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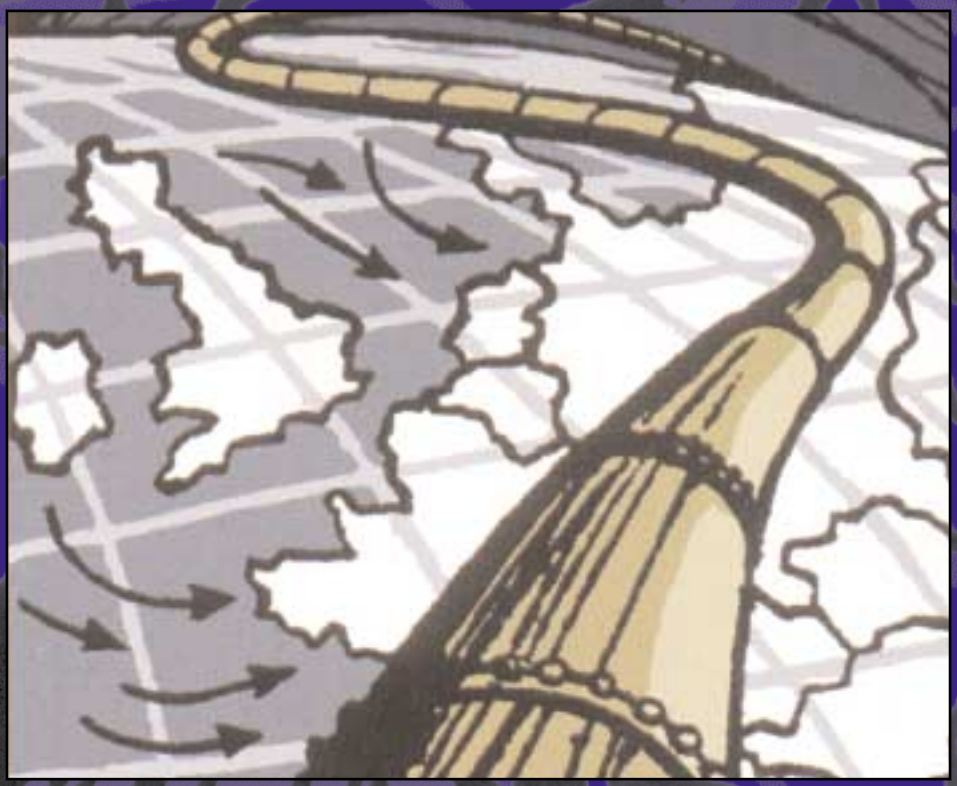
SECURITY OF EUROPEAN NATURAL GAS SUPPLIES

The impact of import dependence and liberalization



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Import dependence

Security of natural gas supplies has resurfaced on the European energy agenda because of concerns about an anticipated rapid increase in dependence on imports from non-European suppliers – from one-third to two-thirds of demand – over the next 20 years. On a national basis, European import dependence is already an established fact: nine out of 33 European countries are more than 95% dependent on imports; only five are self-sufficient or net exporters.

Gas reserves available to European countries from a variety of sources are abundant. Higher levels of import dependence for Europe as a whole, even if they materialize as anticipated (which is by no means certain), need not of themselves necessarily increase security of supply problems. The past 20 years of European gas trade have seen very few gas security incidents of any kind, including those arising from disruption of imports.

A cartel of exporters?

Since 2001, a new element of concern has surfaced with the creation of the Gas Exporting Countries Forum (GECF). It has expressed no intention to form a cartel to exert control over European gas supplies and prices. Nevertheless, individual gas-exporting companies and their governments have strongly objected to what they perceive to be a lack of consultation on the part of European Union institutions and national governments with respect to liberalization and competition initiatives. This may complicate the dialogues and new institutional relationships between producers and consumers, which is a major plank of EU energy security policy.

Liberalization

Long-term contracts

Security concerns have been expressed in relation to potential contractual and financing problems raised by the transition to liberalized and competitive markets. Continued reliance on *traditional* long-term contracts is not necessary for the assurance of security of supply. Market liberalization does not mean that long-term contracts will disappear; indeed they are likely to remain dominant for the next two decades. But price terms will become more flexible and restrictive elements will need to be deleted. Creation and expansion of traded markets will largely eliminate potential take-or-pay problems, by allowing market players to sell volumes which are surplus to requirements.

Multi-billion-dollar investments

Investments of up to $2bn will continue to be financed by new long-term contracts. But there is a major issue as to whether investments in excess of $2bn, and particularly in excess of $5bn, in remote greenfield locations, which cannot be made in stages, can obtain finance when they are selling into liberalized and competitive markets. There are not large numbers of such projects but in order to facilitate them, EU and national regulators may need to agree time-limited exemptions from access conditions, and may be willing to do so if such projects can make a demonstrable contribution to source and transit diversification.

Emergency events

The introduction of liberalization has created uncertainty by removing the all-encompassing, but extremely expensive, provision by the dominant merchant transmission companies against events of low probability but high impact.

This is particularly relevant in the case of the UK, where the gas market has been fully liberalized for some years and where in the event of a major supply emergency – for example the failure of a major receiving terminal – the response capability of market players and the impact on customers is uncertain. Such considerations are not yet urgent in many major continental European countries which still retain huge storage and interconnection capacity built before the liberalization era. Thus despite – or perhaps because of – their much greater degree of import dependence, continental European countries are in a far better position than the UK to withstand major and prolonged gas supply emergencies.

As a consequence of market liberalization, European governments need to make cost/risk judgments and create a transparent security framework of standards and obligations which set out:

- the specific security events for which responses need to be designed in order to prevent disruption of supply to firm, and specifically residential, customers;
- the obligations which should be placed on different market players for them to be able to maintain the required minimum level of supply and capacity in the event of such events;
- the costs associated with such obligations and how these should be allocated;
- whether, in the light of the foregoing analysis:
    - limits should be placed on source, transit route and facility concentration;
    - large gas consumers, such as power generators, should be obliged to have alternative fuels available for security reasons.

Such a framework would enable all market players – including customers – to understand which security events have been anticipated and which have not. It will allow genuine debate about governments' views of security risks and cost/risk judgments. This framework would better enable all stakeholders to appreciate who is being protected, and against what; the costs of this protection; and who is paying those costs.

1 Introduction

There is renewed interest in the issue of European energy security following publication of EU and International Energy Agency (IEA) studies showing an anticipated major increase in energy import dependence over the next two decades.[1] This is particularly true for the natural gas sector where the consensus is that the share of imports as a percentage of European gas demand will increase from one-third of demand in 2000 to around two-thirds by 2020.[2] Since natural gas demand for electricity is projected to increase substantially, a gas supply security crisis might trigger similar problems for electricity supply. At the same time, the institutional and commercial structure of the industry is changing with the introduction of liberalization and competition in continental European gas industries.

This paper investigates the impact on security of supply of increased import dependence and liberalization. It looks at the four different parts of the traditional security framework: reserves and reserve-to-production ratios, long-term contracts and multi-billion-dollar investments, import dependence, and emergency security events, all of which may be affected by liberalization and competition. In particular, using the UK as an example, it shows how a liberalized market requires much greater transparency in terms of the security events to which market players are required to respond without curtailing supply to firm customers. It sets out a framework for defining these events and for allocating the costs associated with responding adequately to them.

Defining natural gas security

In a short paper there is limited space for a methodological definition of gas security.[3] Perhaps the briefest way to deal with definitions is to say that this paper deals with the threats of supply and price disruptions arising from risks associated with the sources of gas supplies, the transit of gas supplies and the facilities through which gas is delivered. There are two major dimensions of these risks:

- *short-term* supply availability versus *long-term* adequacy of supply and the infrastructure for delivering this supply to markets;
- *operational* security of gas markets, i.e. daily and seasonal stresses and strains of extreme weather and other operational problems versus *strategic* security, i.e. catastrophic failure of major supply sources and facilities.

This paper deals mainly with the adequacy of *long-term* supply and the infrastructure and the framework needed to create *strategic* security against emergency supply situations. This framework is designed to force regulators and policy-makers to address the following specific security questions:

- who should be protected and against what?
- what are the costs of this protection?
- who should pay those costs?

[1] This paper uses a very broad geographical definition of Europe comprising 33 countries: all European Union and continental European countries – including those of the Baltic region – but excluding other countries of the former USSR.
[2] IEA, *World Energy Outlook 2000* (Paris: OECD, 2000), Table 3.6, p. 90. European Commission, *Green Paper: Towards a European Strategy for the Security of Energy Supply*, 29 November 2000 (COM (2000) 769, Technical Document, p. 32.
[3] The most extensive definitional discussion is in *The IEA Natural Gas Security Study* (Paris: OECD, 1995).

2 The traditional approach to natural gas security

Reserves and reserve-to-production ratios

The first part of the traditional approach to security of supply for European gas (and other types of fuel) is to look at available information on remaining reserves and make judgments as to when they are likely to 'run out'. Table 1 shows remaining proven reserves in major gas-resource-holding countries of, and existing suppliers to, Europe.[4] It does not show the position of potential suppliers such as Middle East countries with established reserves nearly as large as those of the former Soviet Union and reserve-to-production ratios well in excess of 100 years.[5]

Table 1: Remaining proven reserves at 1 January of respective years in major European countries and external suppliers, 1981–2000, Bcm (reserve-to-production ratio)

	1981	*1986*	*1991*	*1996*	*2000*
Norway	1314 (45)	2228 (82)	2300 (81)	3000 (70)	3808 (72)
UK	739 (16)	634 (13)	545 (9)	760 (8)	760 (7)
Netherlands	1578 (17)	1815 (25)	1970 (24)	1765 (20)	1714 (24)
Germany (West) *	190 (10)	182 (12)	199 (12)	223(10)	270 (12)
Italy	175 (14)	290 (18)	328 (20)	290 (15)	206 (12)
Poland	120 (19)	96 (15)	161 (30)	149 (31)	146 (40)
Romania	125 (4)	180 (6)	130 (20)	389 (21)	348 (24)
Denmark	139 (na)	94 (49)	161 (30)	167 (26)	142 (17)
Algeria	3174 (71)	3030 (57)	3300 (55)	3700 (49)	4077 (43)
FSU **	30500 (68)	37500 (58)	54530 (66)	56650 (77)	56892 (79)

* Unified Germany after 1991.
** Former Soviet Union (principally Russia, Turkmenistan, Kazakhstan and Azerbaijan).
Source: Cedigaz, *Natural Gas in the World* (respective years).

When viewed in a historical perspective, the proven reserves of European countries and their current suppliers have remained obstinately robust in the face of continued predictions over the past three decades that they will be exhausted within 20 years. It is a little surprising to discover that, despite substantial increases in production, most countries have greater – and some substantially greater – remaining reserves in 2000 than they did in 1981.

Despite widespread use of such comparisons, there is serious doubt as to exactly what these data tell us. Proven reserves figures may or may not accurately reflect gas which can be delivered to market under current economic and commercial conditions. The resource base is far larger than the *proven* figures shown in the table. In 2002, technology is available for the commercial development of resources which could not have been so developed in 1980. With those caveats, reserve-to-production ratios are higher in most – but certainly not all – countries compared with 20 years previously; only the UK has a reserve-to-production ratio of less than 10 years. There is evidence that, as markets

[4] It is important to stress the word *proven* here; more speculative categories of identified reserves, such as probable, possible and yet-to-find reserves are not shown.
[5] Cedigaz, *Natural Gas in the World,* 2000, Tables 4 and 6, pp. 25 and 28 show total proven Middle East gas reserves to be 53.9 Tcm and reserve-to-production ratio of 239 years.

liberalize and become more competitive, single-figure reserve-to-production ratios become more common: a reflection of 'just in time' inventory management by the industry, rather than imminent exhaustion of the resource base. The US gas reserve-to-production ratio has not been above 12 years since 1975 and has stabilized at around 8–9 years for the past decade.[6] The historical data suggest that reserve-to-production ratios should *not* be interpreted as the number of years before reserves 'run out'.

Reserves and reserve-to-production ratios provide some support for the proposition that indigenous production will decline over the next two decades, particularly in the UK. However, there are different views on this likelihood and even the EU Green Paper is agnostic about how quickly indigenous European production may decline.[7]

Long-term supply arrangements in liberalized markets

The second part of the traditional approach is to estimate whether adequate supply arrangements are in place to meet expected demand. Various studies have addressed the issues of supply/demand balances over the next two decades.[8] The general conclusion is that in the short term, many of the major companies on the European continent have a surplus of long-term contract gas over and above their national requirements. This is one reason why major companies such as Ruhrgas, Gaz de France and ENI Gas and Power are selling gas to other market players, often in other European countries. Another reason is the introduction of competition regulation in Italy, which places a legal limit on ENI Gas and Power (the dominant company) with respect to the proportion of the total Italian market which it is allowed to supply. This has forced the company to sell gas contracted in excess of this market share to other market players.

Reasons for the short-term surplus include over-contracting by dominant market players anxious to prevent supply from reaching new entrants, and warmer than expected weather throughout the 1990s. The other main cause is slower than expected construction of new gas-fired power stations in many European countries. The reasons for this include:

- a collapse of electricity prices in northwestern Europe in the late 1990s as a result of liberalization, at the same time as oil-linked gas prices increased to their highest levels for a decade;
- circumstances in individual countries, such as Turkey, where economic and financial crisis has placed in doubt some of the major power generation developments for which large supplies of gas have been contracted.

[6] Cedigaz (2000), Figure 40, p. 108.

[7] The Green Paper shows EU 30 gas production in 2030 at the same level as 1990, having fallen gradually from a peak in 2001. For a view that Europe's production could be 60% higher in 2025 compared with the levels of 1995 see Peter Odell, 'Europe's gas consumption and imports to increase with adequate low cost supplies', *Energy Exploration and Exploitation*, Vol. 15, No. 1, 1997, pp. 35–54. See also the paper by the International Association of Oil and Gas Producers (OGP), *EU/EEA Gas Supply and the Policy Framework*, for the Madrid V Regulatory Forum, 7–8 February, 2002. *http: europa.eu.int/comm./energy/en/gas_single_market/madrid3/madrid5.html.*

[8] For example, Observatoire Méditerranéen de l'Energie, *Assessment of Internal and External Gas Supply Options for the EU, Evaluation of the Supply Costs of New Natural Gas Supply Projects to the EU and an Investigation of Related Financial Requirements and Tools*.

Long-term contracts

How long the current European gas surplus will last is a matter for conjecture. But in the longer term the major issue is whether new large-scale supply can be obtained for the period up to 2020. This in turn raises the question of whether the traditional long-term contracts which have dominated the industry since its inception may be threatened by liberalization and competition.

The arguments for and against long-term contracts have been rehearsed many times within the industry during the liberalization debate.[9] The reality appears to be that liberalized markets, despite their emphasis on short-term trading, do not signal the demise of long-term contracts. Even where gas markets have been completely liberalized for several years (such as in Britain), around 70% of gas supplies are still sold on long-term contracts. Neither market liberalization nor the EU Gas Directives preclude the conclusion of new long-term take-or-pay contracts.[10] However, significant elements of the *traditional* long-term contract will need to be changed and such changes are already under way in new contracts:

- Contract length is shortening, such that henceforth 'long-term' will be more likely to mean 8–15 years, rather than 15–25 years.
- Take-or-pay obligations – traditionally 80–90% of the annual contract quantity – may be reduced, perhaps to 50–60%;
- Oil-linked pricing and indexation is changing in favour of floating indexation to a product with immediate relevance to the customer, e.g. a gas or electricity spot or futures price in a relevant location. Such indexation guarantees the buyer that prices will remain competitive with other gas supplies. The emergence of a spot market assures buyers that they will be able to on-sell volumes surplus to their requirements, rendering take-or-pay obligations much less onerous.

Multi-billion-dollar investments

The more important security issue is whether market liberalization will undermine the ability and willingness of sellers and buyers to enter into long-term take-or-pay contracts to support new multi-billion-dollar 'greenfield' infrastructure outside Europe. With the need to finance such infrastructure likely to become more important after 2010, it may be that owners of remote resources will not be able to finance developments in the absence of *traditional* long-term take-or-pay contracts. In some countries this is being used as a reason to support the consolidation of gas and electricity companies into 'national champions' large enough to operate on an international stage, and with sufficient market share to enable them to sign traditional long-term contracts for substantial volumes of gas.[11]

The issue here is the extent to which gas industry investments may be different to similar large investments in other industries. Broadly speaking, for investments up to $1.5bn it is difficult to make any special case for gas. Oil refineries, petrochemical facilities and automobile plants all need to make investments of this magnitude under competitive market conditions without any guarantee of capacity

[9] This author has dealt with this debate in greater detail in *Traditionalists versus the New Economy: Competing Agendas for European Gas Markets to 2020*, RIIA Briefing Paper No. 26, November 2001; and *Competition and Liberalization in European Gas Markets: A Diversity of Models,* (London: RIIA 1998).

[10] The issue of existing long-term contracts which embody 'anti-competitive elements' is more complicated (see the discussion of exporters and liberalization below).

[11] Such arguments have been used by German government officials to support the proposed merger of E.On and Ruhrgas.

utilization. In these industries, new capacity has to compete with existing capacity with all the accompanying risks.

Where gas is different – or at least a case can be made that gas *may be* different – is in pipeline projects which require investments in the region of $2–5bn (and sometimes as much as $10bn) *which cannot be implemented in stages*, and which need to be assured of rapid build-up to high capacity utilization to ensure commercial viability. There are a number of different ways to address this problem. One possible response is simply that 'the market will decide', and that if such large-scale supply developments prove to be beyond the capacity of seller and buyers to organize, then the gas market will not expand as quickly as anticipated and consumers will use other fuels. A more analytical approach may be to consider how many specific projects may be affected by this problem. Perhaps surprisingly, given the infrastructure which already exists to bring gas to European gas markets, there are not many current projects which *clearly* fit into this category.[12] One which does is the Shtokmanovskoye gas field in Russia's Barents Sea, coupled with the onshore transportation system and the North Transgas pipeline system under the Baltic Sea (see Appendix A).

Other projects involving pipeline gas from Central Asia and the Caspian region – Turkmenistan, Kazakhstan and Azerbaijan – may also come into this category. But here production costs are much lower than in the Barents Sea and parts of the necessary transportation systems already exist (albeit requiring refurbishment), or else routes are established and capacity simply needs expanding. Gas pipelines from the Gulf to Europe may also come into the category of very large greenfield investments, but this will depend on the specifics of individual projects.

In order to assist with the mobilization of supplies from large greenfield projects, some special consideration from EU (and perhaps also national) regulators and policy-makers may be important in two respects:

- a regulatory environment which allows EU and national regulators to give exemptions (or in EU language 'derogations') from current rules of access to multi-billion-dollar greenfield infrastructure projects *for a limited period* in order to assist supply and infrastructure investments in moving forward. This will require mutual understanding and agreement on the type of contractual and regulatory frameworks which will be needed in the supplying countries in order to promote projects of this magnitude given the liberalization frameworks, including 'reciprocity' requirements, of all parties.
- a political environment which fosters ongoing dialogue between the EU and Russia, individual states of the Caspian region, the Middle East and North Africa. An essential component of this would be an agreement on the commercial conditions of transit across countries, including sanctity and transparency of transit rules and tariffs, and a dispute resolution procedure along the lines of the Energy Charter Treaty's Transit Protocol (see below).

Such initiatives will not be *sufficient* to ensure that very large greenfield investments proceed. But they may be *necessary* to the success of large supply projects, and only the EU is in a position to promote such comprehensive initiatives which are not possible for commercial companies and national governments acting alone. However the criteria for supporting such projects should include not just the fact of large incremental supplies, but the magnitude of the contribution which they would make to source and transit route diversity and hence security. The North Transgas pipeline would

[12] This is not simply because of the difficulty of estimating investment requirements, but also because many projects can be built in stages using some of the existing infrastructure.

meet the transit requirement and to some extent the source requirement, since it would reduce dependence on Siberian (but not Russian) supplies.

3 Import dependence

The third part of the traditional framework is an estimate of current and future dependence on imports, particularly imports from non-European countries.

Table 2 shows that European countries and regions have very different levels of natural gas import dependence. What stands out is the current reality of import dependence for the majority of European countries.[13] In 2000, 19 out of 33 European countries were dependent on imports for more than 95% of their gas demand, and only 5 out of 33 were self-sufficient or net exporters. The 15 EU member states were substantially better placed, with fewer than half (7 out of 15) more than 95% dependent, and 3 out of 15 self-sufficient or exporters.

Table 2: Natural gas import dependence of European countries, 2000

	100% dependent	**>95% dependent**	**20–83% dependent**	**Self-sufficient/ net exporters**
EURO 33 *	12	7	9	5
EU 15	4	3	5	3

*All EU and other continental European countries including the Baltic countries but excluding other countries of the former USSR.

The risks arising from import dependence can be divided into source dependence, transit dependence and facility dependence.

Source dependence

Table 3 shows the same data disaggregated by country and source of imports.[14] In addition, instead of grouping countries by political and institutional affiliation (EU or OECD), it groups them by geographical region – which is more relevant for a continent where 95% of gas demand is delivered by pipelines, many of which transit through a number of countries within a geographical region. The main conclusions to be drawn from Table 3 are that:

- northern Europe is completely import-dependent and poorly diversified, with Russian gas as the predominant source of supply;
- central and southeastern Europe is also highly import-dependent and poorly diversified. Exceptions are Romania and Croatia which have much lower import dependence, while Hungary and Switzerland are better diversified;
- southern Europe is also heavily import-dependent, with Italy the only significant producer. The region is heavily dependent on Russian and Algerian pipeline gas and liquefied natural gas (LNG) with very little supply diversification aside from Spain and Italy.

[13] The data in Tables 2 and 3 have been taken from Cedigaz, *Major Trends for the Gas Industry in 2000: Interim Results*) Rueil Malmaison, July 2001. While this data is not completely consistent with that of individual countries (e.g. the UK Department of Trade and Industry's *Digest of UK Energy Statistics, 2001*), this is a well-established and geographically comprehensive source using a consistent methodology across a wide range of statistical sources.

[14] Table 2 does not include the five European countries which are self sufficient or net exporters: the UK, the Netherlands, Norway, Denmark and Albania.

Table 3: Import dependence (i.e. % of total imports) by region and by country, 2000

Northern Europe	**RUSSIA**	**ALGERIA**	**NORWAY**	**NETHERLANDS**	**OTHER**
Finland	100				
Sweden					100*
Estonia	100				
Latvia	100				
Lithuania	100				
North West Europe					
Belgium		26	34	37	3*
Luxembourg				43	57*
France	31	25	28	14	2***
Ireland (64%)					100*
Germany (83%)	45		25	23	7*
Central Europe					
Switzerland	13			20	67
Austria (78%)	83		11		6*
Slovakia	100				
Czech Republic	80		20		
Hungary (73%)	76				23*
Poland (66%)	91		3		6*
South East Europe					
Bulgaria	100				
Former Yugoslave Republic of Macedonia	100				
Slovenia	64	36			
Bosnia/Herzogovina	100				
Romania (20%)	94				6*
Yugoslavia (63%)	100				
Croatia (40%)	100				
Southern Europe					
Greece	75	25			
Spain		61	14		25**
Italy (79%)	37	49		11	3**
Turkey	71	24			5**
Portugal		100			

Note: Percentages in brackets in Column 1 denote imports as a percentage of gas demand; countries without percentages are dependent on imports for more than 95% of gas demand.
* European pipeline sources: Denmark, Germany, UK.
** Non-European LNG;
*** Mix of European pipeline gas and non-European LNG
Source: Cedigaz, *Major Trends for the Gas Industry in 2000 (Interim Results),* Rueil Malmaison, July 2001.

- although northwestern Europe is heavily import-dependent, it is best placed in terms of import dependence on non-European supplies and diversity of sources. The UK's exports to this region through the Interconnector pipeline have improved the apparent position of northwest European import dependence on non-European sources.

Yet even this more detailed statistical picture is misleading in that it tells us only about 'contractual source diversity'[15] and little about actual dependence on gas flows and vulnerabilities in the event of a range of supply failures at different times of the year.

Transit dependence

Because 90% of European gas imports is delivered by pipelines, gas is transported across several sovereign territories, raising the possibility of a further layer of risk, especially commercial and political risk, and hence heightening security concerns. As the EU enlarges to include central/east European countries, transit risks decrease.

Figure 1: Transit routes for Russina and Algerian pipeline gas to Europe

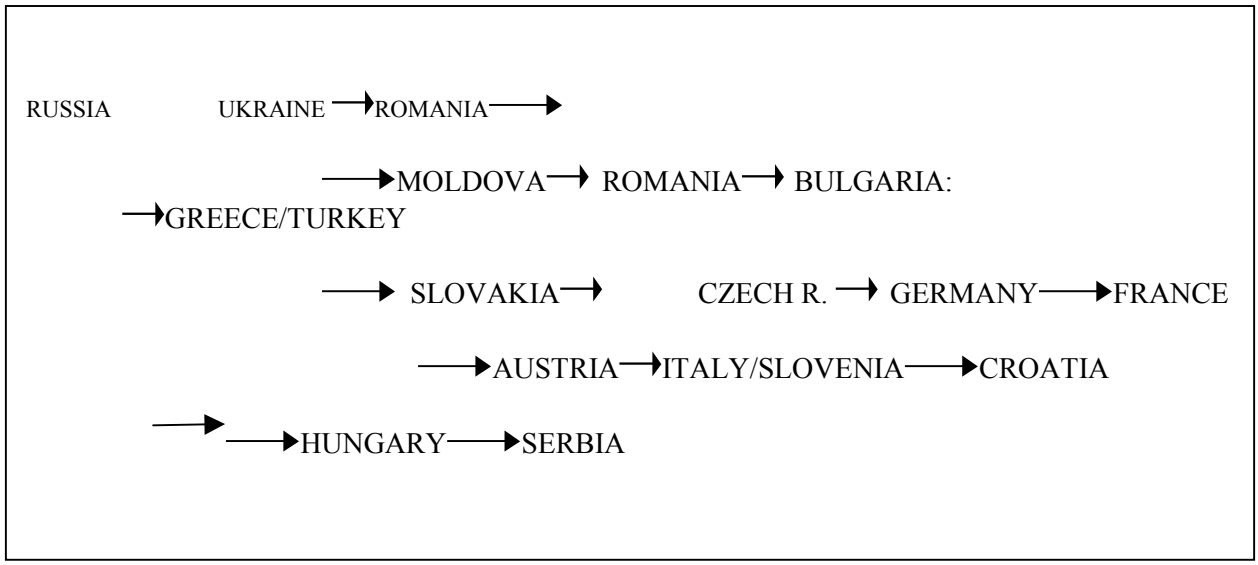

Figure 1 shows the countries through which Russian and Algerian gas exports to Europe are required to transit. In 2000 around 90% of Russian gas exports to Europe transited Ukraine and a minimum of two other countries before reaching an EU border. Figure 1 also shows transit routes for Algerian gas through either Tunisia or Morocco. There have been no reported problems with these transit countries since gas began to flow, but it is worth recalling that in both cases the start of these projects was held up because of Algeria's difficult internal political and security situation and relationships with its North African neighbours.

All gas arriving in Europe from Russia transits either Ukraine or Belarus; and pipeline gas arriving from Algeria transits Tunisia or Morocco, before reaching a European border. Russian gas is mostly required to cross at least two further borders before reaching an EU country, although by 2010 (and

[15] 'Contractual source diversity' means the contracts which importing companies have with suppliers as opposed to actual flows of gas. For example, even though the Czech Republic has contracted for 20% of its supplies from Norway and pays Norwegian companies for those supplies, it is believed that it actually receives 100% of its supplies from Russia (although the infrastructure exists for physical delivery from Norway if necessary).

perhaps before) all of the central/east European countries may have become members of an enlarged Union. Each border crossed adds an additional layer of security risk with the potential for conflict within these transit countries, and between the latter and the supplying country.

Since early 2000, a Transit Protocol has been under negotiation between the 51 governments of the Energy Charter Treaty (ECT). When concluded and ratified by governments, the Transit Protocol will ensure security of energy transit across member countries backed by a legally binding dispute resolution procedure.[16] The ECT has been ratified by almost all European countries and states of the former USSR. The notable exceptions as far as gas is concerned are Russia and Belarus, which have not ratified but are applying the Treaty provisionally; and Norway. North African countries have not been involved in the ECT process.[17]

Facility dependence

The International Energy Agency's major study of natural gas security contains a judgment that is universally relevant:

> Perhaps the greatest risk of prolonged interruption comes from the destruction of a major production or processing facility or a deep water pipeline whose replacement might take many months to build. [18]

In 1998, this was most graphically demonstrated when an explosion at an onshore processing plant in the Australian state of Victoria caused the disruption of gas supplies to all customers throughout the entire state for a period of nearly two weeks.[19] Despite the fact that gas supplies originated from different domestic offshore fields through different pipelines, all gas production was dependent upon the availability of the plant.

European gas supplies from particular sources are vulnerable to potential accidents at key transmission and import facilities, some of which are remote from European territory. These facilities, together with their supply potential, are listed in Appendix B. The most important are the Yamal–Nenets pipeline corridor, which carries nearly 90% of Russian gas production; the Ukrainian pipeline corridor, which carries around 90% of Russian gas exports; the Trans-Mediterranean and GME pipelines from Algeria to Italy, Spain and Portugal; the Troll field and associated pipeline infrastructure, which account for more than half of Norwegian production and exports. Although it is highly unlikely that any of these facilities – particularly those involving multiple pipelines or LNG trains – would suffer a major failure for any significant period of time, such low-probability events could have a substantial impact on a particular source of transit route and therefore an entire European region (Table 3).

[16] *www.encharter.org.*

[17] For a review of the importance of North African energy relationships with the EU see Ali Aissaoui, 'European strategy for the security of energy supply: re-evaluating relations between the EU and the producers and transit countries of North Africa', *Med-Energies*, No. 3, March 2002.

[18] IEA*, World Energy Outlook*, p. 147.

[19] *The Esso Longford Gas Plant Accident*, Report of the Longford Royal Commission, Government Printer for the State of Victoria, No. 61, Session 1998–99, June 1999.

Security incidents, 1980–2001

It is useful to look back over the past two decades at some specific experiences of European and other countries in respect of security problems. Interestingly, given the potential vulnerabilities of installations indicated in Appendix B, there are no clear examples of facility incidents.

Source security: in April 1986 a strike among Norwegian offshore workers spread to the British part of the Frigg field and the country lost around one quarter of total supplies for period of several days.[20] Neither the fact of UK gas import dependence nor this potentially serious security event attracted any significant publicity at that time.

In November 1997, a terrorist bomb exploded in an onshore Algerian section of the Trans-Mediterranean pipeline to Italy. Supplies were maintained from storage and through additional deliveries from alternative suppliers, and there was no suggestion that the incident caused any significant inconvenience, although at the time it was feared that it might herald the beginning of a sustained campaign of action against gas installations in Algeria's worsening civil disturbances.[21]

The most recent example of source insecurity in natural gas trade outside Europe occurred in 2001 when political instability in northern Sumatra shut down the Arun liquefaction plant for several months and Indonesian LNG exports to Japanese and Korean buyers were curtailed.[22]

Transit security: the transit of natural gas exports across Ukraine has encountered particular problems in the delivery of Russian gas to Europe in the post-Soviet era. The basis of the problem has been a lack of money in Ukraine to pay for Russian gas supplies. This has led to a decade of 'unauthorized diversions' by Ukrainian companies of gas in transit to European customers. These difficulties have caused the Russian company Gazprom to devise an entirely new export route strategy based on avoiding transit countries wherever possible, and in particular reducing volumes in transit through Ukraine.[23]

With very few exceptions, the transit difficulties in Ukraine have lasted only a few days, mostly not at times of peak demand in Europe, and European gas companies have managed them relatively easily. In only two cases, both in Turkey, have they caused physical shortages for end-users of gas in Europe, prior to the commissioning of the LNG import facility:

- at the start of 1994 daily deliveries of Russian gas were reduced by about 50%;
- in early March 1995, one of the existing gas-fired power plants had to switch the majority of its input to fuel oil, and two fertilizer plants were put on standby. [24]

[20] 'Norwegian gas customers unruffled by production shutdown', *World Gas Report*, 21 April 1986, p. 3.
[21] 'Bomb disrupts Algerian gas supplies', *Energy Compass*, 13 November 1997, pp. 21–3.
[22] 'Arun challenges Asian LNG reliability rules', *Gas Matters*, March 2001, pp. 1–6.
[23] For the early history of Ukrainian diversions, see Jonathan Stern, *The Russian Natural Gas 'Bubble': Consequences for European Gas Markets,* (London: RIIA, 1995), Box 3.1, pp. 60–61; for more recent events and an account of Gazprom's new pipeline route strategy, see Jonathan Stern, 'Soviet and Russian Gas: The Origins and Evolution of Gazprom's Export Strategy', in Robert Mabro and Ian Wybrew-Bond, eds, *Gas to Europe: The Strategies of the Four Major Suppliers*, Oxford University Press, 1999, pp. 135–200.
[24] IEA, *Energy Policies of IEA Countries, Turkey, 1997 Review* (Paris: OECD, 1997), p. 72.

Security perspectives to 2020: pipeline gas and LNG

The fact that relatively few security incidents of any type have been recorded over the past two decades – a period which has seen a substantial increase in international trade and import dependence – does not necessarily suggest that complacency about future security is warranted. However, taking into consideration the fact that this period saw:

- the rise of Islamic extremist parties in Algeria, bringing that country to the brink of civil war;
- the collapse of the communist regimes in Europe and the former Soviet Union;
- the subsequent creation of new independent states, and fundamental restructuring of political and economic relations between these states;

the consequences for natural gas trade and security could have been expected to be considerably more problematic than actually proved to be the case. It is difficult to imagine that the next two decades will see more fundamental changes in European international relations than occurred during the 1980s and 1990s, and this should inform our attitudes towards natural gas trade and dependence.

It is difficult to believe that the position of European countries in respect of source or transit dependence will substantially improve in the next two decades. Russia, Algeria and Norway will significantly increase their deliveries, with the possibility of a Baltic route for Russian gas and an additional Mediterranean route for Algerian gas. Other large-scale pipeline supplies from the Middle East and Caspian region are possible, with Turkey as the key transit country. New supplies from Central Asia (Turkmenistan and Kazakhstan) would be likely to increase dependence on existing transit routes for Russian gas. In any event, large-scale pipeline gas supplies from new sources seem unlikely until after 2010.

In the short term, new LNG supplies can make a substantial contribution to source and transit dependence. This is evident from developments in southern Europe – particularly Spain – where a number of new LNG projects are in the construction and planning stages. The combination of much greater commercial and delivery flexibility of new LNG – in comparison with pipeline gas – projects means not only that projects can be built and expanded within a relatively short time, but also that sources of imports can be both diverse and relatively flexible as an international LNG spot market develops. LNG avoids problems of transit dependence, and the growing numbers and flexibility of ships able to deliver to alternative destinations greatly decreases source dependence, at least in comparison to pipeline gas. Even though LNG accounts for only 6% of European gas supply, it can play an important security role for individual countries and potentially the whole of southern Europe.

With the concentration of policy attention on source and transit security, facility security – in terms of the risk of technical failure – may have received less attention than it deserves. Much of the European pipeline network – as well as the pipelines in countries exporting to the European continent – was built in the 1970s and 1980s. While there is no reason to believe that maintenance has been neglected in most countries, an ageing system will be subject to a greater risk of technical failure and hence disruption. Clearly this could have a major impact if it were to affect facilities listed in Appendix B. Issues of technical risk, and how quickly infrastructure should be replaced, become important as markets liberalize and become more competitive.

Despite the excellent safety record of LNG over the past three decades, any significant accident – even if it occurred outside Europe – would increase environmental concern and public resistance to new (and even perhaps existing) terminals.

4 Security and relationships with non-European exporting countries

Commercial and political risks

Despite the fact that (as we have seen above) there are very few cases over the past two decades where such risks have caused significant problems for operating natural gas trades, it is commercial and political security risks associated with gas imports that excite the greatest anticipation and public debate.[25] These have focused particularly on Russian gas; there have been periodic debates within Europe, and between European governments and the United States, about the wisdom of increasing such imports.[26] Less debate has taken place regarding the security of Algerian gas supplies despite a difficult period in the early 1980s when Algerian demands for much higher prices caused some disruption in LNG trade, causing the loss of Algerian markets in the US and, temporarily, in Europe.[27]

In the post-Soviet era, it is rather more difficult to devise a scenario in which Russia would choose to threaten European countries – individually or collectively, commercially or politically – by threatening to cut off gas supplies. While Russian gas deliveries to Europe will increase substantially up to 2010 in absolute terms, and perhaps also as a percentage of European gas demand, Gazprom's monopoly over gas exports to Europe will undoubtedly be broken at some stage during the decade. While Gazprom will remain an extremely powerful export presence, it is entirely possible that as many as six other companies will have significant quantities of Russian gas to export to Europe in competition both with one another and with other suppliers.[28] The liberalization of the Algerian gas sector is also under way with the passage of the law of December 2001.[29]

Moreover, ample non-Russian sources of gas seem likely to be available. A combination of Central Asian, Caspian, Middle Eastern and North African pipeline gas, and LNG from a variety of sources, should be available in large quantities. While these would increase source diversity, there is reason to question whether such sources would be any more or less politically or commercially secure than gas from existing (Russian and Algerian) sources. There are further reasons to analyse carefully the routes that such gas would take to reach Europe in order to ensure the maintenance of transit diversity. This is particularly the case for gas from Central Asian countries, for which transit through Russia and Ukraine is the most commercially viable route.

But gas exporters have a dependence on the revenues from their exports which may be just as great as the dependence of importers and, as has been convincingly demonstrated in respect of oil exporters,

[25] The key word here is *operating*, because there are a large number of cases where political problems have prevented the development of economically attractive gas trade. However, as noted above, there is a recent example of political unrest on the Indonesian island of Sumatra which closed the Arun LNG plant (cutting off supplies to Japan and Korea) for several months from April 2001.

[26] For a history of such debates and incidents during the Soviet era see Jonathan Stern, *Soviet Oil and Gas Exports to the West: Commercial Transaction or Security Threat*, (Aldershot: Gower, 1987).

[27] Ali Aissaoui, *Algeria: The Political Economy of Oil and Gas*, OIES: 2001, pp. 91–3.

[28] Even if the current plans to 'break up' Gazprom are not carried through immediately, it is difficult to see the company retaining its present level of dominance for even the next decade, let alone the next twenty years. See Jonathan Stern, 'Soviet and Russian Gas: The Origins and Evolution of Gazprom's Export Strategy', in Robert Mabro and Ian Wybrew-Bond, eds, *Gas to Europe: The Strategies of the Four Major Suppliers*, Oxford University Press, 1999, pp. 135–200.

[29] Ali Aissaoui, 'Liberalisation of Algeria's electricity and gas supply industry', *Middle East Economic Survey*, 24/31 December 2001, pp. D1–D4.

this need for revenue is likely to be a source of competition for market share in the future.[30] In 2000, natural gas exports provided 16% ($16.6bn) of Russian, and 33% ($7.1bn) of Algerian, convertible currency revenues.[31] Given the fragility of these countries' economies, to risk losing such revenues as a result of political or commercial threats would be a high-stakes act. Moreover, given the rigidities of gas exports compared with oil – the pipelines and the markets are where they are, and export volumes cannot be reoriented to other destinations – any threat to use gas as a commercial or political weapon risks depriving exporters of any long-term export future.

An 'OPEC for gas': a response to market liberalization?

A new factor in producer/exporter behaviour has been introduced by the possibility of the formation of an 'OPEC for gas'. A meeting of gas exporters *and importers* first took place in Algiers in late 1998 when the main topic of debate was low oil-linked prices.[32] The meeting was mainly attended by European suppliers and importers, although non-European representatives were also present, and at the time it seemed possible that this could be the start of a 'producer-consumer' dialogue for gas.

In the event that did not happen and a community of exporters was created with the inaugural meeting of the Gas Exporting Countries Forum (GECF) of 11 gas-producing states – including Russia, Algeria and Norway (as an observer) – in May 2001. A second meeting of the Forum, in February 2002, lent some credence to the possibility that a gas exporters' cartel might be formed, despite the explicit denial by the GECF that it intended to be anything other than a periodic meeting of exporters to exchange views.[33] Nevertheless, a meeting of Russian and Algerian energy ministers in March 2002 set up a joint working group 'to conduct a dialogue with the European Union on gas exports'. The Russian minister spoke of coordinating the export policies of the two countries and the possibility of including Norway in the group.[34] At the same time, Russian President Putin proposed a Eurasian gas alliance of Russia, Turkmenistan, Kazakhstan and Uzbekistan with the possibility of including transit countries – Ukraine, Moldova and Georgia (and possibly also Slovakia and Poland)[35].

The concept of a 'gas exporters' cartel' in respect of Europe would be based on the idea that three or four countries could account for a sufficiently substantial proportion of European gas supplies to allow them a measure of control over supply and prices. The institutional basis for a European gas cartel organization is at present relatively weak given that it would need to include Russia, Algeria, Norway and the Netherlands. It is difficult to imagine that Dutch and Norwegian sellers could become an integral part of a price-setting cartel – if only because of EU competition rules. For non-European participants in a potential cartel, institutional structures are moving away from direct government ownership and participation, with gas exports operated by companies in which private ownership is increasing.[36] Nevertheless, because of the importance of foreign exchange earnings from gas, the

[30] John Mitchell et al. *The New Economy of Oil: Impacts on Business, Geopolitics and Society* (London: RIIA/Earthscan, 2001), pp. 182–3.

[31] There is a stark contrast between the position of these countries and that of Norway and the Netherlands, which have smaller populations and much higher per capita incomes and which are much less dependent on income from gas exports.

[32] 'Vyakhirev in Algiers turns his back on oil indexation', *World Gas Intelligence*, 18 December 1998, p. 9.

[33] The original 11 were Algeria, Brunei, Indonesia, Iran, Malaysia, Nigeria, Oman, Qatar, Russia, Turkmenistan and Norway (as an observer). Norway and Turkmenistan failed to attend the Tehran meeting and were reported to have 'dropped out' of the Forum. Bolivia, Egypt, Libya and Venezuela attended the second meeting of the Forum.

[34] *Gas Matters Today*, 12 March 2002 based on Itar Tass reporting.

[35] 'Putin urges Eurasia alliance', *International Gas Report*, 4, February 2002, p. 11.

[36] The only exception Algeria, where Sonatrach is still 100% state-owned although a proportion of gas exports are managed by joint venture companies where Sonatrach has international partners. In the other countries, major exporting companies are partly state-owned and partly privately owned.

potential influence of government over exporting companies and export policy in all countries will remain substantial.

While there is anecdotal evidence of dialogue between the major companies and governments involved in exports to Europe over the past two decades, the only tangible commercial consensus between exporters has been a determination to maintain:

- oil-linked pricing, rather than prices set by gas-to-gas competition;
- the traditional long-term take-or-pay contractual structure, rather than a traded gas market;
- sales to the dominant gas purchasers and refusal to sell to market players believed likely to disrupt the status quo.

Far from taking their commercial future into their own hands, therefore, exporting companies have been relatively content to allow OPEC to set their prices, and importers to dictate their markets.[37]

Since 2001, however, there is some evidence that the initiatives to develop liberalized and competitive markets in Europe (and elsewhere) are acting as a rallying call to producers and exporters to create a more formal institution to respond to such measures. During the 1990s, all of the major gas suppliers to Europe spoke against liberalization, but the Dutch and (somewhat later in the process) the Norwegians became reconciled to the emerging reality of the EU Gas Directive. No such reconciliation has been seen from either Russia or Algeria, whose position perhaps found its most coherent expression at the GECF meeting in February 2002 when the Algerian Minister of Energy observed:

> Those who have an impact on the market, that is the European institutions, should be aware of our issues. When they passed their legislation, they never consulted us. They never thought of talking to the gas-exporting countries before passing their laws. [38]

This could be the beginning of an argument which could conclude by European gas liberalization being constructed as an attack on the interests of producers and exporters – particularly non-European exporters. There are at least three reasons why exporters might believe that liberalization constitutes a form of unfair discrimination against them:

- It is very clear from the experience of gas markets where liberalization and competition have already developed that the producers are the first group of market players to see their margins eroded. While EU liberalization policies were in no way targeted against producers – let alone particular groups of producers – the initial impact of gas-to-gas competition could be strongly negative.[39]

- As discussed above, liberalization is likely to make the development of new gas projects under long-term take-or-pay contracts more complicated than previously, particularly new multi-billion-dollar greenfield projects in non-European countries.

[37] The major exception to this was the creation, at Gazprom's initiative, of the Wingas transportation and marketing joint venture in Germany.
[38] 'Algeria: forum of gas exporting countries ends', *BBC Monitoring Service*, 2 February 2002.
[39] The usual argument from importing countries is that although the initial impact of competition may be negative for producers, in the longer term this is outweighed by larger market potential and greater sales.

- The issue of *existing* long-term contracts which embody 'anti-competitive elements' is currently being addressed by EU competition authorities. The latter are seeking changes in contracts, such as those concluded under the collective negotiation of the Norwegian gas sales organization (GFU), and clauses in Russian and Algerian contracts which prevent resale of gas to other market players, particularly in other countries. Exporting countries regard this as unjustified interference in established commercial arrangements.

Failure to resolve such issues could jeopardize relationships between producers and the European Commission. This would be particularly unfortunate in that developing relationships with producers is an important strand of an emerging EU policy on energy security aimed at defusing the potential for conflicts with exporting countries.[40] This has been especially important in respect of Russia, where an EU–Russia Energy Dialogue has been set in motion; the idea is that a partnership agreement can eventually be negotiated over the next few years and that natural gas is likely to play a significant role.[41] Similar dialogue initiatives could be extended to other major gas external suppliers; for example, in North Africa via the EU–Mediterranean partnership initiative.[42]

It is too early to know how effectively the GECF or similar groups of gas-exporting countries could or will organize themselves in any attempt to control volumes and prices of gas. But it is not too early to observe that in their moves towards liberalized markets, European governments and regulatory authorities have been insensitive to the potential impact on exporting countries outside Europe and that lack of sensitivity may invite the development of a concerted response to – even a retaliation – against liberalization.

[40] European Commission, *Green Paper: Towards a European Strategy for the Security of Energy Supply*, 29 November 2000, COM (2000) 769 final, pp. 74–5.
[41] *EU/Russia Energy Dialogue – An Overview*, 1 June 2001, *http.europa.eu.int/comm./dgs/energy_ transport/ index.html.*
[42] Ali Aissaoui, 'European strategy for the security of energy supply: re-evaluating relations between the EU and the producers and transit countries of North Africa', *Med-Energies*, No. 3, March 2002.

5 Security policy in traditional and liberalized gas markets

In traditional European gas markets a single company had a *de facto* monopoly or an overwhelmingly dominant position in the purchase, high-pressure transmission and sale of gas.[43] The exception to the single company model was Germany, where Ruhrgas held a dominant position among merchant transmission companies.

Supply and import dependence management

In the traditional gas market, responsibility for security of supply at the wholesale level was vested totally in the dominant merchant transmission companies. These companies were in charge of ensuring that supply and transportation capacity would be adequate to meet both short- and long-term market needs up to twenty years ahead. This was achieved by signing long-term contracts which ensured delivery of adequate volumes at prices related to oil products, the principal competitor to gas in end-use markets.

The traditional approach to gas security in Europe for countries with domestic gas reserves was a 'depletion policy' where the speed of development of the known domestic resource base was controlled by government. In the Netherlands, this policy was explicit, but in countries such as Germany and Italy, Table 1 strongly suggests an implicit policy of maintaining a specific level of proven reserves over a long period of time.

As domestic reserves became insufficient to meet demand, they were supplemented by diversified import sources, organized by the dominant merchant transmission company with government oversight. In European countries lacking domestic gas and unable to gain access to diversified imports, gas became only a minor part of the energy balance, or else a market was never developed.[44] This follows a 'traditional' line of reasoning applied to virtually all energy commodities, and pursued by the majority of policy-makers until the last decade when it assumed that domestically produced resources were secure and cheap, and that imported resources were insecure and expensive.

Management of emergency events

Traditional merchant transmission companies provided security sufficient to meet a range of emergency events ranging from extreme weather to a prolonged cessation of supply from an external supplier for technical or political reasons. This involved investing in a considerable volume of gas storage capacity, plus transportation capacity to bring gas from storage; and also switching supplies from one import entry point to another in the event of a supply curtailment. In the British case, offshore producers were required by British Gas to invest in production and delivery capacity substantially in excess of normal contractual requirements.

Exactly how decisions were taken as to the seriousness of the security events which needed to be provided for, and the measures which needed to be taken, was never made clear. Undoubtedly governments were involved in the approval – and probably also the decision-making – process leading

[43] None of these companies was dominant in gas production and only (the former) British Gas and Gaz de France held dominant positions in gas distribution and sales to small customers.

[44] Particularly countries on the geographical periphery of Europe, e.g. Finland, Turkey, Portugal and Greece. This only began to change in the 1990s in southern Europe as pipeline gas from Russia (to Turkey and Greece) and Algeria (to Spain and Portugal) could be supplemented by LNG and pipeline gas from different sources.

to investments in security for customers. Equally unclear are the size of those investments and how the costs were passed on to customers. However, given the storage capacity which was created over the past two decades in major continental European countries (see Appendix C), the investment must have been substantial. Because different departments of the dominant company carried out all necessary security functions, often without internal transfer charges, there was also no need for any significant degree of contractualization between different parties in the industry.

The magnitude of security provisions in traditional European gas markets was illustrated by a study carried out by the IEA in the mid-1990s which showed that, even in a worst-case scenario, Germany, France and Italy could withstand a curtailment of Russian gas supplies in excess of one year without cutting off any firm customers.[45] In a 'best case' scenario – with all interruptible customers cut off and help from other suppliers – all major OECD European gas markets could withstand curtailment of any single external supplier for a period in excess of two years.[46] Up to the mid-1990s, such measures were generally greeted with approval as prudent policy. But as markets liberalize they are as likely – perhaps more likely – to be viewed as 'stranded assets', a source of high costs and unnecessarily high consumer prices.

Price management

Another part of the task of the traditional utility was to ensure that price volatility was avoided to the maximum possible extent. This was achieved by contracts and agreements which set wholesale and retail prices for several months. Changes in wholesale prices – usually indexed to other energy prices (predominantly oil products) – were introduced with a considerable lag (usually nine months) based on averages of the preceding period. Thus the likely increase to be passed on to the retail market was, to a large extent, predictable. Governments – or in the case of Germany, competition regulators – needed to approve retail price changes, and this gave them ultimate discretion over how large an increase (or decrease) would be passed on to customers. The (largely unspoken) aim of this traditional process was to smooth out short-term fluctuations to avoid price volatility, particularly in respect of residential customers. This was particularly important in the early years of European gas markets when customers were being persuaded to switch to gas from other fuels.

[45] *The IEA Natural Gas Security Study* (Paris: OECD, 1995), Table 6.4 p.151. France was similarly protected against curtailment of Algerian supplies; Italy might have experienced problems within six months.
[46] Exceptions at that time were Turkey, Spain and Austria; Italy would have experienced difficulties after one year.

6 Security arrangements in liberalized markets

By contrast with traditional markets, in a liberalized and competitive market aimed at maximizing efficiency, minimizing costs and producing the lowest possible prices for customers, an important guiding principle is to ensure that monopoly power cannot be exercised by a dominant player in respect of commodity or service. Where natural monopoly is involved – particular in terms of network ownership – this must be regulated in such a way as to promote 'reasonable' charges for transportation and rules for use of the network. The reasoning behind this approach is that by setting a regulatory framework and allowing market players and market (particularly price) signals to dictate commercial decisions, efficiency will be maximized and costs minimized, translating into lower prices for consumers.

For *producers*, the liberalized market means freedom to bring forward production on their preferred commercial time schedule. This is why newly liberalized markets have tended to experience supply surplus and subsequent price collapse. Acceleration of production has a significant impact on the rate of depletion of the proven resource base, which in the case of the UK (see Table 1) is likely to accelerate import dependence.[47] The merchant function of *transmission* and *distribution* companies is replaced by a larger number of players – transporters, shippers, suppliers and others – all operating under legislation and regulation which sets out their obligations. The *network* owners and operators operate with similar obligations. Regulators – with the assistance, or on the instructions, of governments – will generally have the authority to alter the security obligations of market players as dictated by market conditions.

As gas markets become more competitive, players will not only operate on slimmer margins, but they will lose their ability or willingness to tolerate any assets or contractual arrangements for which there is no identifiable short-term profitability. In a traditional market it may be commercially possible to have assets which will only be used in the event of supply emergency. Companies operating in a liberalized and competitive market gain competitive advantage through continual cost reduction, a large part of which comes from maximizing the utilization of assets and operating 'just-in-time' supply management. They will not willingly hold unnecessary inventories of gas, reserve transportation or storage capacity surplus to immediate requirements, unless they are allowed to pass through the extra costs to other market players or customers. Thus a liberalized and competitive market requires complex contractualization of security arrangements between market players and regulators and between market players themselves.

Where liberalized markets have an advantage over traditional markets is in the creation of exchange trading and financial instruments which allow available supplies to be allocated in the most efficient way by creating a range of price signals for allocating gas and transportation capacity in conditions of supply emergency. Futures trading allows a range of risks to be hedged as far as five years ahead. Where such markets may have a disadvantage is in their emphasis on short-term (i.e. up to five years), rather than longer-term provision of sufficient gas, capacity and financial hedging capability: 'Although some claim that such futures markets will develop, the fact is that for *current* investment projects and current long-term take-or-pay contracts, they do not remotely cover the time period'.[48]

[47] As noted above, the proven reserve base is only one part of identified resources. There is no commercial incentive for a company to prove up resources which it is not intending to produce within a few years. This is why reserve-to-production ratios do not *necessarily* say anything about imminent production decline.

[48] Dieter Helm, 'Energy policy: security of supply, sustainability and competition', *Energy Policy*, Vol. 30, 2002, pp. 173–84.

The other disadvantage for these markets is reduced ability to make effective preparations for security events of low probability but high impact, which may create severe supply emergencies.
The EU regulatory framework, as set out in the Gas Directive and the proposed new Electricity and Gas Directive, demonstrates the clear intention to allow member states to take their own decisions on security but not to allow them to use security of supply as an excuse to prevent competition from emerging in their markets.[49] The slow transition to liberalized markets in most continental European countries (relative to Britain) may increase security risks by causing substantial uncertainty and delaying the arrival of a spot market and short-term trading. Arguably a long transition could expose continental Europe to the worst of all security worlds: disappearance of the old certainties of the traditional market, combined with uncertainty as to how the emerging market players will be obliged and equipped to cope with security problems.

The case of the UK

Because the liberalized market in Britain has been in place much longer – and is, therefore, further developed than other European countries – it is useful to look at the British approach to security of supply. In addition to its relatively long liberalization experience, the UK example is interesting for a number of reasons:

- it is a major gas producer;
- it has a history of substantial gas imports; in the late 1990s the UK became a significant gas exporter, but is anticipating that within a decade its trading position may once again have switched to that of significant importer;[50]
- one part of the country – Northern Ireland – is entirely dependent on supplies though a single pipeline;
- from a pre-liberalization position of having almost no gas-fired generation, by 2001, 37% of the country's electricity was produced from gas fired stations – a figure which could rise to 60–70% by 2020;[51]
- government and regulatory policy over the past decade has been focused on the creation of liberalized energy markets, an important part of which has been to urge continental European governments to follow the UK example.

This anticipated change in the country's trading position – from net gas exporter to anticipated net importer, possibly of substantial proportions – caused some policy concern and was one of the major foci of a recent energy review commissioned by the government.[52] One of the reasons why energy security is on the policy agenda is that:
'the sensitivity to the UK's future need to import gas, possibly across long pipelines and from trading partners who seem to offer less security than we are used to'. [53]

[49] 'Directive 98/30/EC of the European Parliament and of the Council of 22 June 1998 concerning common rules for the internal market in natural gas', *Official Journal* L204, 21/07/1998, pp. 0001–0012, Articles 3 and 24; 'Proposal for a Directive of the European Parliament and of the Council of 22 June 1998 amending Directives 96/92/EC and 98/30/EC concerning common rules for the internal market in electricity and natural gas', *COM (2001) 125, Communication from the Commission to the Council and the European Parliament*, Brussels 13.3.2001, Article 4a.
[50] One scenario is that imports will comprise 29% of demand by 2010 and 74% of demand by 2020. *The Energy Review*, Cabinet Office, Performance and Innovation Unit Report, February 2002, Annex 7, Table 4, p. 203.
[51] The 2001 figure fell from nearly 39% in 2000; *Energy Trends*, March 2002, Chart 5.2, p. 32; 2020 figures from *Energy Review* (2002), Figure 4.1, p. 58.
[52] *The Energy Review* (2002).
[53] Ibid., p. 7.

On both the issues of increased import dependence and liberalization, the *Energy Review* draws very clear conclusions:

- there appear to be no pressing problems connected with increased dependence on gas, including gas imported from overseas;
- the liberalization of European gas markets will make an important contribution to security.[54]

A theme of the review is that liberalized and competitive markets will deliver a higher level of security than traditional monopoly markets and that 'future gas security for the UK depends in part on the liberalization of European gas network industries'.[55] This invites the conclusion that continental European gas industries are less secure today than that of the UK, and that if those industries remain in a less liberalized state, they will jeopardize future UK gas security. This proposition is highly dubious. In the long term there is no obvious reason why UK gas security would be jeopardized by a lack of liberalization in continental Europe, which is not to say that liberalization should not be encouraged for other reasons.

Moreover, it is very hard to see how the proposition that the liberalized UK gas market provides greater security of supply than non-liberalized European gas markets can be justified, given the relatively low level of UK storage in comparison to continental Europe (see Appendix C). The review appears to acknowledge this when it recommends that key measures to be considered for enhancing security include increased availability of gas storage and LNG.[56] In addition, the major continental European countries have the ability to withstand curtailment for months (and in some cases years) of any of their major supply sources, without cutting off firm customers. This is not to argue that UK gas security is *necessarily insufficient*, simply that attempting to claim that it is superior to that of major continental European countries is untenable. Any claim that liberalization *demonstrably* improves security of supply should be made with great care, unless the particular circumstances of this improvement are carefully explained.

The fundamental principles on which liberalized and competitive markets are based are cost reduction and increased efficiency, whereas in the traditional European gas market a fundamental principle was the assurance of absolute security of supply at unknown, but probably very high, cost. The claim that a liberalized and competitive British gas market can make is not that it is *more secure* than a less liberalized continental Europe, but that it *offers acceptable and efficient levels of supply security at much lower cost* than less liberalized markets.[57]

Such a claim can be made for the British market with reference to the market mechanisms which have been created and the choices which are offered to customers to control the cost of their own security needs.[58] But what also needs to be demonstrated is that government and regulators have security standards in respect of long-term and short-term supply disruptions which market players have

[54] Ibid., p. 5.
[55] Ibid., 56–57.
[56] Ibid., p. 79.
[57] This statement is specific to the circumstances of British and the major continental European gas markets (i.e. France, Germany and Italy); it is not a generalization which can be extended without further qualification.
[58] *Performance and Innovation Unit Energy Policy Review*, Office of Gas and Electricity Markets (Ofgem), Volume 1, October 2001, Chapter 3.

obligations to meet. If there are no specific standards and/or no obligations on market players then the consequence of supply emergencies remains uncertain.

Supply and facility concentration

The specific aspect of security in the liberalized UK gas market which is open to question is its ability to deal with emergencies. Table 4 shows national dependence on offshore gas networks and receiving terminals. It shows a healthy diversification, with the Bacton and St Fergus terminals – and their associated processing plants – being the only obvious points of vulnerability. Any incident which affected the availability of a substantial proportion of these terminals' capacity for any significant period of time, particularly during the winter months, could have serious security consequences.[59]

Table 4: British dependence on gas facilities, 2000

OFFSHORE GAS PIPELINES	% of total production	RECEIVING TERMINALS	% of total gas received	Approx number of fields	% Peak entry capacity*
FLAGS	9	Bacton**	20	>40	21
CATS	12	Barrow	11	4	11
MORECAMBE	11	St Fergus	35	50	24
SAGE	15	including:			
		- Flags/Fulmar	10	27	
		- Frigg	9	11	
		- SAGE	15	11	
		- Miller	1	1	
		Teesside	13	14	7
		Theddlethorpe	12	24	7
		Easington	2	6	6
		Dimlington	4	5	
		Point of Ayr	2	2	
		LNG			6
		Storage			18

* 1:20 peak entry capacity as % of 1:20 peak day demand.
** There are four terminals at Bacton (plus the IUK terminal).
Sources: Department of Trade and Industry, *Development of UK Oil and Gas Resources, 2001*, Appendices 10 and 11. Office of Gas and Electricity Markets, *Performance and Innovation Unit Energy Policy Review*, Vol. 1, October 2001, Table 4.3, p. 74.

From a security perspective, therefore, it is questionable whether any further supply concentration at either St Fergus or Bacton is desirable because of the consequences of any incident which might affect a large proportion of transmission or processing capacity for any period of time. This is recognized, if somewhat obliquely, in the 2002 *Energy Review*, in its statement that: '…the government should consider whether existing terminals are the right location for future developments.' [60] A possible

[59] But note from Table 4 that these terminals are large physical sites comprising four different installations over a substantial land area. It is, therefore, not certain that any incident short of terrorist attack would result in a complete loss of terminal capacity.
[60] *Energy Review* (2002), para 4.102, p. 77.

conclusion is that new pipeline supplies – particularly imported supplies – should be directed to alternative landfalls. Such a conclusion may not be popular with market players, which naturally wish to minimize costs in a competitive market.

Impacts on electricity supply

The rapid increase in gas-fired power generation, both in absolute terms and as a percentage of both gas demand and electricity supply, has led to fears that a gas supply crisis could also trigger an electricity supply crisis. To the extent that surplus generation capacity exists and/or that retired coal-fired stations are mothballed rather than demolished, these fears may be eased.[61] But given that gas-fired stations would be among the first loads to be shed in the event of a supply crisis, this is an important issue. Concern could be eased by requiring new gas-fired stations to hold stocks of alternative fuels (in particular oil products), but this would not only involve additional costs but also require a seamless switch to those fuels in the event of a gas shortfall. In the past there has been resistance from owners of some new gas-fired stations to operating on liquid fuels owing to increased wear on turbines.

Interconnection and security

In what has been said above, the terms 'Britain' and 'UK' have been used with some care since, in terms of gas security, they are not interchangeable. Table 4 does not include the Interconnector pipeline (SNIP) between Scotland and Northern Ireland which carries the latter's entire gas supply. Disruption of this facility could cause a serious security situation, particularly in respect of residential gas customers, given the total dependence on a single facility and a single source of supply.[62] The planned pipeline connection between Northern Ireland and Eire will provide the province with an additional supply route and this is envisaged at two levels: government-to-government – the 'all-island' initiative – and commercial. Eire is also substantially dependent on the Ireland–UK Interconnector and the capacity of this link will be increased in the future. Despite the fact that additional Irish offshore gas supplies at the Corrib field are under development, the impact of any British supply emergency on both the northern and the southern Irish gas supply would be significant.

Continued development of gas trading infrastructure – the British–Belgian Interconnector (IUK) and the Frigg pipeline connection with the Norwegian continental shelf (combined with new offshore infrastructure such as the Vesterled pipeline) – will provide Britain with imported gas options in the event of a gas security crisis. Before 1990, Britain was a 'gas island' with no connection to Ireland (including Northern Ireland) or continental Europe.[63] The future will increasingly see the UK integrated into the European gas market, in terms of both supplies and prices.

Thus imports, far from being a *security problem*, have become an important part of a *security framework* and British security issues should be viewed in the context of the European gas market. But this also means that a supply crisis in continental Europe would increase prices on the continental

[61] For example, in 2002 PowerGen reopened a coal-fired plant which had been closed since 1996 and mothballed a new gas-fired plant. *Gas Matters Today*, 2 October 2001.

[62] In 2000, only 9% of Northern Ireland's gas was used in distribution; the majority is burned at the Ballylumford power station, which can also use heavy fuel oil.

[63] IUK was commissioned in 1998 and hence large-scale trade with continental Europe did not start before that year. Small-scale exports to Germany via the Netherlands had begun in 1992 with the connection from the Markham field.

side of IUK and cause British supplies to flow in that direction.[64] It is therefore equally important that British contingency plans and security obligations take into account the possible impact of a continental European supply crisis.

Price volatility

It is also important to look at policies towards gas pricing, and particularly price volatility, given that there is evidence from the United States that prices in liberalized markets tend towards greater wholesale price volatility.[65] We noted earlier that determined efforts to avoid price volatility were a part of the security framework. Ofgem's view on policy towards volatility is completely opposite to the traditional thinking:

> One of the essential prerequisites for ensuring the effective functioning of the incentive mechanism provided by competitive markets is that regulators and governments do not seek to control price in periods of genuine supply shocks … if customers do not face the full cost of their energy needs they will not cut back demand when supplies are tight, nor will they have the incentive to contract with reliable suppliers … Therefore price signals have an important role in rationing demand during periods of genuine supply scarcity. Also suppliers and producers will not have the incentive to enter the market if they believe they may be prevented from supplying their product at competitive prices and will not have the incentive to seek out reliable producers/source of supply if they believe they will be bailed out by the government when prices are high. [66]

The *Energy Review* was less definite about policy towards price volatility, recommending only that the joint government/regulatory working group on security of supply should, 'assess the market signals surrounding gas prices'.[67]

Price issues also have an important international dimension. By 2001, oil-linked continental European price movements had a major influence on British prices. In future, price signals on either side of IUK will mean that a supply crisis which increases prices in Britain will cause supplies to flow from the continent.

Emergency planning and supplier obligations

Missing from the British legal/regulatory framework are any plans to prepare for specific security events of low probability but high impact, which may disrupt supplies or disable specific facilities producing or transporting substantial quantities of gas.[68] This type of planning is somewhat different in nature from the generalized response planning which the UK's Gas Emergency Committee is undertaking. The Committee is putting in place plans which set out how market players will curtail

[64] As shown in Appendix C, storage volumes in northwestern Europe are so large that market players can respond adequately to a very severe and protracted supply crisis. Nevertheless, the possibility should form part of the framework.
[65] US price volatility has increased substantially since deregulation and by 20% during the 1990s. Adam Sieminski, *Natural Gas Price Volatility: Causes, Implications and Solutions*, DOE/EIA NEMS Conference, 12 March 2002, *http://www.eia.doe.gov/oiaf/aeo/conf/handouts.html*.
[66] Ofgem (2001), paras 3.17–3.19, p. 32 (see note 58).
[67] *Energy Review*, para 4.27, p. 60.
[68] These issues are set out in greater detail in Jonathan Stern's 'Security of UK Natural Gas Supply and Import Dependence', House of Commons Trade and Industry Committee, *Security of Energy Supply*, Second Report of Session 2001–02, Appendix 7.

and then restore supplies to consumers in the event of an emergency.[69] By contrast, what is being suggested here is the need to:

- identify and model the impact of specific security events, e.g. the loss of a major receiving terminal such as Bacton and St Fergus for a specified period of time;
- judge the severity of the impact of these events on groups of customers and on the basis of that judgment;
- decide what type of specific obligations need to be placed on market players to ensure that supply curtailments arising from these events are minimized.

The British legal/regulatory framework also lacks any specific policy or regulatory instrument which might prevent concentration of transportation or processing infrastructure at a particular location. Concentration increases the potential severity of a security event, should it occur. In the case of the UK – and other European gas markets as they start to liberalize – it is worth considering an expansion of the policy and regulatory framework to include:

- the creation of security standards in the form of obligations on market players to have in place contingency plans to respond to specific security events. Obligations would be expressed in terms of physical and contractual arrangements which each of the market players would be required to put into operation for a given period of days.
- the degree of supply and facility concentration which is considered prudent in terms of the ability to respond to the failure of a specific supply source or facility.

Examples of such policy instruments can be found in the Spanish legislation to liberalize energy markets, which requires suppliers to maintain 35 days' supply of strategic gas stocks and stipulates that not more than 60% of the country's gas may be imported from one source.[70]

In Britain, the starting point for developing such arrangements would be annual modelling simulations by Transco of the supply consequences of major supply or facility failures – particularly at Bacton and St Fergus – of varying duration in different seasons of the year, and the likely regional and sectoral impact on shippers, suppliers and customers. For each simulation, shippers and suppliers could be required to set out how they would allocate available gas and capacity between their customer groups and geographical locations.

Examination of shipper and supplier plans would allow the government and regulators to determine the adequacy of contingency plans for a range of supply emergencies. For example, if it was found that the majority of suppliers were intending to depend largely on availability of short-term gas during a supply emergency, then volatility and huge price spikes could be anticipated. In addition, the contingency plans of shippers and suppliers would almost certainly require additional capacity to be built by Transco in other parts of the network. The purpose of such an exercise should therefore be to develop a transparent policy and regulatory consensus as to the severity of the security events which market players should be required to withstand without major curtailments of supplies to firm customers.

[69] There is currently little in the public domain about the work of the Committee but a study is due to be published later in 2002.

[70] Jordi Dolader, *Gas Security of Supply in a Growing Market*, IEA Regulatory Forum, February 2002. There are similar (but less explicit) provisions in the Italian legislation.

The *Energy Review* comes close to recognizing this possibility by recommending that:

- the DTI should carry out an assessment of cost-effective policy responses that could enhance security of the system. Key measures which could be considered include increased availability of UK gas storage and LNG;
- departments should examine barriers to private sector construction of either option, in particular how these projects are represented in planning guidance;
- if sufficient private-sector investment is not forthcoming, then consideration may have to be given to the imposition of mandatory obligations on storage. [71]

The idea of mandatory obligations suggests a partial reversion to traditional policy practices of instructing market players as to what type of specific security arrangements they are required to make. Better suited to a liberalized market would be a policy which laid down security standards for both emergency gas supplies and capacity, leaving market players free to choose how to meet those standards on the basis of the best combination of options available to them, including:

- contracts for additional supplies either from production or storage from domestic or imported sources;
- contractual interruption of customers by region and customer class.

Annual evaluations of security standards and contingency plans would allow for obligations to be changed over time as appropriate, for example factoring in the security aspects of imported supplies as (and when) these begin to increase. Contingency plans for any supply crisis should feature market-based solutions to the maximum possible extent, with additional gas imports being an increasingly likely option. Comparing volumes of gas storage with annual demand and imports, it is clear that the heavily import-dependent countries in both northwestern and central Europe have much greater protection against supply crises than Britain (Appendix C). Contracts with continental European companies in the event of a security crisis could be an attractive option for British suppliers.

However, the imposition of security obligations would entail additional costs for market players – Transco, shippers and suppliers. Government and regulators would need to decide how those costs should be apportioned between the players themselves, and between players and the customers for whose benefit they would be implemented. Given the nature of security as a 'public good' it might be appropriate for these costs to be shared among all parties.

Avoidance of negative consequences of price volatility might also be included in the obligations of suppliers towards customers. Although prudent suppliers will hedge price risk using financial instruments, those that do not will expose themselves to the risk of price volatility. This does not expose customers, who can switch in the event of imprudent suppliers attempting to raise prices, or receive protection from the regulator's 'supplier of last resort' provisions, in the event of the supplier becoming insolvent.[72] Nevertheless, the risk of a major insolvency crisis involving multiple suppliers owing to insufficient hedging of price risk might be considered unacceptable, and obligations could be required.

[71] *Energy Review* (2002), p.79.

[72] Ofgem has powers under the Utilities Act 2000 to direct one or more other suppliers to be a supplier of last resort for a failed supplier's gas (and electricity) customers. Ofgem, *Supplier of Last Resort – Guidance on Current Arrangements*, March 2001; and *Supplier of Last Resort – Security Cover and Levies, A Consultation Document*, June 2001.

7 A strategic security framework for liberalizing markets: obligations and costs

We noted above that in the mid-1990s, the major continental European gas markets had the ability to withstand an interruption of any major source of supply without curtailing supply to firm customers for periods in excess of one year. We also noted that in liberalized markets (such as Britain) commercial pressures do not allow the building of strategic assets which, under normal conditions, would be expected to have low utilization rates. Hence Britain has far less gas storage and surplus pipeline capacity and would be less well placed than continental European countries to withstand supply curtailments. As markets liberalize, therefore, the need for a strategic security framework becomes important, irrespective of the degree of import dependence.

The harmonizing aspirations of the Single European Energy Market initiative raise the issue of whether a single European set of security standards and obligations would be appropriate. More research is needed in this area but, given the huge differences in the gas markets of the 15 EU member states, it would be difficult to apply common standards and obligations across the Union. Differences in size, market penetration, stage of liberalization and views of likely security risks suggest that national rules (subsidiarity) should apply. Nevertheless member states could be required to produce a transparent set of security standards and obligations – a 'security framework' – which could act as building blocks for an analysis of EU security preparedness against a range of possible events.

Standards which governments and regulatory authorities might be required to set include specific supply security events to which market players would be expected to respond without curtailing supplies to firm gas, in particular residential, customers. The events would include:

- loss of a specific source of supply for a specific number of days during the peak demand season;
- loss of a specific facility (or facilities) through which a large percentage of national or regional supply passes, for a given number of days during the peak demand season.

The obligations which governments might then place on market players would be related to their role and participation in terms of capacity and gas supply shares of the market. Obligations would be stated in terms of:

- the amount of capacity which the network owner and operator must have available to move gas to different regions of the country in the event of a specific event;
- the volume of emergency gas supply – in storage reservoirs, access to additional supply, or demand reduction measures – which suppliers (and shippers) must have available to allow them to maintain supply to different categories of firm customers in the event of a specified emergency.

Because the commercial pressures on market players in liberalized markets are so much greater than in traditional markets, substantial analysis will be required before governments and regulators are able to make proposals on security events and obligations. The first part of the analysis would need to be carried out by the network operator which would model various different security events in order to evaluate:

- the impact on different classes of gas customers, including power generators;
- measures which would need to be taken to provide additional transportation capacity in order to reduce the impact on consumers to acceptable proportions; and

- the cost of those measures.

The next part of the analysis would be carried out by (shippers and) suppliers in the light of the capacity additions suggested by the network operator, to evaluate a range of emergency supply options, including demand reduction, and the costs associated with those options. The analysis would arrive at a range of measures – with associated costs – necessary to respond adequately to different security events.

In the light of this analysis, the task of governments and regulators would be to arrive at standards sufficient for the market to withstand security events of 'reasonable likelihood' at 'reasonable cost' to market players and customers. This should involve complete transparency as to:

- which events fall within the security framework – i.e. are considered 'likely' – involving costs which are considered 'reasonable';
- which groups of market players – network owners/operators, shippers, suppliers, traders and customers – should bear what percentage of the costs of the required responses.

It should be expected that European governments will differ in their views as to how much security insurance their gas markets need, and the costs which they are prepared to impose on market players and customers. Over time, as market conditions, international relationships between importers and exporters, risk perceptions and governments change, and as facilities age, so security frameworks will also change.

Finally, we return to the definitional questions posed at the beginning of this paper: who is being protected against what; what are the costs of this protection; and who pays those costs? As markets liberalize and become more competitive, the framework for answers to these questions must be created by governments and regulators, and must be transparent and contractualized. The most important element in such a framework is the extent to which customers – and in particular residential customers – should be protected against major supply and facility failures. Governments and regulators need to compare the costs of such protection against a specific range of events with the risks of such events occurring and the damage they will cause if they do occur. Questions of import dependence, adequacy of long-term supply and long-term contracts are all parts of this framework but, of themselves, do not constitute major security problems.

The major strategic security problems are those connected with events of low probability but high impact on supply. Adequate responses to such events, in terms of preventing curtailment of supplies to residential customers for a period of weeks, may entail high costs; particularly since such events may never occur. This balance of cost and risk can only be determined by government and regulators. They need to decide the required degree of customer protection, identify the costs of that protection and allocate those costs between market players and customers. This is a complex task involving a range of difficult judgments and calculations. But unless it is tackled effectively, it will be difficult to claim that liberalized gas markets are taking seriously the challenge of security of supply.

Appendix A: The Shtokmanovskoye gas field and North Transgas pipeline

Appendix B: Some Major Fields, Pipelines and LNG Plants Delivering Gas to Europe

SOURCE	FACILITY	APPROXIMATE CURRENT ANNUAL CAPACITY Bcm/year	COMMENTS
RUSSIA:	Yamal-Nenets Transmission corridor; 18 56 inch pipelines bringing gas from 3 super-giant fields	500 Bcm/year	Transports >90% of Russian gas from Siberia to Russia and export markets
	Ukraine export corridor. 7 pipelines (via 3 different routes) run across Ukraine, meeting near Uzhgorod on the Russian-Ukrainian border near the border with Hungary.	130 Bcm	Around 120 Bcm utilised in 2000. Concern about the condition of some of these pipelines and the degree of refurbishment which may be needed has let to speculation on how long capacity can be maintained.
	Yamal pipeline through Belarus and Poland	13 Bcm (will be 25 Bcm by 2003)	New route to Germany avoiding Ukraine.
	Finnish pipeline		
ALGERIA:	Trans-Med pipeline via Tunisia and Sicily to Italy	30 Bcm	Algerian pipelines and LNG plants are particularly
	GME pipeline to Spain via Morocco and Gibraltar	11 Bcm	important for southern European countries such as:
	Arzew LNG Plant 12 Trains	21 Bcm	Italy, Spain and Portugal
	Skikda LNG Plant 6 Trains	6.5 Bcm	
NORWAY:	Troll Field	25.5 Bcm (1999)	Over half of Norwegian gas production
	Frigg pipeline(s) landing at St Fergus*	11 Bcm	
	Norpipe pipeline Landing point Emden* (Germany)	19 Bcm	
	Zeepipe landing point Zeebrugge* (Belgium)	13 Bcm	
	Norfrapipe landing point Dunkirk* (France)	19 Bcm	
	Europipe 1 and 2 landing point Emden* Germany	17 and 21 Bcm	

*Receiving terminal facility.

Appendix C: Underground Gas Storage Facilities in Europe (end of 1999)

	DEPLETED FIELD	AQUIFERS	SALT CAVITIES	TOTAL WORKING CAPACITY (BCM)	WORKING CAPACITY AS A % OF:	
Northern Europe					Annual Demand 2000	Imports 2000 ***
Denmark		1	1	0.82	16	
Latvia			1	2.5	184	184
Northwestern Europe						
Belgium		1	1**	0.65	4	15
France		12	3	10.8	32	44
Germany	13	9	16+1	18.37	20	54
Netherlands	3			5	11	
UK	1		1	3.2	3	
Central Europe						
Slovakia	1			2.38	29	30
Czech Rep.	3	1	1*	1.8	19	24
Austria	5			3	38	59
Hungary	5			3.6	29	51
Poland	4			1.1	10	16

	DEPLETED FIELD	AQUIFERS	SALT CAVITIES	TOTAL WORKING CAPACITY (BCM)	WORKING CAPACITY AS A % OF:	
South East Europe						
					Annual Demand 2000	Imports 2000 ***
Bulgaria	1			0.5	16	16
Romania	4			1.25	7	40
Yugoslavia						
Croatia	1			0.5	18	45
Southern Europe						
Greece						
Spain	2			1.27	7	9
Italy	9			15.1	21	25

* mined cavity ** disused mine *** non-European imports

Source: Adapted from: Cedigaz, *Natural Gas in the World, 2000 Survey*, Rueil Malmaison, December 2000, Table 37.