the gas market. The government has recently given priority to renewables to fill the gap left by nuclear power.
- The feasibility of the Nordic Gas Grid, which is currently under study, will determine the possibility of diversification of suppliers. Currently all natural gas is imported from Denmark. The Nordic Gas Grid is supposed to link the grid of Sweden to the grids of both Norway and Finland, which will also give an impetus to domestic infrastructure development.

The natural gas industry is in an early development stage, and is dominated by the transmission company Vattenfall Naturgas, which has a *de facto* monopoly on imports, and owns and operates all main transmission facilities.

Table B.1 *Summary of key indicators EU countries for the year 1996*

	GDP per capita [US$-90]	Share of gas in total primary energy requirements (1997) [%]	Share of gas input in electricity/ heat generation [%]	Import dependency for gas[c] [%]	Gas consumption per capita [m^3]	Growth domestic consumption (1995-1996) [%]	R/P ratio[a] [years]
Austria	22,171	24	32	82	989	7	14.7
Belgium	20,787	20	12	100	1,373	11	-
Denmark	27,814	18	12	-46	790	17	17.0
Finland	26,465	9	11	100	713	5	-
France	21,860	13	1	91	648	12	6.5
Germany	22,044	21	10	83	1,232	8	14.6
Greece	8,788	1	0	21	4	6	210.5
Ireland	18,177	22	33	17	892	11	4.1
Italy	20,266	30	21	66	978	3	14.8
Luxembourg	33,095	21	31	100	1,655	9	-
Netherlands	20,947	48	52	-81	3,419	9	19.0
Portugal[b]	7,495	0	n.a.	n.a.	n.a.	n.a.	-
Spain	13,774	11	3	96	241	9	36.5
Sweden	26,764	1	1	101	102	14	-
United Kingdom	18,112	34	20	0	1,463	21	7.8

[a] Only for countries with gas reserves.
[b] As the Portuguese gas market has only started in 1997, most figures are not applicable for 1996.
[c] Negative number: domestic production exceeds domestic use.

Finland

In Finland, natural gas does not play a major role. Gas accounted for 9.4 per cent of TPER in 1997, and limited growth is expected up to 13.5 per cent in 2005. Demand is met completely by imports from the former Soviet Union, although the Nordic Gas Grid might change this situation in the future. The Finnish gas network is limited to a small part of the country, and therefore there is hardly any residential consumption. The Finnish gas industry is dominated by Gasum Oy, a joint venture of Neste Oy and Gazprom. Gasum Oy has a *de facto* monopoly on imports and transmission.

B.2 Emerging markets; maturity expected within 5-10 years

Spain

Spain has one of the fastest growing gas markets in Europe. The share in TPER of 10.5 per cent in 1997 is expected to rise to 12-14 per cent by the year 2000, and government policy intends to increase this share up to 25 per cent in 2006. This should be attained by growth in all sectors, but especially in power generation. Spain is almost entirely dependent on imports for the supply of natural gas, with the majority coming from Algeria. With the Maghreb-Europe line completed the dependency is expected to increase in the near future. As demand increases and import dependency is large, security of supply is a key issue in Spain, and is being improved through the construction and upgrading of pipelines, storage facilities and LNG terminals. The Spanish gas market is dominated by the Gas Natural group, which has extensive interests in the transmission and distribution of natural gas, and has a *de facto* monopoly on imports.

The Spanish government is in favour of liberalisation, but in practice developments are not fast. Since end 1996, there is a legal provision for nTPA, but only for a limited group of large consumers. In practice there is no unbundling of gas prices in Spain.

Denmark

Denmark has a fast growing gas market. Started in 1985, it is maturing rapidly. Natural gas accounted for 18 per cent of TPER in 1997, and is expected to grow to 24.5 per cent in 2000 and 29.8 per cent in 2005. Growth will be particularly strong among small-scale CHP plants and industry. Denmark is a net exporter of energy, exporting gas to Germany and Sweden. This will change in the next years as domestic consumption is expected to grow further and indigenous production is expected to fall after 2005. Imports from Norway are under negotiation. Denmark intends to build a position as a transit country for future Norwegian supplies to Sweden, and, in the long run, possibly Russian supplies to Western Europe. The Danish transmission of natural gas is handled by Dangas, which purchases all domestic production. The company has a *de facto* monopoly on both imports and exports. There exist no unbundled gas prices and no TPA in Denmark. Since 1996, the Danish government has introduced several environmental taxes on fossil fuels, thereby shifting from the traditional emphasis on direct regulation and planning towards a more market based approach.

Ireland

Although the Irish gas market is less than 20 years old, natural gas plays an important role, accounting for 22 per cent of primary energy demand in 1996, and expected to increase to over 25 per cent after 2000. Therefore the market can be regarded as close to maturity. As the domestic reserves are declining, import dependency will increase in the next few years. At the moment all imports are coming from the United Kingdom, but this will change after UK-Continent Interconnector opens. Demand mainly comes from the transformation sector. Currently, the gas network is limited to the south and east of the country, but extensions are under consideration. The gas market is dominated by the state-owned company Bord Gáis Éireann (BGE), which owns and operates all transmission and distribution networks, including the UK-Ireland Interconnector. BGE has no legal monopoly on transmission, and since 1995 TPA is legally granted for 75 per cent of the customers, but not used in practice. No unbundled tariffs exist in Ireland.

B.3 Mature markets

Austria

Natural gas plays a major role in Austria, accounting for almost 24 per cent of primary energy requirements in 1997. Domestic demand is expected to grow only slowly. Demand was met for 78 per cent by imports from Germany, Norway, and in particular Russia. Austria intends to increase its role as transit hub for Russian gas in Western Europe, and continues to expand its transit capacity. The gas market in Austria is dominated by ÖMV, which has a (full or near) *de facto* monopoly in transmission, storage and imports of natural gas. Its main, but small, competitor is RAG. There are no unbundled gas tariffs, except for transit gas. There is no legal provision for TPA.

Belgium

Belgium plays an increasingly important role as a transit country for natural gas. Within the country, natural gas accounts for over 20 per cent of TPER in 1997. This share is expected to grow only slowly, to 22.5 per cent in 2000. Belgium relies completely on imports, from The Netherlands, Norway, and Algeria (LNG). Imports from the UK will probably start after 1998, when the Interconnector pipeline is operating. There are plans for expanding the transmission network to carry UK gas delivered at Zeebrugge, and to link the grid to a delivery point on the German border. This will allow shipment of Russian gas. The gas market is dominated by (recently privatised) Distrigaz, which holds a *de facto* monopoly on imports and exclusive rights to transportation and storage. There are no unbundled gas prices in Belgium except for transit gas. Access to the market is limited, with Distrigaz having a monopoly on transmission and sales. However, this is likely to come under pressure now that the Interconnector is opened and low cost UK gas flows through Belgium.

France

The French gas market is mature in age, but the share of natural gas in primary energy requirements is small compared to other mature gas markets, only 13 per cent in 1997. Growth is not expected, due to the dominance of nuclear power, which causes the negligible share of gas in electricity generation. The majority of gas supplies is imported, mainly from The Netherlands, Norway, Russia and Algerian LNG. The natural gas market in France is dominated by the state owned Gaz de France, which has a legal monopoly on imports, exports and controls the major transmission pipelines. Unbundled prices for gas services do not exist, and there is no TPA for end-users. Changes to French legislation are likely to be driven by the EU Gas Directive, and might turn the *de jure* monopoly of GdF into a *de facto* monopoly with Elf.

Germany

The German gas market is the largest in volume in Europe and the share of natural gas in TPER was 21 per cent in 1997. A further increase in demand is expected. 86 per cent of the consumption is imported from several countries, among which the largest suppliers are The Netherlands, Russia and Norway. After the opening of the Interconnector, supplies from the UK will rise considerably. The market structure is complex, with a plurality of actors, extensive cross-ownership and a low level of government involvement. Since the emergence of Wintershall, gas-to-gas competition has been introduced to the German market. There are no unbundled gas tariffs, except for transit gas. Early 1998 a new energy law has come into effect, abolishing demarcation agreements between suppliers and introducing nTPA.

Italy

Italy is the third largest natural gas consumer in Europe, and demand has been increasing steadily in recent years. In 1997, gas had a share of 29.6 per cent in TPER, which is expected to grow to 33 per cent in the year 2000. Growth will be driven by the power sector, as the government aims to decrease the share of oil in thermal power generation. Approximately 67 per cent of domestic consumption is imported from Algeria, Russia and The Netherlands. Further diversification of suppliers, i.e. Norway, UK and Libya is sought. Italy is investing heavily in new infrastructure to meet the increased demand for gas. The Italian gas market is dominated by the state-owned ENI group, which is currently being privatised. One of its subsidiaries, SNAM, has a *de facto* monopoly on imports and transmission. TPA has to be granted to domestic producers and the electricity company ENEL. Gas prices have to be published and are supervised by a regulator.

Luxembourg

Although the gas market in Luxembourg is small in volume, natural gas is an important energy carrier in this country, accounting for over 20 per cent of primary energy requirements in 1997. This share is expected to grow in the next years, up to 28 per cent in 2000, driven by the power sector and the residential sector as a result of expansion of the grid. Luxembourg relies completely on imports from Norway through Belgium and France. The market in Luxembourg is dominated by the transmission company Soteg, which has a de facto monopoly on both imports and transmission of natural gas. There are no unbundled prices in Luxembourg, and access to the market is limited.

The Netherlands

The Netherlands probably has the most mature gas market in the world. Natural gas accounted for about 50 per cent of primary energy requirements in 1997, significantly more than in any other European country. The gas consumption per capita is twice that of the second largest country (Luxembourg). In 1997, about 50 per cent of domestic production was exported to Germany, Belgium, France, Italy and Switzerland. Some natural gas was imported from Norway and the United Kingdom. In the future imports will also come from Russia.

The market is dominated by NAM, a Shell/Exxon subsidary company (production) and Gasunie (transmission), which has a *de facto* monopoly on transportation of natural gas. Liberalisation of the gas market will be introduced gradually, in a time frame of (probably) 1998-2007 and including nTPA and administrative unbundling of transportation, storage and production.

United Kingdom

In the United Kingdom, natural gas has replaced oil as the main primary fuel. In 1997 it accounted for over 34 per cent of primary energy requirements, and is expected to grow further to over 36 per cent in 2000. Domestic demand is almost completely met by indigenous production, a small amount of gas was imported from Norway. Exports went to Ireland and to The Netherlands. The export volume is expected to increase considerably now that the Interconnector to Belgium is in operation. The natural gas market in the United Kingdom is the most liberalised gas market in the European Union. The regulatory system is mainly based on licences. Transportation, distribution, storage, exploration, production and international downstream business are all controlled by British Gas. The transmission and distribution of natural gas is a *de facto* monopoly for Transco, a subsidiary of British Gas plc. Gas prices are unbundled, and there is TPA for onshore transmission, storage and distribution of natural gas.

Table B.2 *Natural gas shares of the three main energy consuming sectors in domestic gas consumption in the EU countries, 1996 [%]*

	Transformation	Industry	Residential/Commercial
Austria	37	25	30
Belgium	19	36	44
Denmark	40	19	28
Finland	58	39	1
France	2	40	54
Germany	19	31	43
Greece	33	14	0
Ireland	53	27	19
Italy	22	34	42
Luxembourg	7	57	35
The Netherlands	26	23	53
Portugal	0	0	0
Spain	11	68	17
Sweden	41	42	7
United Kingdom	20	20	46

APPENDIX C ECN GAS MARKET MODEL 'GASTALE'

This appendix contains a brief description of the model developed by ECN for analysing the liberalisation of the EU gas market for the 'Shared Analysis' project.

C.1 Introduction

The ECN model builds on earlier modelling work in this field. In a thorough review article, Smeers (1997) discussed the potentials of combining Industrial Economics and computation of economic equilibrium in order to analyse the restructuring of European electricity and gas markets. In the context of the European gas market, mainly imperfect competition Cournot paradigms have been applied. Mathiesen, Roland and Thonstad (1987) concluded that the gas market is best described by the Cournot equilibrium (as compared with perfect competition and collusion between producers). Competition can be expected to take place through quantities, since long-term take-or-pay contracts still prevail in the natural gas market. Effects of liberalisation were analysed by Golombek, Gjelsvik and Rosendahl (1995 and 1998). In their 1995 article, they focused on the effects of price discrimination and arbitrage possibilities. Gas traders will exploit arbitrage possibilities; therefore, the development of market power is prevented. Using the same model, the 1998 article studied the optimal organisational structure of gas production.

The ECN model 'GASTALE' (Gas mArket System for Trade Analysis of Liberalisation in Europe) describes the European gas market in terms of the production companies that are active on the supply side and the consumers that are active on the demand side of the market. Transmission and distribution companies are not explicitly modelled. The market structure is assumed to be an oligopoly of gas companies that maximise profits. In equilibrium, total gas demand equals total supply. The equilibrium is driven by the cost structures of the companies and the demand elasticities of the consumers.

Below we provide a brief overview of the theoretical economic model describing producer behaviour in the European market for natural gas. Next, the empirical assumptions regarding consumer demand, production costs and costs of transport, distribution and load balancing as specified in the model are described.

C.2 Theoretical model of producer behaviour

Assume that the supply side of the gas market is formed by an oligopoly. Assume also that producers choose their quantities simultaneously (one-stage game). Each producer maximises its profit given the quantities chosen by the other firms. Quantity competition in an oligopoly is represented by a Cournot equilibrium. A Cournot equilibrium with a large number of firms is approximately competitive, i.e. the market price tends to the marginal costs (Tirole, 1988, p.220).

A distinction is made between i=1,..,I Cournot producers and a group of other producers for which production is exogenous (total exogenous production is denoted by *exog*). The end-user markets are distinguished by country, denoted by n=1,..,N, and by market segments, denoted by g=1,..,G. The objective function of a profit maximising Cournot producer i is given by:

$$\pi_i = \max_{q_{ing}} \sum_n \sum_g p_{ng} \cdot q_{ing} - c_i(q_i) - \sum_n \sum_g t_{ing} \cdot q_{ing}$$

Where, p_{ng} is the price of natural gas in consumer market *ng* and q_{ing} is gas delivered in market *ng* by producer *i*. The price is determined as a function of consumed quantities, i.e. the inverse demand function $p_{ng} = D_{ng}^{-1}(x_{ng})$. It is assumed that the inverse demand is decreasing and concave in x_{ng}, that is, $p'_{ng} < 0$ and $p''_{ng} \leq 0$. Costs of producing quantity q_i are denoted by $c_i(q_i)$. It is assumed that the cost function is increasing and convex in q_i, that is, $c'_i > 0$ and $c''_i \geq 0$. Other costs, such as for transmission, distribution and storage of gas are denoted by t_{ing} per unit of gas deliveries q_{ing}. Note, that differences between the total quantity produced and consumed (for example, losses of gas during transmission) are ignored because $x_{ng} = exog_{ng} + \sum_i q_{ing}$.

When choosing its output, firm *i* takes into account the adverse effect of the market price change on its own output, rather than the effect on aggregate output. Therefore, the optimal response to increased production from other producers (q_{-ing}) is to reduce your own production (q_{ing}), because increased production from the competitors drives down the market price (p_{ng}) and hence lowers marginal revenue (Tirole, 1988, p.219). Since marginal revenues should equal marginal costs, marginal costs should also decrease. Given that $c'_i > 0$, production decreases.

Solving the first order condition for q_{ing} result in:

$$q_{ing} = -[p_{ng} - (c'_i + t_{ing})] \cdot D'_{ng}(p_{ng})$$

The Cournot equilibrium implies that marginal costs are not equalised, as would be the case in a perfectly competitive market (except in the symmetric case). Too little is produced and the industry's cost of production is not minimised.

The second order conditions for maximum profits are:

$$\begin{aligned} \frac{\partial^2 \pi_i}{\partial q_{ing} \partial q_{jng}} &= p'_{ng} + p''_{ng} \cdot q_{ing} && \forall i \neq j \\ &= 2p'_{ng} + p''_{ng} \cdot q_{ing} - c''_i && \forall i = j \end{aligned}$$

Since $p'_{ng} < 0$, for the profit function to be concave ($\pi''_i < 0$), it suffices that the firm's cost function be convex ($c''_i \geq 0$) and that the inverse demand function be concave ($p''_{ng} \leq 0$).

The latter assumption suffices for quantities to be strategic substitutes ($\pi''_i < 0$). For example, for linear demand ($p''_{ng} = 0$) and constant returns to scale ($c''_i = 0$) the assumptions are met.

C.3 Empirical assumptions

Demand

Total consumption of natural gas in the European Union was around 346 bcm in 1995 (IEA, 1997). However, the majority (92%) of total EU consumption is located in just six countries (Belgium, France, Germany, Italy, The Netherlands and the UK). In this study we focus on countries that are classified as mature gas markets. The classification is based on the importance of natural gas in total primary energy requirements and the number of years that have elapsed since the introduction of natural gas (Aalbers and Uyterlinde, 1998). As a result, the following countries have been classified as mature: *n*={Austria, Belgium, France, Germany, Italy, Netherlands, UK}. As a small country, Luxembourg is not included in our analysis, although it classifies as a mature market. Spain, Denmark and Ireland are rapidly emerging gas markets and maturity is expected within five or ten years. Gas markets in Greece, Portugal, Sweden and Finland are still immature.

Within a country, natural gas is consumed in three main sectors: *g*={households, industries, power generation}. The share of each sector in domestic consumption differs substantially between countries. For example, due to the dominance of nuclear power in France, gas is hardly used in power generation. Based on the seven countries and three market segments, 21 separate gas markets within the EU-15 are distinguished in this study.

Following Golombek, Gjelsvik and Rosendahl (1995), we assume a linear demand curve. The empirical specification of the linear inverse demand function is given by:

$$p_{ng} = \alpha_{ng} + \beta_{ng} \cdot x_{ng}$$

where α_{ng} and β_{ng} are the parameters to be calibrated at given prices, consumption and elasticities for the base year (1995). This procedure ensures that all demand functions go through the actual market points in the base year (Mathiesen, Roland and Thonstad, 1987). The price elasticity of demand is defined as:

$$\varepsilon_{ng} = \frac{\partial x_{ng}}{\partial p_{ng}} \cdot \frac{p_{ng}}{x_{ng}} = \beta_{ng}^{-1} \cdot \frac{p_{ng}}{x_{ng}}$$

Elasticities are taken from Pindyck (1979). However, he did not distinguish power generators as a separate sector, therefore, we take the elasticities for industries as a proxy. Moreover, Austria was not distinguished as a consuming country by Pindyck. In this study, elasticities in Austria are set equal to those of Germany.

Production and sales

The ownership structure on the supply side of the European gas market is an extremely complex oligopoly. The most important upstream gas companies supplying the EU (in terms of production volumes) have been selected as the Cournot producers in our model (*i*={Gazprom,.., Lasmo}). Production of subsidiary companies (e.g. BEB in Germany, owned by Shell and Exxon for 50 per cent each) are allotted to the companies behind the subsidiary.

For simplicity, production and sales of natural gas by Gazprom, Sonatrach and GFU is assumed equivalent to the production and sales by the former Soviet Union, Algeria and Norway (i.e. non-EU countries) respectively. The production of each Cournot producer is allocated to the markets defined. First, the production is allocated to the countries according to information on indigenous production, import and export. Exogenous production is defined as total consumption in each country minus total production from Cournot producers. Note that total production per Cournot producer only consists of the production that is destined for the countries distinguished here. Other production quantities (e.g. production of Gazprom for their domestic market) of the companies are not taken into account. Second, the production/sales are allocated to the market segments within the country, according to the share of each market segment in total consumption.

At the supply side, it is assumed that gas is simultaneously extracted from several fields that may have different unit costs. The predetermined capacity of the fields that are exploited by producer is given. A profit-maximising producer, producing from two or more fields, carries on extracting gas from a particular field until its marginal cost equals the marginal cost of the other fields. Thus, the marginal cost of producer equals the marginal cost of the field (that is in production) with the highest production cost. The marginal cost functions have to fulfil the theoretical requirements, i.e. increasing and convex in production (see Golombek, Gjelsvik and Rosendahl, 1995):

$$c_i'(q_i) = \gamma_i + \delta_i \cdot q_i + \varepsilon_i \cdot \ln(1 - q_i / Q_i) \qquad \gamma_i, \delta_i > 0,\ \varepsilon_i < 0,\ 0 < q_i < Q_i$$

The associated primary cost function is:

$$c_i(q_i) = \gamma_i \cdot q_i + \tfrac{1}{2}\delta_i \cdot q_i^2 - \varepsilon_i \cdot (Q_i - q_i) \cdot \ln(1 - q_i / Q_i) - \varepsilon_i \cdot q_i$$

The parameters of the marginal cost function, γ_i, δ_i and ε_i, are determined in line with available information (mainly from Golombek, Gjelsvik and Rosendahl, 1995). The intercept, γ_i, is interpreted as the marginal cost of the first unit of production.

Transport, distribution and storage

Additional to the production cost, delivering one unit of gas to market *ng* involves cost of transport, distribution, load balancing and storage (the sum was denoted by t_{ing} in the theoretical model). Transport costs consist of two elements. First, there are costs involved in the transmission of gas over long distances from the well head to the border of the consuming country. These costs depend on the distance, and offshore transportation is usually more expensive than onshore transportation. There is a difficulty in defining the international transmission cost from each producer to each country, since a particular production company usually exploits several gas field that are located in different regions (e.g. Elf produces both in the North Sea and at the French main land). We assume that gas is sold from the nearest production field of the producer. The second element in the transport costs, involves the domestic transport of gas from the border of the consuming country to an artificially defined consumption node within the country. Domestic transport costs are assumed independent from the producer and the market segment.

The distribution costs represent the cost of distributing gas from the country's consumer node to the specified market segment. Consumers in the household sector are served by local distribution companies, while large industries and power generation are often served directly by a transmission company. Therefore, distribution costs for serving the households are larger than for industries and power generation. Distribution costs for serving industries and power generation are assumed the same in each country.

Additionally, there are costs involved in balancing the load of natural gas in the network due to variations in supply and demand flows. Storage facilities are often used for this load management. Costs of gas storage are assumed to be higher for the household sector than for the industries and power generation, because of the more fluctuating demand pattern of households. Due to lack of information, storage costs per market segment are assumed the same in each country. Furthermore, in order to include derogation from the Directive, producers market share cannot exceed 75%.

Arbitrage

An important element in market liberalisation is free access to the transportation system. If third party access is effectively, large price differences between different consumer markets will disappear. The only source of price difference between two markets is the cost difference of serving these markets. Thus, traders will collect arbitrage profits. In order to account for the exploitation of arbitrage possibilities, costs of trading between the consumption nodes in the different countries are specified. Note that we have included the UK-Interconnector in the model as well.

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