The Interconnector Pipeline

A Key Link in Europe's Gas Network

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Preface

The Interconnector pipeline has rarely been out of the news since it was first proposed in the early 1990s. It is probably not too much of an exaggeration to say that it has transformed short term trading in north west Europe, causing companies to enter into commercial behaviour that they had not previously considered possible or, in some cases, desirable. Equally interesting were predictions (before it was built) that the project was likely to be a waste of time, followed by periodic claims that: gas was flowing in the wrong direction; that larger or smaller volumes of gas should be flowing; and that shippers on one side or the other were responding inappropriately to price signals.

For a gas research programme this made the Interconnector a particularly suitable research project which fits perfectly into our work on European gas issues. This is the first publicly available document to provide a detailed account of the Interconnector pipeline supported by primary source materials.

I am very grateful to Mark Futyan for taking on such a challenging project and seeing it through from the other side of the Atlantic alongside his MBA.

Jonathan Stern March 2006

CONTENTS

GLOSSARY

ABBREVIATION	DESCRIPTION
bcm/y	Billion normal cubic metres per annum
CCGT	Combined Cycle Gas Turbine
DTI	Department of Trade and Industry (UK)
EASEE	European Association for the Streamlining of Energy Exchange
EIB	European Investment Bank
EU	European Union
Fluxys	Belgian natural gas network operator
Forward Flow	Flow from the UK to Belgium
ISIS	Interconnector Shippers Information System
IUK	Interconnector (UK) Limited
LNG	Liquefied Natural Gas
NBP	National Balancing Point (NTS notional trading point)
NGT	National Grid Transco (NTS operator)
NTS	National Transmission System (UK natural gas network, operated by NGT)
Ofgem	Office of Gas and Electricity Markets (Regulator)
PLUTO	Pipeline Under the Ocean (Pipeline used to supply fuel to troops in France during WW2)
Ppm	Parts per Million
Reverse Flow	Flow from Belgium to the UK
Send-or-pay	Capacity utilisation pricing structure where the charge paid is independent of capacity utilisation.
Spot price	Short-term price
STA	Standard Transportation Agreement (The contractual agreement between IUK and its customers)
Take-or-pay	Pricing structure involving fixed volumes at pre-agreed prices, but with the option for the customer to reduce the offtake quantity without refund.
TTF	Title Tansfer Facility (virtual trading point in the Netherlands)
UKCS	UK Continental Shelf

ABSTRACT

The Interconnector pipeline links the UK and mainland European gas networks. This paper studies the history of the Interconnector from initial conception through to present day operation and contrasts the impact of the pipeline with expectations.

The speculative nature and multi-partner approach of the project led to unique financial, project management and political challenges. The original investors in the Interconnector link had quite different ambitions and a corresponding variety of expectations. Operational experience has demonstrated Interconnector flows to be lower and more variable than expected by most stakeholders, reflecting the pipeline's primary role as a trading line rather than a bulk transportation facility.

This paper was originally written during early 2005 and reflects knowledge at that point in time.

ACKNOWLEDGEMENTS

I would like to express thanks to the many individuals who have contributed to this paper. In particular I would like to thank Jonathan Stern and Roger Cornish for planting the idea of a paper into the Interconnector's history and for their continued support throughout its development.

I am also sincerely grateful to James Alcock OBE, Jean Vermeire and Tony Mulcare and Hari Kambo for sharing their wealth of knowledge and experience with me.

Finally, I would like to thank my wife for her tireless patience, support and love.

1 INTRODUCTION

1.1 Interconnector Overview

The Interconnector pipeline became operational in October 1998, providing a bi-directional link between the gas networks of the UK and mainland Europe. The 235 km line runs from Bacton in Norfolk to Zeebrugge in north west Belgium and has the capacity to transport 20 billion cubic metres per annum (bcm/y) in UK export mode and 8.5 bcm/y in UK import mode. At the time of construction, the export mode was approximately equal to one third of the UK gas market or twice the domestic Belgian market. An enhancement project is currently under way to increase the UK import capacity. The first phase of this project was completed in November 2005, doubling import capacity. The system has an ultimate import capability of 25 bcm/y.

An independent company, Interconnector (UK) Limited, was created in 1994 to finance, design and build and operate the pipeline.

1.2 Facilities

The Interconnector system was originally designed primarily for the export of gas from the UK. Compression facilities were installed at the Bacton terminal to raise the pressure of gas taken from the UK grid for transportation via the sub-sea line to Zeebrugge. In addition to the UK National Transmission System (NTS) connection, gas can be delivered directly from the Shearwater and Elgin fields in the central North Sea. A reception terminal at Zeebrugge controls the temperature and pressure of gas arriving from the sealine before delivery to the Belgian transit grid.

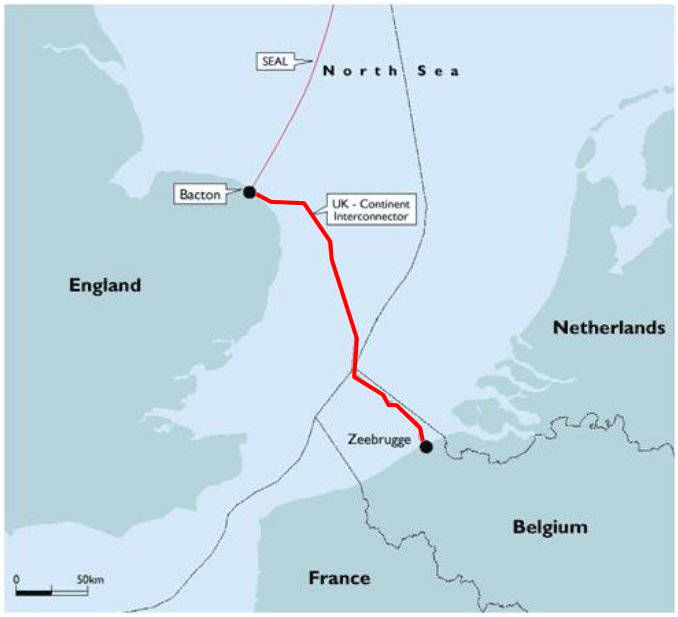

Figure 1: Pipeline Route

The original design provided for a limited capacity in the reverse direction using the Bacton compressors to 'suck' gas from Belgium to the UK. In 2002, a marketing campaign generated sufficient interest in increased UK import capacity to justify the expansion of the Interconnector system with the installation of compressors in the Zeebrugge terminal and a pressure let-down station in Bacton. The offshore line lies within the UK and Belgian sectors of the southern North Sea and has a diameter of 40 inches.

1.3 A Ten-year History

While the facilities themselves are conventional in terms of technology, almost every other aspect of the Interconnector is unique and innovative. National distribution aside,[1] gas pipelines are normally built in order to connect a supply source to a market by players who negotiate the commercial terms. To minimise risk and to justify the investment, long-term contracts are typically agreed to guarantee an income stream. In the case of the Interconnector, the link was not 'field to market', but 'network to network'. There was no single source or destination for gas and long-term contracts were not agreed by the participants prior to committing to the venture. Investment in the Interconnector therefore involved significant uncertainty. Indeed it was described by one commentator as 'speculative engineering on a scale not seen in the hitherto tightly managed European gas scene'.[2]

The construction of the Interconnector coincided with a period of rapid liberalisation of the UK gas market and the onset of liberalisation in continental markets. In one sense, the project represented a reaction to the uncertainty created by an increasingly dynamic marketplace. Furthermore, the Interconnector heralded fundamental change to the UK gas market by bringing to a close the country's history as a 'gas island'. As a result, the project initially generated a great deal of interest and speculation.

The business model for the Interconnector was also unique. The traditional model for joint venture projects involves a small number of partners investing equity with a single joint venture partner as project manager and subsequently operator. For the UK-Continent Interconnector, an independent company was established to construct and operate the pipeline, and shareholding was separated from capacity rights.

Ten years on, the Interconnector is established and the true role and impact can be compared to expectations. This presents a timely opportunity to appraise the project from a variety of perspectives.

The pages that follow provide a survey of the venture's history from initial conception through to present day operation, discussing project history, key stakeholders and project challenges. Operational and commercial data are presented to establish the evolving role and impact of the Interconnector. Future development is also considered including a discussion of the reverse flow capacity enhancement.

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[1] National distribution systems are usually either monopolistic or highly regulated, so do not make as relevant a benchmark.

[2] Patrick Heren, 1995, source 'The Interconnector – From Theory to Reality', James Alcock, SMI UK Network Codes Conference, 18−19 May 1995.

2 PROJECT HISTORY

2.1 Early Concepts

The concept of transporting fuel by pipeline across the English Channel is not a new one. The earliest example is PLUTO (an acronym for 'Pipeline Under the Ocean'), a Second World War project which supplied the allied troops in Northern Europe with petroleum.

The idea was first suggested for natural gas in the 1960s when Dutch producer, NAM offered to sell Groningen gas to the then Gas Council. A decade later, British Gas proposed the construction of an Interconnector in order to persuade Norwegian producers that they could safely export their gas to Scotland (a much closer selling point than Germany) without the risk of down-pricing due to market constraints within the UK. The strategy failed because of concern over the centralised control over the UK market at the time and the UK government's refusal to allow gas imports. Discussions took place between British Gas and counterparts in Belgium and Holland in the 1980s to create an alternative import route for Norwegian gas 'veiled' in the form of an EU connection, but by this stage the case for gas imports had been weakened by strong exploration results in UK waters.

By the early 1990s, several other companies including UK Continental Shelf (UKCS) producers BP, Conoco, Elf and Shell and Norwegian producers Norsk Hydro and Statoil had also independently studied the possibility of a cross-channel natural gas Interconnector, in most cases in the form of connected offshore fields or lines. None of these studies ultimately resulted in a commitment to invest because they failed to secure the approval of the UK government.

2.2 The Study Group

In 1992, the Energy Minister, Tim Eggar, brought together the six companies who had been considering the construction of a cross-channel gas pipeline to form a study group for a shared project. The study group was chaired by Sir Geoffrey Chipperfield, a former permanent secretary to the then Department of Energy. Initial results were less than promising since all the organisations involved had previously evaluated and rejected the idea of investing in an interconnector. Following a lengthy initial meeting, a show of hands was requested to gauge interest in proceeding with the study. When all hands remained firmly at table level, Sir Geoffrey declared that the response was not satisfactory and discussion would continue until the situation improved. By nightfall the study group was formed comprising British Gas, BP, Elf, Conoco, Norsk-Hydro and Statoil. The group proceeded essentially at the behest of the UK government.

The study group spent 18 months during 1992 and 1993 developing the technical and commercial concepts for the Interconnector. During this period, Zeebrugge was selected as the European landfall at which point Distrigaz was invited to join the study group.

The initial commercial concept was that the seven study group members would own the line with capacity made available both to themselves and a wide range of potential users. Return on investment would be secured through long-term capacity sales contracts. With this in mind, a project description brochure was produced and distributed to 85 European oil and gas companies, requesting non-binding indications of capacity requirements. The scale of response exceeded expectations resulting in an increase in the design capacity of the line from 15 bcm/y to 20 bcm/y.

During detailed discussions, it became clear that the proposed business model placed undue risk on the potential non-shareholding shippers. Companies found it difficult to put in place the sales, purchase and transit agreements to justify long-term investment in the Interconnector while the project remained only a possibility. The investment was thus highly speculative with most risk left with the capacity holders, but a degree of reward with the potentially different owners. In order to overcome this inequality and continue progress on

key commercial terms, the Study Group took the decision in April 1994 to offer equity in direct proportion to capacity bookings.

The need to maintain momentum was strongly influenced by the first mover advantage. Similar interconnection projects were concurrently under consideration, including the Gasunie Den Helder to Bacton link. This project was ultimately delayed by a decade by Interconnector's timely progress. See Section 3.1 for further discussion of Gasunie's motivations.

From the large number of potential shippers who expressed interest in Interconnector capacity, four further companies joined the study group members to become the initial shareholders of the newly formed company, Interconnector (UK) Limited, or IUK. The motivations and composition of the shareholder group are discussed further in Section 3.3.

3 KEY STAKEHOLDERS

The key stakeholders who have influenced the development of the Interconnector project are discussed in the paragraphs below. The groups considered are shareholders who own equity in Interconnector (UK) Limited, shippers who own capacity rights in the line, government authorities and landfall partners. Initially, the shipper and shareholder groups were aligned, but due to independent shareholding and capacity holding exchange, these two groups have diverged. Market expectations are also reviewed in this section using contemporary press publications as a basis.

3.1 Landfall Partners

A number of potential landfalls were considered. Anyone who has travelled from the UK to mainland Europe by ferry will be aware that Bacton to Zeebrugge is not the shortest route. However, a number of factors were considered alongside pipeline length. Both landfalls needed a well developed onshore and offshore infrastructure, with sufficient capacity in the adjacent gas transportation systems to flow Interconnector gas. The existence or potential for a trading hub and ease of access to adjacent markets was also important.

On the UK side, a number of potential sites were considered in the South East of England. Environmental constraints posed a significant restriction with coastal industrial sites in short supply. Bacton was chosen based on the presence of existing gas terminals and spare capacity in the existing connecting onshore pipelines.

On the European side, landfall points were considered in Belgium, France, Holland and Northern Germany. The proposed German landfall was considered too far both from Bacton and some of the major European markets. The case for the French and Dutch landfalls was weakened by the lukewarm response from potential landfall partners Gaz de France and Gasunie, neither of whom was keen on increased competition in their domestic markets. As a potential landfall partner, Gaz de France wanted to be the sole buyer for all gas flowing through the Interconnector.

At Zeebrugge, the presence of a Liquefied Natural Gas (LNG) import terminal and a landing point for Norwegian gas provided the potential for the development of a European trading hub and offered proximity to German, Dutch and French markets.

The landfall partners, British Gas and Distrigaz influenced the development of the Interconnector both as connected transporters and as shareholders. The connection contract, agreed with each, needed to be consistent with other connections to the respective grids and set operational principles for the line. In their capacity as project stakeholders, both landfall partners resisted proposals for direct access connections to the Interconnector which would bypass their own grids and reduce transit revenues. On the UK side, a direct connection was ultimately constructed from an offshore line (see Section 5.5), but on the Belgian side, a plant modification to allow flexibility of connection to France or the Netherlands was opposed and ultimately blocked by Distrigaz.

3.2 UK Government

The same political drive that gave rise to the Channel Tunnel prompted the UK government to provide impetus for the Interconnector; namely support for European integration, a belief in the power of market forces to provide economic growth through competition, and the desire to spread this philosophy to continental Europe. More importantly, the government recognised the risk of exploration stagnation and potentially even market collapse due to oversupply in a newly liberalised UK gas market.

The change from a managed to competitive market structure posed certain risks which the UK government believed an interconnection to the larger gas markets of Europe could resolve. Prior to market liberalisation, the UK gas market had been in a position of oversupply for a

number of years, but beach prices had remained steady under the British Gas managed market.[3] With the change to a competitive market system, prices would be driven by the gas supply-demand balance. The government was concerned that the oversupply position would lead to a breakdown of volume clearing and a resultant increase in gas price volatility. Such volatility could lead to stagnation in UKCS investment.

To compound these concerns, supply was being contracted in excess of demand as new entrants purchased gas to meet overambitious sales targets and British Gas failed to reduce bookings in accordance with lost market share. Also, with Norway in the process of negotiating for EU membership, the possibility of blocking Norwegian imports[4] would become more difficult. On the demand side, a number of Combined Cycle Gas Turbine (CCGT)[5] projects were delayed. Under these circumstances, the lack of an 'escape valve' could have led ultimately to market price collapse.

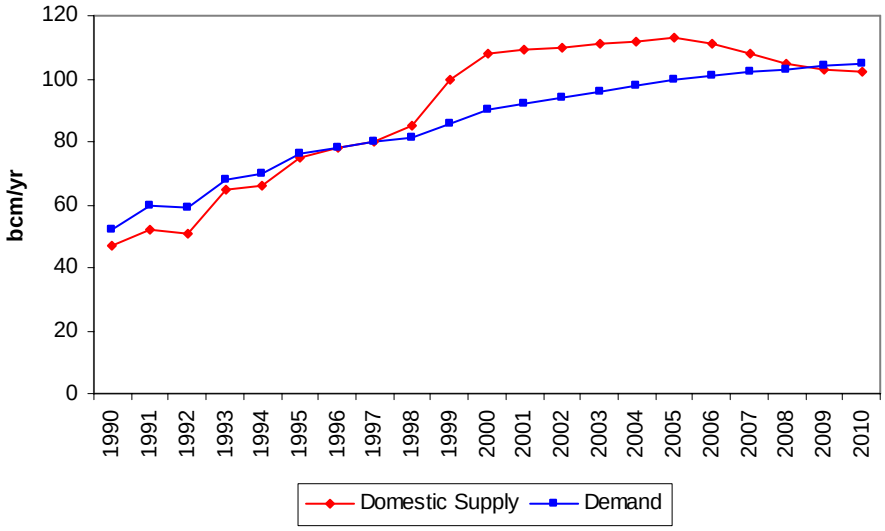

Figure 2: Potential for Gas Export

Source: Wood MacKenzie, 'UK-to-Belgium gas line stirs northwest European market', Floor Touber, *Pipe Line & Gas Industry*, pp. 41−44, November 1996.

The relationship between supply and demand is shown in **Figure 2**. The data, prepared by Wood MacKenzie, were used extensively by the Study Group to justify the project. The chart illustrates that the 'gas bubble' was expected to persist for only a decade up to 2009, after which the UK would become a net importer of natural gas. The Interconnector thus increased the UK's long-term supply security.

The initial government concept was for an export only physical line which would set a floor on UK gas prices and hence maintain market stability and encourage offshore investment. At the start, the UK government strongly opposed a bi-directional Interconnector, supporting an agenda for the spread of the free market economic model, while maintaining protectionist

[3] Beach prices were normally set on the basis of alternative fuel prices and the perceived need to secure medium and long-term gas supplies, with price fixed for the duration of field life.

[4] In 1985, the UK government cancelled a significant contract to import gas from the Sleipner fields. The contract had taken British Gas, Statoil and Norsk Hydro two years to negotiate.

[5] Such power stations represented the main growth in natural gas demand.

policies with respect to imports from Norway or through the new Interconnector.[6] This stance was soon dropped once the implications of declining UKCS production were understood.

In 1997, the then Minister for Energy quite rightly stated that, 'Energy costs [were] a significant factor in the competitiveness of industrialised nations'.[7] With European gas prices 30 percent higher than in the USA, British and European leaders were under pressure to reduce energy prices to maintain competitiveness. The Interconnector provided the opportunity to 'export' liberalisation along with gas molecules, the logic summarised by one commentator as follows: 'The 20 bcm/y capacity Interconnector will effectively allow the UK to export the results of its own market liberalisation to the continent, in the form of relatively cheap surplus gas, which is sure to have an impact on the European gas market.'[8]

3.2.1 Changing Role of Government

The UK government conceived the Interconnector and brought together the companies to create it. Together with the EU and Belgian government, they played an instrumental role in making the project a reality. However once the project partners had flown the study group nest, the government's influence was weaker. In order to pursue government and national interests, two key instruments were utilised to influence the development and operation of the Interconnector: investigation and regulation.

3.2.2 European Commission Enquiry

Following liberalisation of the UK gas market, prices fell steadily until 2000, after which they began to rise sharply. This anomaly, combined with a damaging flow reversal, against the prevailing price signal in January 2001, led to concerns that 'gaming around the Belgian Interconnector had manipulated prices' and that the connection to unliberalised markets resulted in 'various restrictive practices'.[9] In response to these concerns, the Trade and Industry Secretary, Stephen Byers, requested the European Commission, which had been given suitable powers to investigate the Interconnector, to carry out an enquiry into the possibility of anti-competitive behaviour by the customers using the service.

The commission investigated capacity exchanges and flow direction changes during January 2001 and used these data to consider whether IUK shippers could have colluded to influence the flow direction of the Interconnector, whether the business rules could be more flexible, and whether Distrigaz had taken advantage of its position as trader and transporter.

The commission concluded that it 'found no evidence of cartel-like behaviour between the companies that ship gas on the Interconnector', rather that the increase in UK gas prices was due to 'the differences in market opening between the two markets concerned'[10].

However, the report did criticise the rigidity of the business rules which were found to be too restrictive for short-term capacity transfers and changes in flow direction.

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[6] The free market ideals were also at odds with the UK government's resistance to other gas Interconnector projects proposed by private industry (see Section 2.1)

[7] 'Development of the European Gas Market', Speech by Lord Fraser of Carmylie, UK Minister for Energy, at the University of Leiden on 17 February 1997.

[8] 'UK Rushes in where Rest of Europe Fears to Tread', Article 17, *Petroleum Economist*, 25 March 1997.

[9] DTI Consultation URN 01/1099: Concerns about gas prices and possible improvements to market efficiency, November 2001. (www.dti.gov.uk/energy/domestic_markets/gas_market/gascondoc.pdf).

[10] European Commission Enquiry into Anti-competitive Use of the Interconnector, March 2002 (europa.eu.int/rapid/ reference=IP/02/401).

Given an understanding of the Interconnector business rules and the available facts, these conclusions appear to be justified. A discussion of changes to the flow transition rules is presented in Section 5 and the reasons for the price increases during the 2001 flow reversal are evaluated in Section 7.3.

3.2.3 Onset of Regulation

Regulation provides a tool for government to create a framework in which business can be encouraged to operate in the national interest. The independence of the regulator from government should ensure separation from political interest. However, regulation presents an additional risk to regulated organisations as the business environment is subject to change.

The 2003 changes to the EU gas directive[11] included the requirement for a system of regulated third party access to be applied to natural gas interconnectors, with possible exemption for new projects which would otherwise be uneconomical. The UK government chose to go a step further and implement a licensing regime for existing and new natural gas interconnectors in the 2004 Energy Act.[12]

IUK was not eligible for exemption from the licensing regime. The criteria for exemption included project completion after August 2003 and that the level of risk attached to the investment would be such that the project would otherwise not proceed. Although the Interconnector enhancement project was not due for completion until after the threshold date, the project mainly affected the Belgian part of the business. As for the measure of risk, the risk lay with the capacity holders rather than the operator.

In a response to a DTI/Ofgem consultation, IUK expressed two key concerns. Firstly, with interconnectors normally being international businesses, there was potential for a conflict of regulatory obligations to the two responsible regulatory bodies, and secondly that the exemption of new projects resulted in an uneven playing field.[13]

The impact of regulation and operation of the asset under the conditions of the licence are yet to be realised for IUK, but given that the terms of the licence in its draft form are not contradictory to IUK's business rules, the initial impact is not expected to be significant.

3.3 Shareholders

3.3.1 Initial Shareholder Group

Twelve potential participants made final bids for capacity, a number of which were conditional. Discussion of conditions led to the withdrawal of three bids. The nine remaining participants came together to become capacity holders and shareholders of Interconnector (UK) Limited.

There are some notable absentees from the Interconnector participation discussions and from the subsequent shareholder group.

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[11] Directive 2003/55/EC concerning the rules for the internal market in natural gas and repealing directive 98/30/EC (europa.eu.int/comm/energy/gas/legislation/amending_legislation_en.htm).

[12] Energy Act 2004, Part 3, Chapter 2: Interconnections for Electricity and Gas (www.opsi.gov.uk/acts/acts2004/20040020.htm)

[13] Response to consultation on Interconnector licences, December 2004 (www.interconnector.com/mediacentre/presentations.htm).

Study Group	Bidders	Initial Shareholders
British Gas BP Elf Conoco Statoil Norsk Hydro Distrigas	British Gas BP Elf Conoco Statoil Norsk Hydro Distrigas Amerada Hess Ruhrgas National Power Gazprom Gaz de France	British Gas (40%) BP (10%) Elf (10%) Conoco (10%) Distrigas (5%) Amerada Hess (5%) Ruhrgas (5%) National Power (5%) Gazprom (10%)

Table 1: Study Group Members and Initial Shareholders

Exxon[14] and Shell[15] did not join the initial study group and did not choose to bid for capacity. These two companies had a historic arrangement to share equity in all UKCS field discoveries, so it is not surprising that they chose the same response to the proposed Interconnector project. Unlike the other UKCS producers, Exxon and Shell had significant interests elsewhere in Europe, including the Groningen field in Holland, the Troll field in Norway and also in Germany. As continental producers, they had little interest in seeing UK gas competing on the continent. Although access to distribution channels made it difficult to sell exported UK gas on the Continent, the fear was that customers would demand access to the gas if the price was below market, which would be potential dynamite in the context of the implementation of the EU directive for gas market liberalisation.[16] Furthermore, based on previous failed proposals for natural gas interconnectors (see Section 2.1), and the speculative nature of such an investment, Exxon and Shell simply did not believe that the Interconnector project would or could succeed without them. However, when the project did proceed, they were still on board through their shareholdings in Ruhrgas.

Statoil and Norsk Hydro, the two Norwegian producers, were Study Group members, but did not become shareholders. When it came to bidding for capacity, their bids were conditional on the successful resolution of the UK-Norway treaty to allow direct gas imports from Norway. This was a difficult condition to meet which would entail lengthy and potentially fruitless negotiations with the UK government. Furthermore, it was not in the interests of the other study group members to pursue this political agenda. The bids were therefore rejected, but both organisations later gained access to the line as shippers.

A further notable absentee from the shareholder group was Gaz de France, a key player in North West European gas markets. The major obstacle for Gaz de France was the speculative nature of the project. They were used to building new pipelines and terminals for contracted volumes and wanted certainty that underlying commodity contracts would be signed prior to go ahead or agreement that they could pull out if these contracts were not signed within a reasonable time period. Such condition precedent was unacceptable to the other Study Group members who had no reason to compromise.

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[14] Now merged with Mobil.

[15] The Royal Dutch / Shell Company

[16] Directive 98/30/EC concerning common rules for the internal market in natural gas (europa.eu.int/comm/energy/gas/legislation/old_legislation_en.htm).

3.3.2 Rationale

The rationale for creating and investing in the Interconnector was different for the various shareholders. The original Interconnector shareholders represented a diverse mix of producers, transporters, marketers and users, each pursuing a different strategy.

In contrast, the initial study group consisted exclusively of North Sea producers, led by the government in response to a perceived need for an export line. Correspondingly, the initial prospectus highlighted producers' issues above others.

A common driving force for many of the investors was the desire not to be the lone major European player outside the project. As long as the project was going ahead, the major players wanted to be part of it in order to at least have influence over how the line would be used. The fact that the project did not appear at first to make economic sense was not a deterrent to most participants, for whom a share in the Interconnector was a relatively modest investment.

The rationale of the investor groups is discussed in the following paragraphs.

UKCS Producers

Of the original Interconnector shareholders, the UKCS producers represented the largest group, comprising BP, Elf, Conoco and Amerada Hess.

The producers, for the same reasons as the UK government, were concerned that an oversupply position in a competitive UK gas market would lead to reduced return on their existing and future UKCS investments. The Interconnector would, in theory, provide market stability and higher prices and in turn a more attractive environment for North Sea exploration and production.

The concept of maintaining strategic reserves for future release when the UK supply position reversed, was discounted by producers on three counts. Firstly, the net present value of future revenues is worth much less than current revenues, particularly when the additional cost of maintaining infrastructure for longer is considered. Secondly, the longer the term of speculation, the greater the uncertainty, with no guarantee of higher prices in a decade's time. Thirdly, producers disputed the supply and demand forecasts which anticipated a supply shortfall by 2010 (see **Figure 2**). These forecasts excluded some potential developments in the central and northern North Sea.

The producers observed the growing demand in continental Europe and felt their own reserves could be easily marketed. Relative to other Continental European gas supplies, UK gas was both proximate to market and politically secure.

Transporters

For the two landing partners, Distrigaz and British Gas, the project was in part seen as a way of increasing transit revenue in a locally mature transportation network. In Belgium, the UK export capacity represented 150 percent of the domestic market.

For Distrigaz, the Interconnector also provided a unique opportunity to become a key player in European gas markets by virtue of Belgium's location between the four key markets: France, Germany, the Netherlands and the UK. Distrigaz and the Belgian government were equally encouraging to the Zeepipe landfall and an LNG import terminal for similar reasons.

Marketers

British Gas and Distrigaz also chose to invest in the Interconnector in their capacity as marketers. Ruhrgas also chose to invest for this reason. Through the Interconnector, each could access a more diverse supply portfolio for their home market. To coincide with the initial availability of IUK capacity, Ruhrgas reduced the take-or-pay element in a number of its supply contracts, particularly during the summer months, enabling them to take advantage of seasonal arbitrage opportunities between traditional contracted supplies and the UK spot gas market.

The Interconnector also provided an opportunity for continental players to diversify their portfolios in anticipation of structural changes to the market brought by liberalisation.

Users

National Power was the sole natural gas user in the shareholder community. As an electricity generator, investing increasingly in gas-fired generation plant, the company was one of the largest users of natural gas in the UK. Diversity and security of supply were therefore primary incentives for investment in the pipeline. Interconnector capacity formed a key part of the company's alliance with Ruhrgas formed in 1993.

National Power's interest in the Interconnector has changed over time as a result of the split into International Power and Innogy in 1999 and its entry into gas marketing.

Importers

Gazprom made a long-term strategic move through investment in the Interconnector. The UK was the only large European market not supplied with Russian gas and the company saw long-term opportunity in the UK gas market through future Interconnector imports. The investment formed part of Gazprom's 'dash for joint ventures',[17] alliances being formed with both large gas merchants and smaller distributors across Europe. Furthermore, the Interconnector project provided a unique opportunity for Gazprom to gain experience in the British liberalised and competitive energy market, as opposed to the traditional monopoly markets of Continental Europe with which it was familiar.

3.3.3

3.3.4 Changes in Shareholding

Figure 3 shows the evolution of the shareholder group. The initial group was dominated by British Gas, with all other participants taking 10 or 5 percent stakes in equity and therefore capacity rights. After the demerger of British Gas (see Figure 4). The shareholding in the Interconnector Group passed to BG Group. The disproportionate size of British Gas' initial stake and subsequent equity sales suggest a pressure to invest in the project beyond the foreseen need for capacity. Indeed, by 1998, only 2 bcm/y (25 percent) of British Gas' capacity had been secured through gas sales contracts (see Section 5.3.3). At the time of rapid change in the UK gas market, mapped out by the UK government, it would certainly have been in British Gas' interests to invest at the behest of the government. Moreover, the 8 bcm/y bid would have resulted in a majority share of the initially proposed 15 bcm/y line, implying a strategic desire to play a controlling role in the project.

Figure 3 also illustrates an overall trend for reduced investment by UK producers transferred to an increase in investment from continental players. This reflects the changing role of the Interconnector from an export line for surplus UK gas to a flexible connection with Europe

[17] UK-to-Belgium gas line stirs northwest European market, Floor Touber, *Pipe Line & Gas Industry* pp. 41−44, November 1996.

and potentially a major import route. The increased investment by continental players was also influenced by the strategy of diversification and international acquisition in preparation for the changing business environment anticipated by such organisations following the passing of the EU directive for gas market liberalisation.[18]

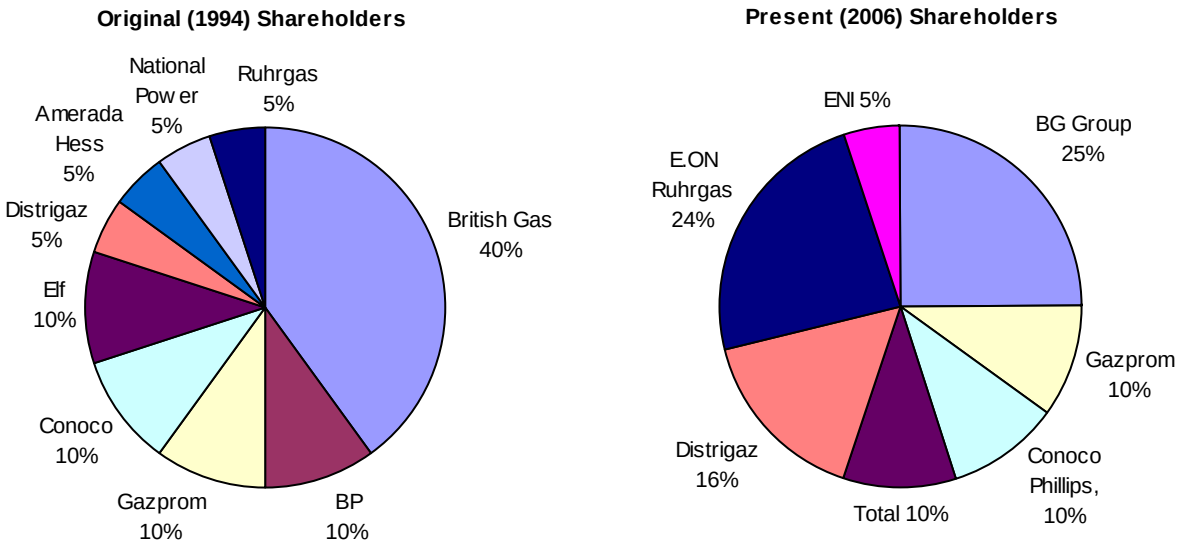

Figure 3: Shareholding

A consolidation to a smaller number of shareholders with more equal weighting is also observed. This reflects the decreasing opportunity for shareholders to influence project development once the Interconnector became established as well as consolidation in the European gas and power industry itself.

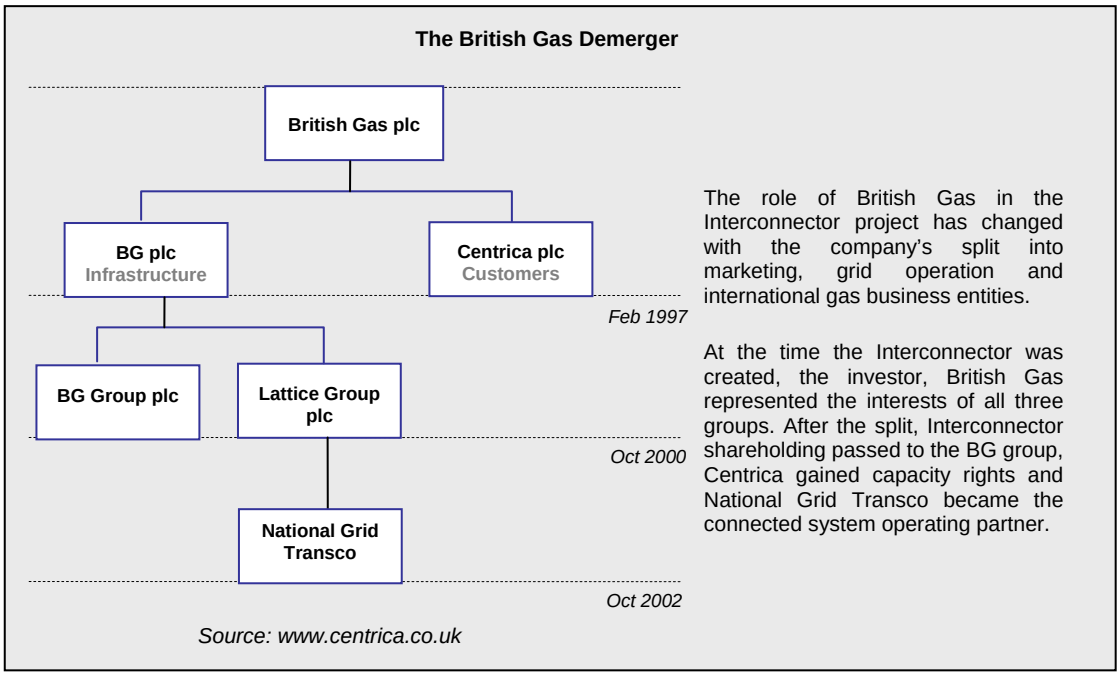

Figure 4: The British Gas Demerger

[18] Directive 98/30/EC concerning common rules for the internal market in natural gas (europa.eu.int/comm/energy/gas/legislation/old_legislation_en.htm).

3.4 Shippers

In contrast, the number of shippers with capacity rights in the line has increased significantly to over twenty. Despite a common starting point, the shipper group is more diverse than the shareholder group due to higher liquidity of capacity holding compared to shareholding. **Table 2** shows the organisations that have held primary Interconnector capacity. In addition, these shippers may sub-let capacity or provide a transportation service to third parties, creating additional shippers who do not have a direct relationship with IUK. The secondary shipper community has included a number of US organisations including Enron and AEP.

Initial Shareholders/Capacity holders	**Other Full Capacity Holders (Assignees)**
British Gas	Statoil
BP	Mobil
Elf	Centrica
Conoco	Gaz de France
Distrigaz	Norsk Hydro
Amerada Hess	Entrade
Ruhrgas	Duke Energy
National Power	Snam
Gazprom	EDF

Table 2: Interconnector Shippers (as at June 2005)

Most of the initial participants in the Interconnector chose to maintain at least part of their capacity rights, and a number of additional shippers joined the group. The shipper community now includes most of the major players in northwest European gas markets, with the exception of Exxon and Shell (see Section 3.3.1). When Exxon merged with Mobil in 2000, Interconnector capacity was sold. In addition, a number of trading companies have used Interconnector capacity on a short-term basis.

3.4.1 Capacity Share

As discussed in Section 3.3.2, the initial shareholders had a variety of reasons for investing in the Interconnector which did not necessarily relate to a need for capacity. This has resulted in divergence between shareholding and capacity holding as initial investors with excess capacity sold their transportation rights to third parties.

Shippers use the line for one of three reasons: to access new wholesale markets (producers), to access new supplies (marketers), or to take advantage of arbitrage opportunities (traders). The evolution of aggregate capacity holding for each of these categories is presented in Figure 5.

The charts demonstrate a clear trend of changing capacity holding within the Interconnector. Producers dominated the original shareholder group, but by first gas flow in 1998, capacity holding had already been traded to provide increased access to capacity by gas marketers. This trend continued into operation and following the 2005 capacity enhancement which is shown on the reverse flow capacity chart. Within the producer group, the reduction in capacity holding has been predominantly from companies with UKCS capacity, while capacity holding for overseas producers (i.e. those with access to Norwegian or Russian supplies) has remained relatively constant.

Since first gas flow, traders have used an increasing proportion of the pipeline capacity. Such shippers normally procure capacity on a short- to medium-term basis indicating that arbitrage opportunities between the UK and the continent produce sufficient returns on short-term trading to justify the transportation cost of Interconnector capacity.

The trends are similar in both forward and reverse flow, influenced by restrictions on relative capacity shares in each direction, but with marketers taking a larger share of forward flow capacity compared to reverse flow.

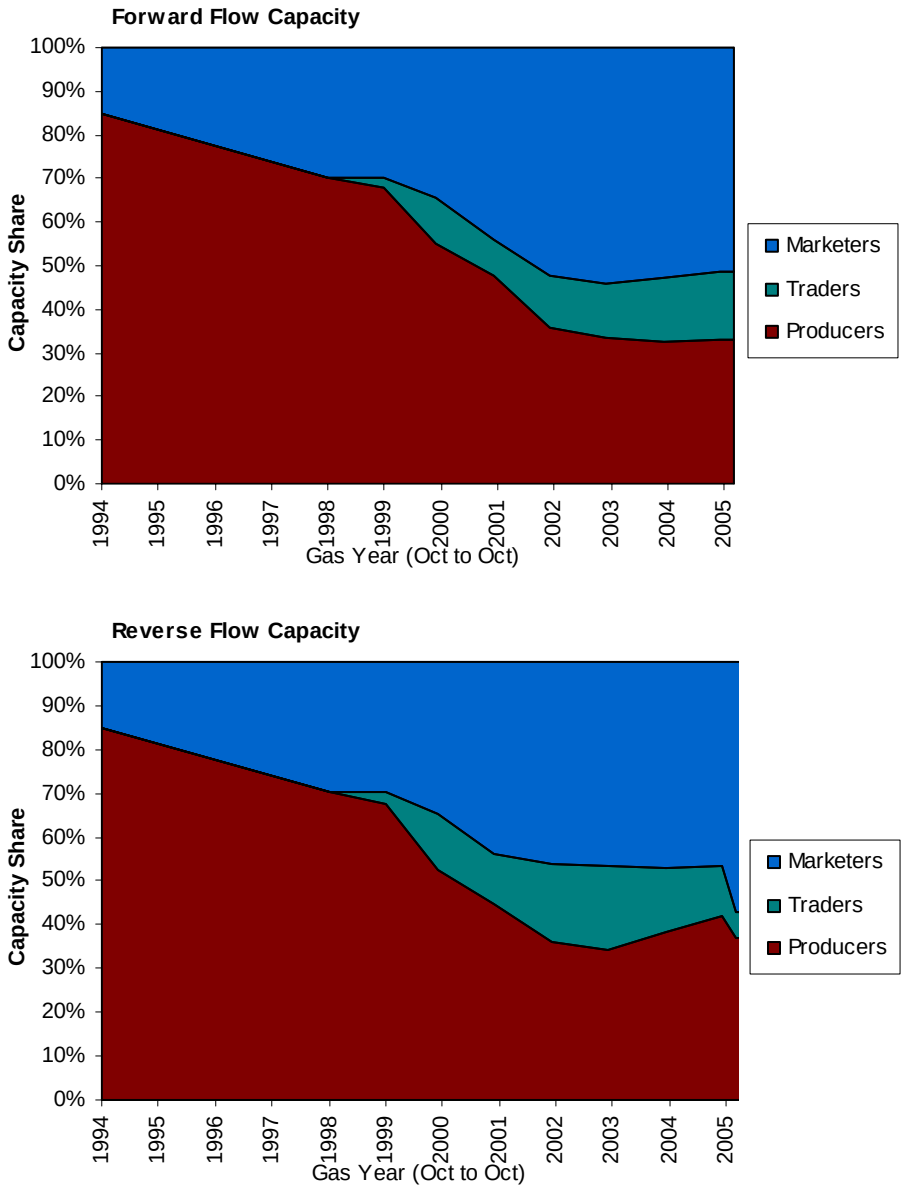

Figure 5: Changes in Capacity Holding (Source: Interconnector)

3.4.2 Value of Capacity

Capacity trades have been driven by the need to maximise the value of Interconnector capacity which is utilised on a 'send or pay' basis. If capacity is underutilised, it soon becomes a liability for the shipper as the monthly bills continue to arrive.

Evidence suggests that the value attached to Interconnector capacity has varied greatly over time. For each of the three development stages (initial construction and reverse flow enhancements), the available capacity has been fully subscribed at the price required to ensure project viability. However, at other times, the secondary market for Interconnector capacity has been weak, particularly in the case of long-term capacity sales. For certain capacity transactions, the capacity holding has been regarded as a liability with the seller paying the buyer or capacity being combined with shareholding to create value for the buyer.

3.5 Market Expectations

The wider gas market was highly divided on the benefits of the Interconnector and the rationale of the participants.

Wood MacKenzie, an authority on gas market matters and advisor to both Interconnector (UK) Limited and the UK government took particular issue with the concept that UK gas could be easily marketed in mainland Europe.[19] The largest and closest markets in Western Europe were mature, with long-term supply contracts already in place. Even when these expired, rollover terms would be attractive to marketers in comparison to UK gas. Imports into Italy and Spain were constrained by limited capacity at the northern borders. Eastern Europe, despite its strong growth, offered no proximity advantage relative to cheaper Russian gas, and suffered from poor infrastructure.

'European Gas Markets' was far more bullish about sales opportunity in mainland Europe. They forecast that participants would be successful in breaking into the closed markets of Western Europe. They also questioned the assumption of predominant forward (UK export) flows, highlighting the uncertainty with respect to both volume and direction of flow.[20]

The view on whether the Interconnector would have any significant impact was also divided. The line was described as 'just a piece of debottlenecking of the European gas grid'. The phrase 'white elephant' was even coined. However, it was also recognised that although the capacity and projected flows were small (less than 5 percent of the European gas market), the impact would be large. A report by EJC Energy in 1998 forecast that the opening of the Interconnector would lead to significant structural changes in European gas markets, with 'the emergence of trading hubs at key connections' such as Zeebrugge.[21] Many continental players felt that the complications of the liberalised UK market would make an unwelcome contribution to an otherwise fully functioning continental market, leading to the description of the project as a 'dirty needle in a healthy body'.

The industry press publication, 'Gas Matters' expressed concern at an early stage that the level of political interference in the project would compromise its ability to act as a successful commercial venture, serving the needs of pipeline users. The scepticism of political driving force led to the project being dubbed as the 'Politipipe'.[22]

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[19] The Interconnector and European Gas Markets, Wood Mackenzie, March 1995.

[20] EGM Comments, *European Gas Markets Review*, April 1995.

[21] Natural Gas Trading in Europe: Liberalisation and its effect on Long-Term Contracts, EJC Energy, Nov 1998.

[22] Politipipe Fate Due Dec. 8, *Gas Matters*, 28/11/1994, p.32.

4 CREATING THE INTERCONNECTOR

4.1 Financing

Financing the Interconnector presented significant challenges, not least because of the diversity of the participants. Shareholders had varying ability to raise funds for an equity injection due to differences in credit rating and size relative to investment. Achieving the right financial solution also required compromise on corporate policies and culture and attitudes to guarantees relative to loans.

4.1.1 Original Financial Structure

Various options were considered for financing the £450 million cost of building the original Interconnector system and to fund the business' working capital.

For a pure equity solution, shareholders fund the capital expenditure in their due proportion. This option was rejected due to the high cost of capital compared to the alternatives. Since tax is paid on income after interest on debt, the tax payments are higher for equity funded projects.

With project financing, the construction is funded primarily by debt which is repaid during the project lifetime. A debt, or project financing solution, was controversial since shareholders would take a proportion of the profit with zero risk, all the risk being borne by the capacity holders. Although there was no distinction between share and capacity holders initially, this was not expected to remain the case.

Under a finance lease arrangement, the asset is owned by a leasing company to which the lessee pays rent for use of the facility. In the UK, the main benefit of a finance lease was the ability of the leasing company to utilise capital allowances during the construction period to reduce tax paid on profit in other parts of the lessor's group. Under a traditional financing structure, there would be no profits during the construction phase for the capital allowances to be offset against, and the allowances would have to be carried forward for offset at a later date, with corresponding losses due to the time value of money. IUK represented a classic candidate for a lease due to the capital intensive nature of the project.[23]

A framework of ground rules was agreed to accommodate the different priorities and concerns of the shareholders. The rules are listed in the Interconnector Shareholders agreement as:

- guarantees to be several,
- no cross-defaults,
- no assignment of assets or revenue streams,
- use of assets to be safeguarded and
- maximum equity to loan ratio of 10 percent.

Based on these rules, a complex financial structure was set up to minimise the net present cost of the construction. The final structure combined finance leasing, debt and shareholder equity. As a strategic European energy infrastructure project, IUK was able to take advantage of the source of funding available from the European Investment Bank (EIB). This loan was guaranteed by the shareholders. Separate loans were required from shareholders with insufficient credit rating to guarantee their share of the EIB loan. The loans and equity were

[23] Most of the cost was incurred during the construction phase before any income was generated through capacity charges.

deposited in two banks to provide collateral against a finance lease obtained from the Abbey National Bank. The structure is summarised in Figure 6.

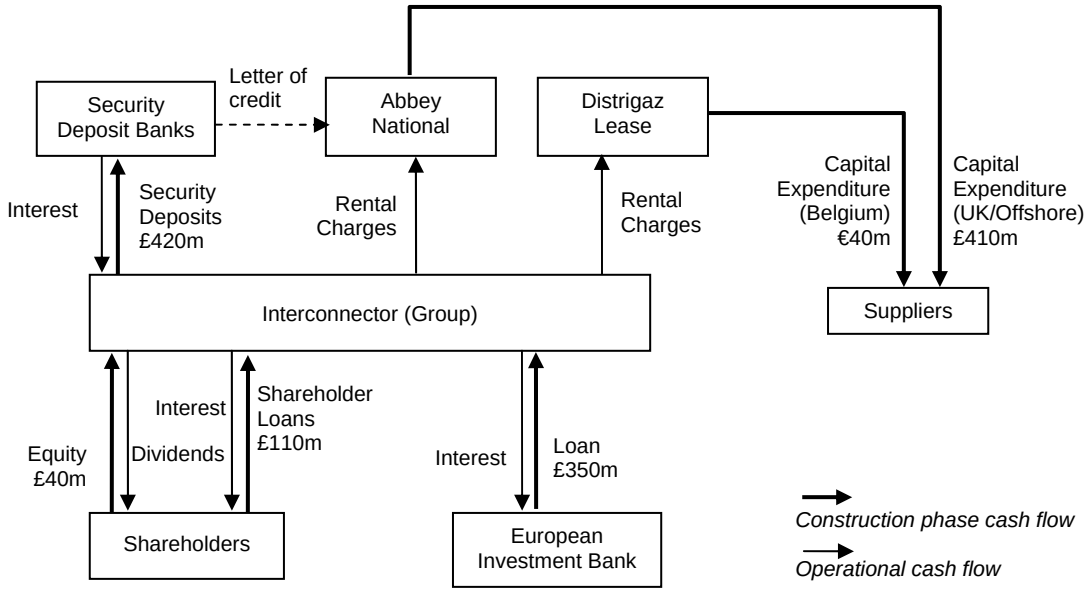

Figure 6: Construction Phase Financial Structure (Source: IUK. Figures are Approximate)

The equity was based on a valuation of the intellectual capital created during the two-year study group exercise. Those leaving the study group sold their stake to the new shareholders from outside the group. In addition to the original £10 million valuation, shareholders injected an additional £30 million in the form of a share premium.

The Zeebrugge terminal could not be built and operated by IUK, a UK company, so a Belgian subsidiary was established, jointly owned by Distrigaz. Due to the complications of cross border investment, a lease provided the optimum practical funding route for the Zeebrugge terminal.

During the first few years of operation, the income stream was high compared to typical projects due to the 'send or pay' capacity sale terms.[24] This resulted in a significant cash balance which could be used to pay off the shareholder loans,[25] the share premium and a significant portion of the leased funds from Abbey National.

4.1.2 Financing the Enhancement

The enhancement project (see Section 8) first became a possibility during 2002 and various funding options were considered.

The cash balance remained high, providing the opportunity to fund the enhancement without additional debt or equity. However, under the terms of the Abbey National finance lease, no funds from the security deposits could be released, even though part of the lease had been repaid. This restriction, together with the reduced attractiveness of finance leasing following the passing of new UK tax laws, led IUK to buy the Interconnector leasing subsidiary from Abbey National.

[24] In a typical project, sales will gradually grow to a stable level or at least stable annual growth. In the case of the Interconnector, sales reached the maximum potential in the first year of operation with no subsequent growth.

[25] With the exception of those required to guarantee the EIB loan.

However, the same practical problems of construction in Belgium remained, so an operational lease arrangement was needed. A lease structure was successfully negotiated with Fortis Lease, a subsidiary of Fortis Bank in 2004. The resulting financial structure is shown in Figure 7.

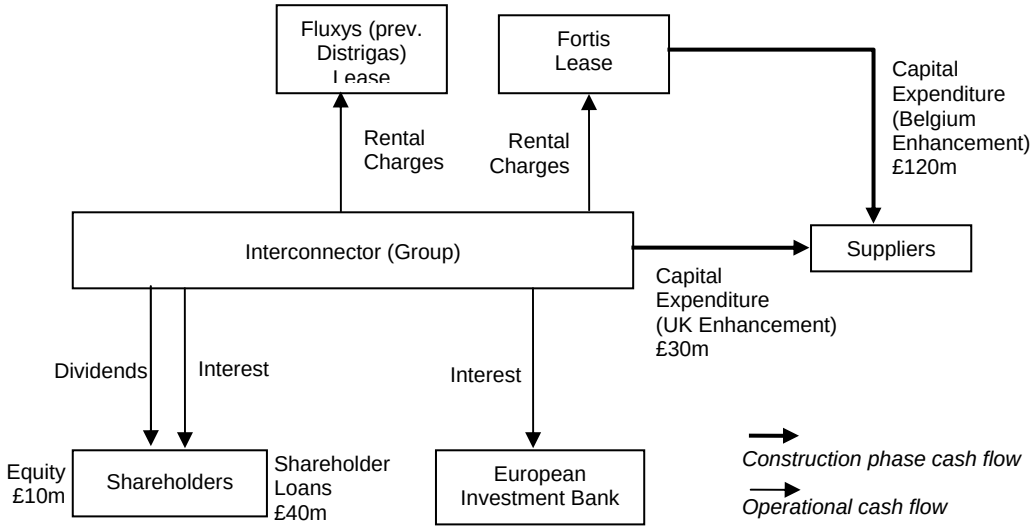

Figure 7: Enhancement Phase Financial Structure (Source: IUK. Figures are Approximate)

4.2 Alliance Structure

Due to the number of organisations working together on the initial construction project, an alliance strategy was chosen for the Interconnector, the first time it had been used for a major offshore trunkline. Essentially, an alliance is an agreement between the client, principal contractors and major suppliers to share the risk and reward of the design and construction. A cost estimate is set and cost savings and overruns relative to this estimate are shared in an agreed formula. Incentives are also put in place to ensure schedules, quality, operability, safety and environmental targets are also met.

Separate alliances were set up for the onshore and offshore works. The alliance structure provided an incentive for project participants to work more closely together and to identify ways to offer improvement across the spectrum of technical, environmental and safety challenges. A review of the technical aspects of the construction project highlighted that 'excellent relationships were established with the key suppliers of compression equipment who on more than one occasion took actions to help the project beyond the call of strict contractual requirements'.[26] The cost benefits of the alliance approach were demonstrated through the reduction from the original estimate of £500m to an actual spend of £456m.

However, the cost savings may have in part been an illusion. Under alliance structured contracts, there is a potential incentive for contractors to reduce up-front costs at the expense of long-term operating costs. It is not possible to include incentives for long-term reliability and operability of plant, so the tendency is to use cheaper materials for the project with lower capital costs, but resulting in higher operating costs and lower reliability.

[26] The Interconnector Project − Meeting the Technical and Environmental Challenges, Chris Marchant, Exploration & Production Technology International, 1998.

At the time of the Interconnector construction, alliancing was popular throughout the industry, but has since lost favour. For IUK's own capacity enhancement (see Section 8), alliancing was not used, suggesting an overall preference for more traditional methods of project contracting. However, the principle of binding contractors together with joint performance bonus incentives remained.

4.3 Technical, Environmental and Planning Challenges

The design and location of the Bacton terminal presented a major obstacle. Despite pressure from central government, the local planning authorities refused planning permission for the proposed greenfield site. The plant layout had to be effectively redesigned to incorporate the site within the existing British Gas terminal, above existing pipework and in an extremely space efficient layout.

Both terminals are located in scenic coastal areas. Zeebrugge, as well as housing an industrial port is a major tourist centre. Between the popular tourist beach and the Interconnector Zeebrugge terminal are coastal dunes, freshwater lakes, a nature area with rare orchids and a polder[27] of historical significance located below sea level. Preventing any disturbance to the natural environment was essential. The solution chosen was to drill the 450 metres from the beach to the polder, following a path set by rock strata experts from the University of Ghent to prevent salt water contamination of the lakes or polder. All work had to be scheduled to avoid conflict with the crab fishing, tourist and bird migratory seasons. A photograph of the drilling works is shown in Figure 8.

Figure 8: Drilling under the Freshwater Lake and Dunes at Zeebrugge

The offshore pipeline route had to negotiate a number of obstacles, including fishing grounds, dump sites, military training areas, wrecks and existing cables. It also crosses the Scheur channel, which takes all traffic to Zeebrugge and Antwerp, the second largest port in Europe. The pipeline under this channel had to be laid in a deep trench without interruption to shipping movements.

On completion of construction, the pipeline was pressure tested with water to ensure its integrity before filling with high pressure gas. Due to the volumes involved (enough water to

[27] A polder is an area of reclaimed land below sea level, protected by dikes.

fill five Olympic size swimming pools), this had to be done using seawater. Conventionally, the seawater is treated using an oxygen scavenger, a corrosion inhibitor and a biocide in order to prevent corrosion. Concern was expressed by the authorities concerning the effect of biocide on the local marine environment, which stimulated academic research into alternatives. By restricting the duration of the tests and using freshwater plugs to wash out the line before drying, corrosion free testing could be carried out without the use of biocide. This set a new benchmark for such tests.[28]

4.4 Inter-Governmental Treaty

The Interconnector system spans two countries and international waters. An inter-governmental treaty was required to set the rules of operation and taxation basis for the Interconnector. To enhance the strength of the Belgian bid for the selected European landfall, the Belgian government agreed to give up its taxation rights for the offshore line. The treaty required ratification by each parliament, which caused significant delay in Belgium due to the process of regional devolution: the Flemish regional government initially disputed the federal government ratification.

Two companies were therefore created, the main company Interconnector (UK) Limited to own and operate the UK terminal and offshore line and a second, Interconnector Zeebrugge Terminal SC/SV, to own and operate the Belgian onshore infrastructure. These companies were established under UK and Belgian law respectively.

[28] Pipeline Construction and Reinstatement: a focus on environmentally sensitive sites, Mike W O'Connor, *Pipes and Pipelines International*, November 1998.

5 BUSINESS RULES

A major challenge throughout the Interconnector's ten-year history has been to develop and continually evolve a set of commercial rules to manage flows through the pipeline. This section considers the original and modified rules and their impact on Interconnector operation and the wider gas markets.

The basic rules divide the pipeline capacity between the capacity holders and treat each quota as an independent 'pipe within a pipe'. Shippers are required to notify[29] the operator, IUK, of flow requirements one day in advance and ensure that flows to and from the line are matched with flows to or from the connected systems. Actual gas flow is then metered and divided between the shippers in proportion with nominations. IUK does not own any gas in the line, so gas flow into and out of the line by each shipper must be controlled to ensure that linepack remains within operating limits.[30]

The business rules are set out in the Standard Transportation Agreement (STA), a common contract between IUK and its shippers. This contract was originally drafted by the study group members and signed up to by the initial investors, but has been regularly renegotiated in response to changes in the marketplace created by the Interconnector itself.

A key factor underlying the development of the business rules is the requirement for unanimity. Each shipper has the right to veto any change to the STA which has resulted at times in a lengthy and frustrating negotiation process. As a result, business rule changes have tended to be complex, reflecting a number of trade offs between divergent interests.

5.1 Flow Direction

The initial concept for the Interconnector was a UK export only line with the potential for addition of import facilities at a later date, in line with the interests of the UK government and UKCS producers. An export only line would in theory place a lower limit, or 'floor', on UK spot gas prices, enhancing the value of reserves supplying the UK. The possibility of gas imports would have the opposite effect, setting an upper limit, or 'ceiling' on UK spot gas prices. The concept of reverse flow was therefore strongly opposed by the UK producers and UK government members of the study group.

Much to the annoyance of the opponents of reverse flow capacity, the design engineers concluded that the design could be modified at just 1 percent of the total project cost to enable the infrastructure to 'suck' gas into the UK, albeit at less than half the capacity of the UK export mode. This, together with an increasing number of credible import scenarios, made pressure from the continental members of the study group difficult to resist. The acceptance of reverse flow became inevitable when a large number of capacity bids were also conditional on this facility.

This unique bi-directional design led to the concept that the Interconnector may act as a 'two way valve' between the connected gas markets, although in reality the changeover takes some time. Before the installation of compression at Zeebrugge in 2005, it was necessary to either raise or lower the inventory of gas in the line. To change from forward (UK export) mode to reverse required the depletion of pipeline inventory and vice versa. Since IUK owns no gas in the line, this was the shippers' responsibility and generally required significant volumes of

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[29] See Section 5.2 for details of the Nominations procedure.

[30] Too little gas in the pipeline would result in a pressure below that of the connected systems, thus preventing gas flows. Too much gas in the pipeline would result in a pressure in excess of safe operating limits. A reasonable analogy can be made to a car tyre: pumping in too much air will cause it to burst and too little will cause it to deflate.

gas to be sourced or disposed under unfavourable market conditions. This, naturally, had a major impact on market prices (see Section 7.3).

For shippers with long-term export contracts in place, the incentive was to make flow transitions as restrictive as possible to minimise inventory change obligations. For importers and traders, flexibility was key and the negotiation objective was the opposite to that of the exporters.

The original business rules provided for transition decisions based on a forecast of nominations provided each Friday for the following week, a small victory for the exporters. The limited flexibility and long lead time were partly based on the false expectation that changes in flow direction would be infrequent. Once flows began in 1998, the frequency and market impact of flow transitions became apparent. In particular, the change to reverse flow after three months of operation came as a surprise to many. Pressure thus mounted, both from the shipper community and the EU commission, to make flow transitions quicker and easier. In simple terms, the rules were modified to enable flow transitions to be executed with only a day's notice, but with additional rules to prevent excessive changes on subsequent days. These new rules were introduced in 2003.

The result has been a significant increase in the frequency of flow transitions and a decrease in the number of 'capping' days where shipper nominations are cut back to maintain the flow direction at the time. Whether or not this is a positive development is subject to whether the reduction in 'capping' is considered to outweigh the requirement to pack and unpack the line for more regular flow transitions. Either way, the development has certainly increased the flexibility and market responsiveness of the Interconnector.

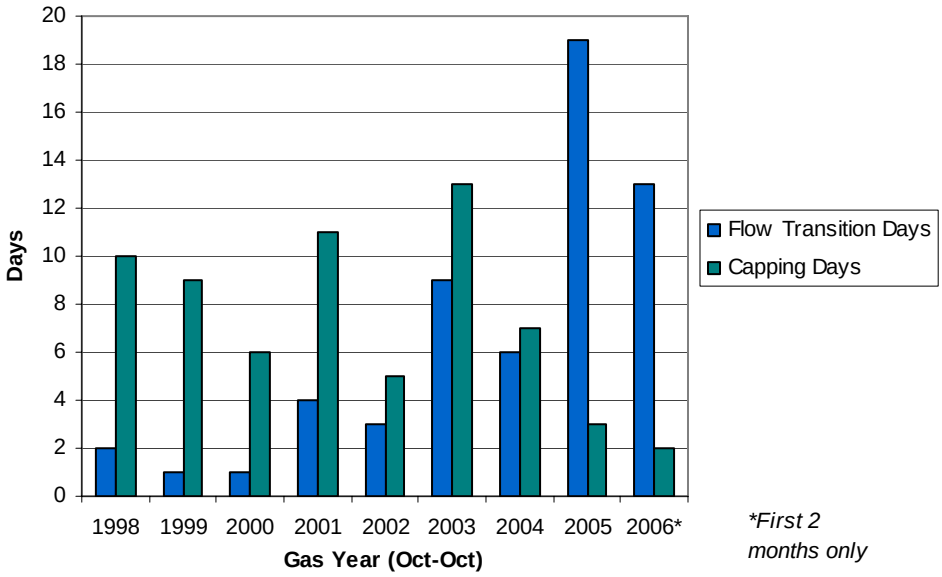

Figure 9: Number of Flow Transitions and Capping Days per Year (Source: Interconnector)

With the completion of the reverse flow enhancement project (see Section 8), the restrictions associated with changes in flow direction have been significantly reduced. Since the pipeline operates at high pressure in both directions, there is no need to add or remove gas from the line, allowing transitions to take place more quickly and at shorter notice. The latest rules, introduced in November 2005, allow for changes in flow direction with 4 hours notice and a 4 hour interruption to change the plant configuration. This change should eliminate restrictive capping days and flow transition days.

5.2 Nominations

Due to the bi-directional nature of the line, shippers are able to flow gas into or out of the line at either end. These flows are made up of a number of individual trades which may even be in more than one direction at one time for a given shipper. The net result of these trades at each connection is the shipper's nomination.

In order to enable system management by IUK and the adjacent transporters, shippers are required to notify the system operators of flow requirement in advance in the form of nominations. Interconnector nominations must pass through a number of checks before the flow requirement is actioned. Firstly, the nominations for flow into or out of the Interconnector must match with those out of or into the connected systems. Second, they must not exceed the shipper's capacity and third, they must not cause the shipper to breach their inventory limits. Nominations may be cut back in the event of a plant interruption.

Under the original concept, nominations would be supplied one day in advance, but shippers asked for greater flexibility to modify nominations at short notice. This led to the creation of two classes of nomination: firm as the highest priority and reasonable endeavours as the lower priority.

A third priority was later created with the introduction of Interruptible Capacity in 2000. This enables shippers to utilise capacity above their limits if system conditions result in a total available capacity higher than the design.

5.3 Capacity and Inventory Trading

The ability to trade Interconnector capacity was a key requirement of the business rules from an early stage. In the initial prospectus, the study group proposed three methods of capacity trading which were later implemented in the business rules: sub-letting, assignment and pooling. Unused capacity can be sub-let to a third party with the original capacity holder remaining the contractual counter-party with IUK. Going one step further, the full capacity rights and obligations can be assigned. Prices and conditions for sub-letting and assignment are negotiated between the parties involved. 'Pooling' enables small portions of capacity from different shippers to be marketed collectively by IUK.

5.3.1 Flexible Trading

In response to pressure from industrial users and government following investigations into cartel-like behaviour among Interconnector users and the potential for regulation (see Section 3.2.2), flexibility mechanisms were introduced in April 2003 to make access to Interconnector capacity easier and to reduce any potential for capacity 'hoarding'. At the same time, the facility to trade gas between users of the line was developed, creating the potential for the line itself to be a trading point. To increase transparency, a bulletin board was created to enable shippers to offer or bid for capacity or inventory, with optional publication to a wider audience via the worldwide web.

5.3.2 Capacity Liquidity

Capacity liquidity is presented in Figure 10 in terms of the percentage of total capacity which is traded for a given time period. If a portion of capacity is assigned, then this is treated as a traded quantity for all future time periods, and if a portion of capacity is sub-let for a fixed period, then this is counted as traded capacity for the duration of the sub-let only.

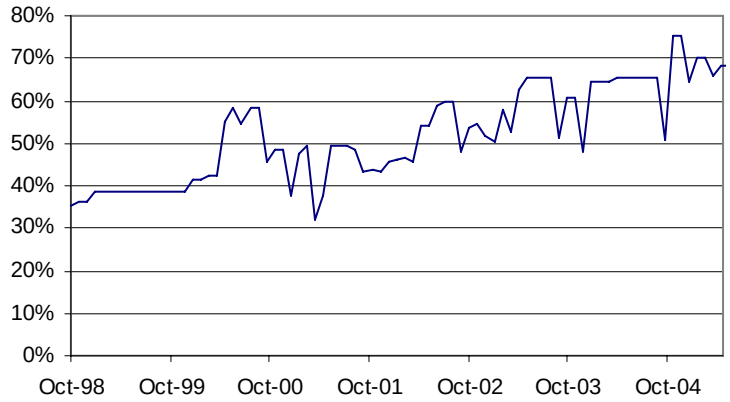

Figure 10: Percentage of Capacity Traded for a Given Month

Figure 10 shows a gradual increase in capacity liquidity over time, although this can be partly accounted for by the compounding effect of long-term trades. Notably, there is little increase in liquidity following the introduction of the more flexible trading mechanism in 2003.

Approximately 50 to 100 percent of gas is traded prior to utilisation. While this is a small fraction of trade values for commodities,[31] Interconnector capacity appears to be reasonably liquid. However, when measured in terms of deals done annually, Interconnector capacity trades are much fewer than the several hundred deals per year recorded for the most liquid gas pipelines in the USA.[32]

5.3.3 Capacity Utilisation: Long-term Contracts

The original concept for the Interconnector was an export line for surplus UKCS gas. Correspondingly, the initial business model for participants involved securing long-term export contracts with continental marketers. Figure 11 shows the proportion of forward flow capacity used to supply long-term export contracts based on capacity holding as at October 1998.

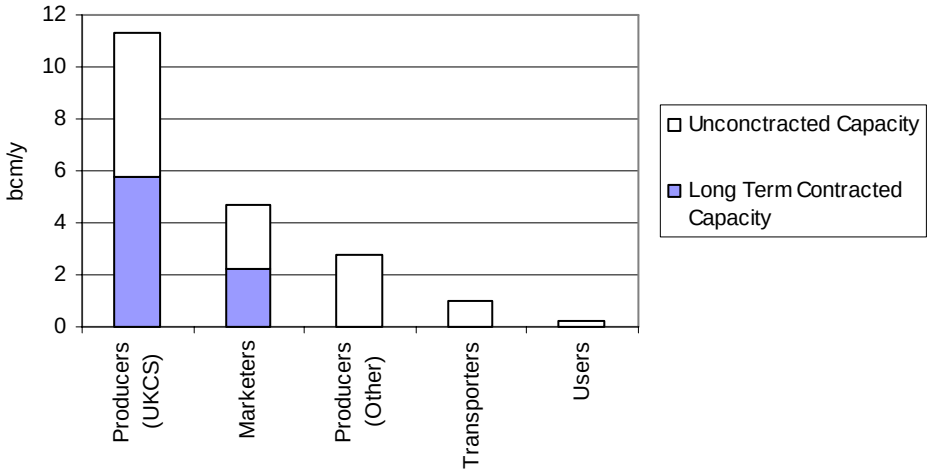

Figure 11: Long-term Gas Sales Contracts

[31] In a liquid market, the commodity is traded many times over leading to a trade ration of several hundred percent.

[32] Top Twenty Most Active Pipelines (www.capacitycenter.com/News20Most.asp)

Although successful negotiation of these contracts demonstrated the competitiveness of exported UKCS gas in continental Europe, the sales were not by themselves sufficient to fully utilise Interconnector capacity. This ultimately led to the observed sale of capacity rights from UKCS producers to other Interconnector users.

5.3.4 Capacity Utilisation: Short-term Trading

Figure 12 shows the percentage of capacity utilised by different Interconnector shippers on a given day during the winter of 2003/4. On the day in question, demand was high in the UK with corresponding high prices and Interconnector imports. A positive differential between the NBP and Zeebrugge Troll prices would be expected to give rise to high Interconnector imports.

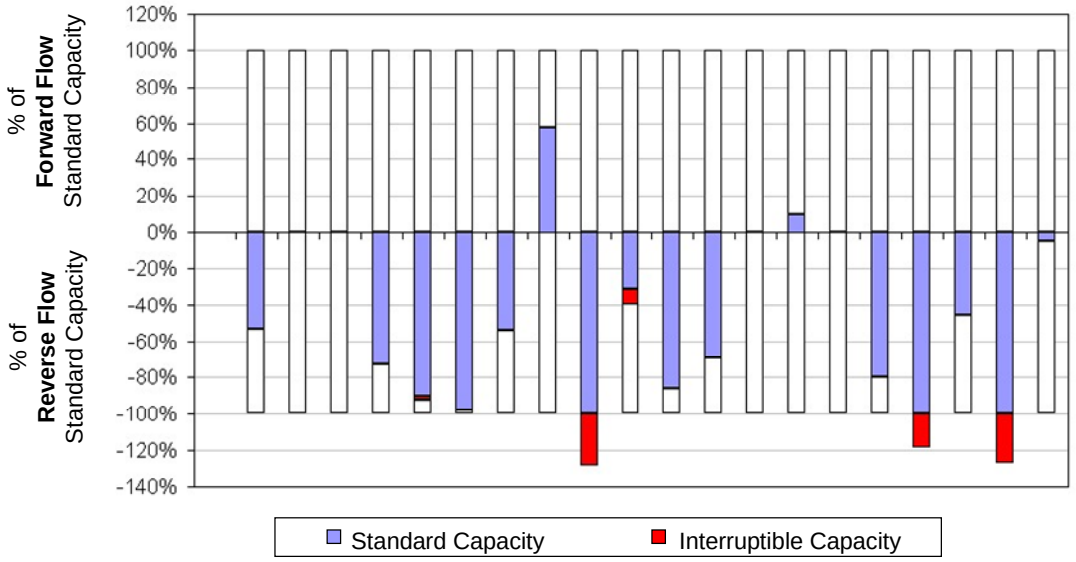

Figure 12: *Capacity Utilisation for a Typical Winter's Day (Source: Interconnector)*

Several important observations can be made from these data. Only four of the twenty shippers utilised their capacity in full, each of these also invoking their right to use additional interruptible capacity (see Section 5.2). Other shippers used lower capacity levels and some used none at all, or exported. Clearly, the twenty shippers have different driving forces for their capacity utilisation, with only some being fully responsive to market prices. A much clearer market response would be expected if the Interconnector was being used purely to profit from the arbitrage between the two ends of the pipeline, but in reality, for most shippers, the Interconnector represents a small part of the value chain between wellhead and burner tip. Most shippers use the Interconnector to manage their portfolios. In some cases, this will involve supplying European customers with gas supplied from the North Sea, hence nominating contrary to the prevailing flow and price direction. Typically, contra-flow nominations are equal to approximately 10 percent of net flows.

5.3.5 Inventory Trading

Very little inventory has been traded using the inventory trading mechanism. Where it has been used, the application has been operational rather than commercial. For example, a shipper breaching its high inventory limit may wish to sell gas to a shipper with a low inventory account.

The low levels of inventory trading within the pipeline are not surprising given the more effective and liquid trading hubs either side of the Interconnector.

5.4 Variable Inventory

IUK shippers own the gas within the Interconnector system. As part of the flexibility enhancements to the business rules, the facility was added to vary this quantity of gas, subject to operational limits. This provides a limited storage service to shippers, but more importantly offers a buffer to protect against imbalance penalties in adjacent systems.

Analysis of shipper activity indicates that the variable inventory service is used regularly and effectively by a limited number of pipeline users. Figure 13 shows the inventory profile for a single shipper on a given day.

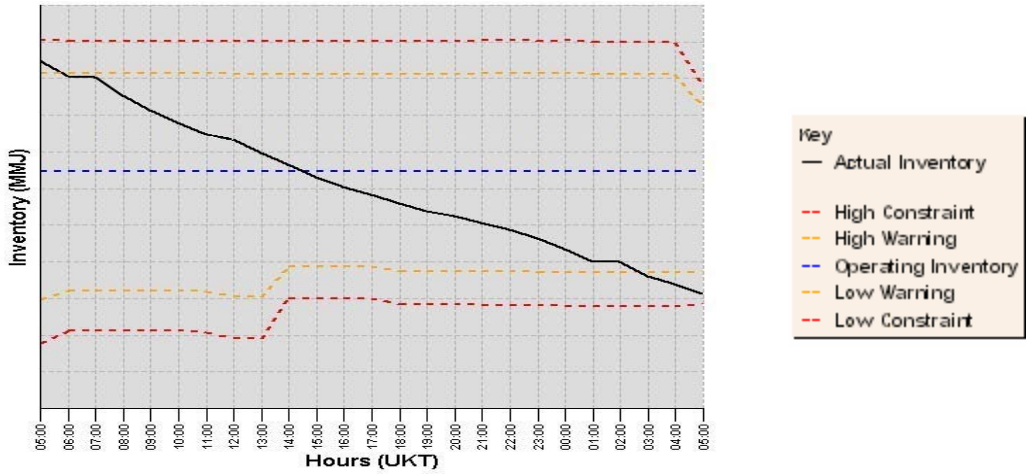

Figure 13: Sample Interconnector Shipper Inventory Account (Source: Interconnector)[33]

On the day in question the price of gas at the NBP was 7p/th higher than the previous day. The shipper had increased its inventory using gas bought at 28p/th and returned that gas to the market at 36.8p/th.[34]

5.5 Direct Access Connection

To avoid transportation charges in the UK grid, a consortium of gas producers with equity in the Shearwater and Elgin fields in the central North Sea, chose to deliver gas directly to Bacton, partially in order to access the markets of the South East directly, but primarily to access the Interconnector pipeline without paying UK transport grid charges.

A direct connection was built connecting the onshore facilities for this line with the Interconnector Terminal at Bacton. This resulted in significant complications for the business rules and physical control of gas flow through the terminal. The cost of these changes, plus the cost of the connection itself was borne entirely by the direct access partners.

Despite completion of engineering works in 2001, the line has seen very low levels of utilisation. Commercial differences between the pipeline operator and onshore terminal operator have been cited as a potential explanation for the lack of sustained commercial flows.

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[33] The chart is taken directly from the Interconnector Shipper Information System. The pipeline itself must contain a certain volume of gas (within a limited range) to enable gas to flow. This gas, referred to as inventory, is owned by the shippers, rather than IUK, and each shipper is responsible for maintaining their share of this inventory. The operating inventory is the midpoint, or recommended inventory level. The constraint levels represent the maximum and minimum allowed inventory levels for the shipper, which if exceeded, will result in a reduction in nominations. A warning is issued to the shipper if the warning levels are breached.

[34] Price source: Heren.

5.6 A Complex System

The business rules are implemented by the gas management system, ISIS,[35] which also acts as the communication interface between IUK and its shippers. Due to the unique nature and logical complexity of the business rules, a proprietary software system was required. The large volume of information (twenty shippers,[36] three connection points, multiple trades, 24 hourly periods) is processed by a database system.

Since their initial drafting ten years ago, the business rules have continually evolved in response to shipper requirements and the changing market environment. This is a commendable achievement, given the need for unanimous agreement between all capacity holders. However, the need for unanimity has in some cases created additional complexity with the final solution representing an imperfect compromise.

The modifications resulted in the creation of a complex and sophisticated system providing a flexible and market responsive transportation service to pipeline users. However, the business rules are arguably now too complex for new users to fully understand, possibly preventing new shippers from successfully accessing IUK transportation capacity.

With hindsight, it is also questionable whether some of the changes, such as Inventory trading, were necessary. The development of a complex set of rules is driven partly by the need to satisfy the varying interests of a diverse group of pipeline users, but also by the charging structure. Since all costs associated with the business rules are capitalised and paid for through shipper tariffs spread over a twenty-year period, there is no upfront investment by those requesting and using the system improvements, and therefore potentially no need to justify the investment in terms of an anticipated return. This postulation is supported by the fact that some modifications, such as the development of short-term capacity trading, are under-utilised with limited tangible results.

[35] Interconnector Shippers Information System

[36] This was the number of shippers at the time of writing. There is no limit to the number which can be entered in the system.

6 FLOW AND PRICE TRENDS

The completion of the Interconnector pipeline created a new market reality. No longer was the UK a gas island with prices driven by local supply and demand, but connected to a larger European network. The impact of the connection on markets at both ends of the pipeline is discussed in the paragraphs that follow. An analysis of flow trends is also included in this section.

6.1 Arbitrage

The concept of arbitrage is important to understanding the driving force for Interconnector flows and their effect on UK and continental gas markets.

Arbitrage is the opportunity to purchase a commodity in one market and simultaneously sell in a different one to take advantage of a price discrepancy. As long as a price difference exists and there is an unconstrained opportunity to sell from one market to another, then the two markets will tend to converge in price. Constraints on trading between markets are: limitations in liquidity of competition in either of the two markets, and limitations on the ability to transport between the two markets.

In the case of the Interconnector, the pipeline represents a physical link between the UK gas market and those in continental Europe. While the UK NBP gas market is liquid and competitive, this is not yet the case in the major markets of North West Europe.[37] Arbitrage exists between gas sold at the two ends of the pipeline. At the UK end, gas is actively traded at the NBP. At the Zeebrugge end, the market has access to gas arriving from the Norwegian Troll field via Zeepipe (the main price marker for continental Europe), from Algeria by LNG and from the Netherlands.

A reasonable measure of price differential is the difference in gas price between UK NBP and Zeebrugge Troll. Figure 14 demonstrates a correlation between flow rate and NBP-Troll price differential. During certain periods, the correlation breaks down indicating inefficient arbitrage, most notably during the unplanned Interconnector outage during July 2002 (see Section 7.2.3).

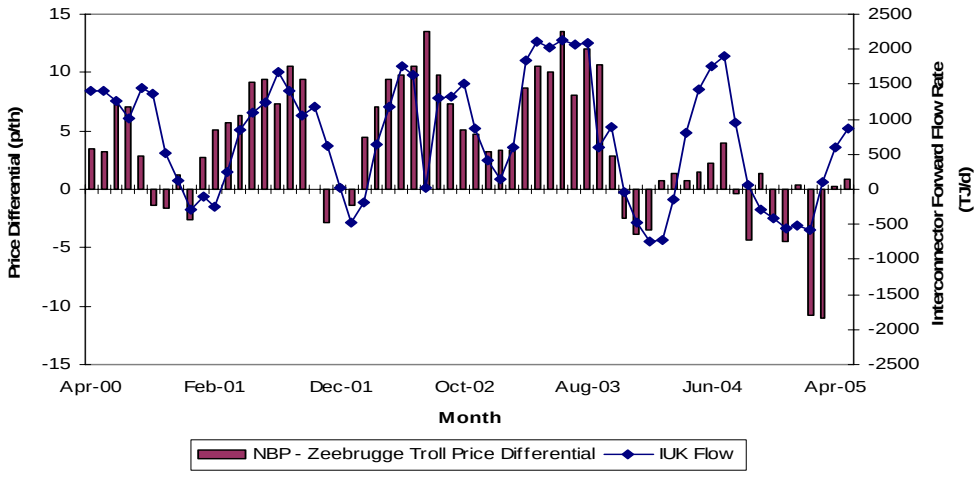

Figure 14: Response of Interconnector Flows to Price Differential (Source: Gas Strategies, Heren and Interconnector)

[37] European Commission Enquiry into Anti-competitive use of the Interconnector, March 2002 (europa.eu.int/rapid/ reference=IP/02/401).

6.2 Pipeline Flows

6.2.1 Flow Trends

Figure 15 presents flow data for the period 1998−2005 on a 30-day average basis. The data exclude flows which are constrained due to Interconnector operational constraints. Reverse flows are shown as negative values.

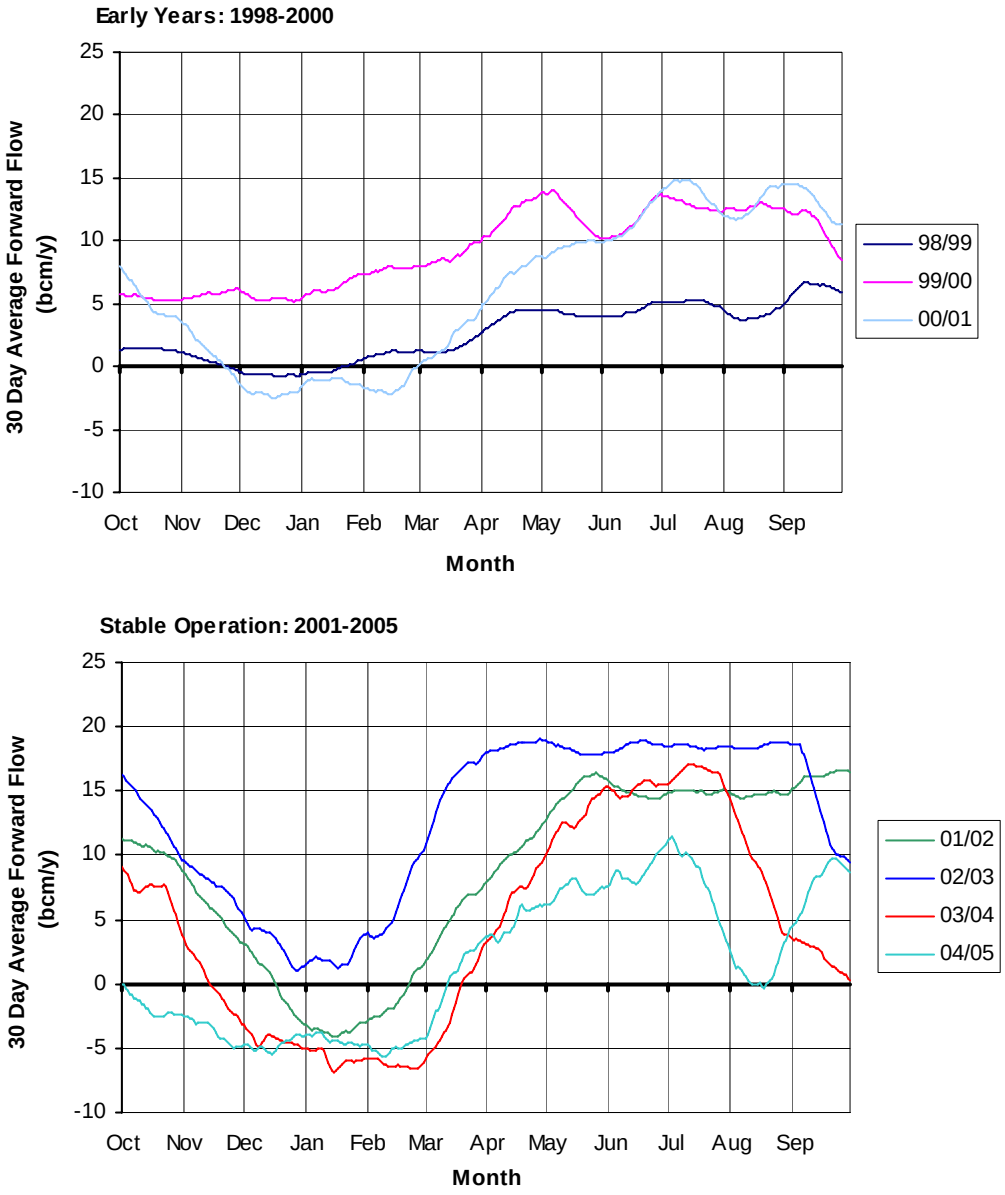

Figure 15: Year on year flow profile (Source: Interconnector)

During the early years of operation, flows displayed only a weak seasonal trend with slightly higher forward rates during the summer months. From 1998 to 2000, flow capability was not fully utilised, with peak flows at just 25 percent of capacity in 1998, significantly less than the total of agreed export contracts. During a question and answer session in 1999, IUK cited the netting off of import nominations against export nominations as an explanation for lower than expected flows. However, contra-flow nominations were not sufficiently high to account for the full difference between stated export contracts and actual flows, indicating that capacity holders found that supplying gas via the Interconnector was not the most cost effective way to meet their supply obligations agreed to justify their initial investment. In 1998, gas prices in

Europe were low due to linkage to falling oil prices, making the sale of gas to European customers by UKCS producers a less attractive prospect.

During the later years of operation (2001−2005), a clear seasonal profile is observed with high UK export (forward) flows during the summer and high UK import (reverse) flows during the winter. This change in flow pattern coincided with the opening of North West European gas markets following the implementation of the first EU Gas Directive. Market opening increased the opportunity for market players to buy and sell gas in Europe on a short-term basis.

The seasonal profile can be explained from both a supply-demand and a market perspective.

UK gas demand is highly seasonal and historically, swing has been provided by turning down dry gas (i.e. not combined oil/gas) fields, and limited use of storage. In comparison, continental demand is less seasonal with higher storage availability to match demand to the flat supply profile associated with most long-term contracted supplies. This allows larger continental markets to act as a pool to accept excess gas during the summer months, and supply the deficit to the high swing UK market in the winter.

The trend can also be understood by considering price structures at either end of the Interconnector. Supplies of gas into Zeebrugge are inelastic, with oil linked prices, and therefore display limited seasonal variation. NBP gas is available on a short-term basis and is hence more responsive to market conditions. Although arbitrage results in price convergence in the long term, higher seasonal variability of UK gas prices creates seasonal arbitrage and hence seasonal flow rates.

6.2.2 Flow Volatility

For the purpose of this analysis, volatility is defined as the weekly flow rate range, averaged over a one-month time interval. For example, to determine the volatility for February 2005, the difference is taken between the maximum and minimum flow rate during each week in that month, and an average of the four values taken.

During the early years of operation, volatility was relatively low due to the low flow rates. From 2000, volatility has generally remained around 5 bcm/y or 25 percent of pipeline capacity, a very high level. During a typical week, the flow rate can vary significantly, demonstrating the short-term response of shippers to market conditions.

There is a spike during 2002 due to the unplanned outage caused by liquids contamination (see Section 7.2.3) resulting in high flow rates falling to zero. More noteworthy is the marked drop in volatility the following summer reflecting a loss of confidence in the use of the Interconnector for short-term supply flexibility.

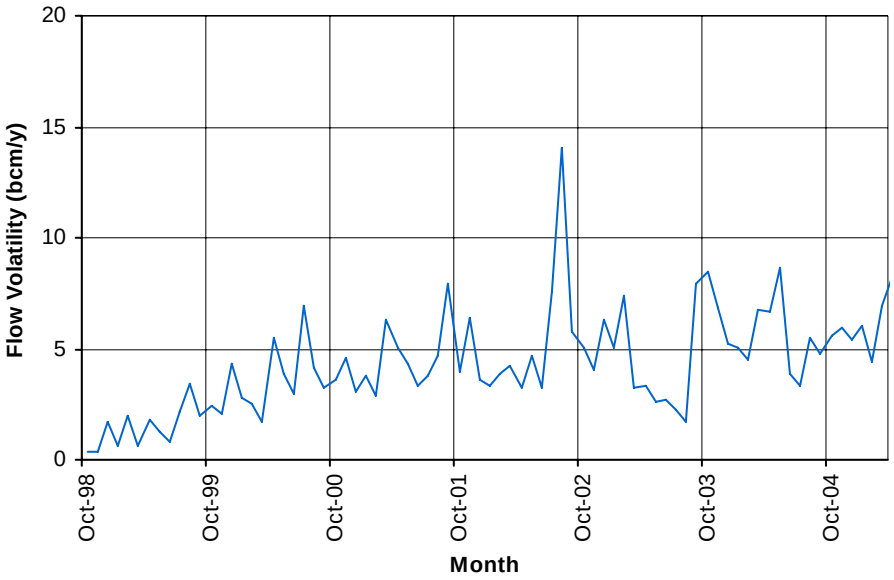

Figure 16: Interconnector Flow Volatility

6.3 Price Evolution

The combined gas markets of northwest Europe are approximately twice the size of that in the UK. The natural result has been that arbitrage has brought prices in the smaller UK market in line with those in Europe. The volume of UK gas introduced to the wider European market has been insufficient to make a significant impact on prices through competition. Lower than expected volumes of UKCS gas have been actively marketed in Europe due to falling UKCS production and the use of Interconnector capacity to access cheaper continental storage before ultimate return to the UK.

The three key gas price indices relating to the Interconnector are the UK NBP, Zeebrugge hub and Zeebrugge Troll. The first two are markets with spot trading for which indices are available: the UK NBP daily index indicates the value of gas in the UK; the Zeebrugge hub index indicates the value of spot gas traded at Zeebrugge, essentially an extension of the UK market onto the continent via the Interconnector. The Zeebrugge Troll price is set under long-term contracts, and is typical in pricing to the majority of wholesale gas sold in North West Europe.

Figure 17 shows the relationship between these three price indices. NBP and Zeebrugge hub prices normally converge, demonstrating the effectiveness of arbitrage between the two ends of the Interconnector pipeline. Convergence is lost when the Interconnector link is unavailable due to planned or unplanned outage (e.g. during the summers of 2002 and 2003). In comparison, there is much lower convergence between Zeebrugge hub and Zeebrugge Troll prices, reflecting inefficient short-term arbitrage between these two alternative sources of gas at the same point. This is due to the inelastic supply arrangements for gas from the Troll field landing at Zeebrugge. However, in the longer term, the Zeebrugge hub and NBP prices do track the Zeebrugge Troll price, but with added seasonal variability.

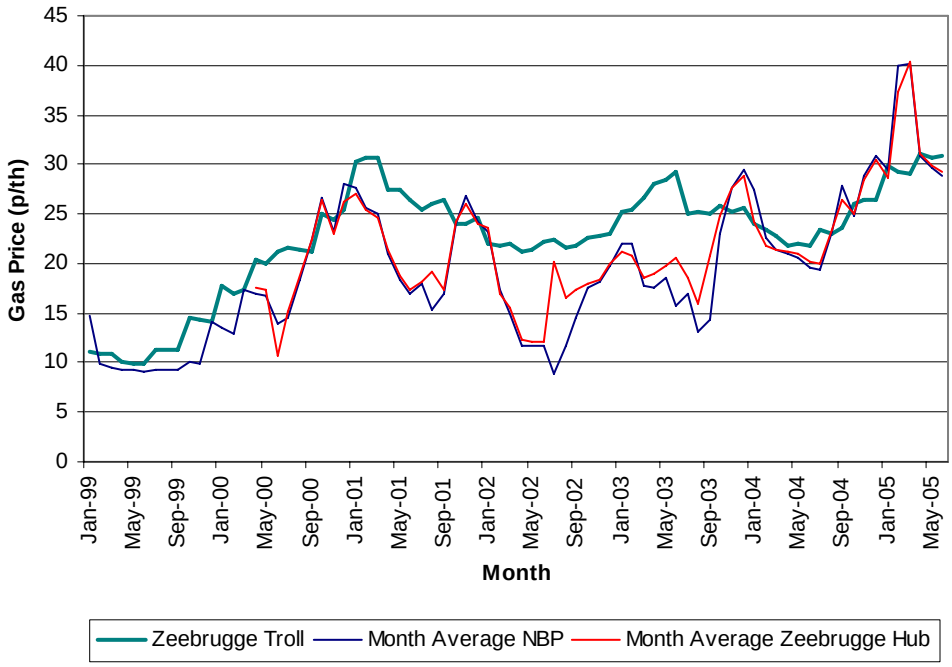

Figure 17: NBP, Zeebrugge Hub and Zeebrugge Troll Prices (Source: Gas Strategies and Heren)

6.3.1 Return to Oil Price Linkage in the UK

Most gas supplied to continental Europe is contracted on a long-term basis, normally with a link to oil prices. This arrangement has not been changed in response to the presence of the Interconnector, resulting in wholesale continental gas prices remaining oil price linked. In contrast, UK market trends have changed considerably since the completion of the Interconnector link, with a return to oil price indexation as demonstrated in Figure 18.

Three distinct phases are highlighted in Figure 18:

Phase 1: Pre-Interconnector and First Flow Year

Before initial Interconnector flows, and during the first year when flows were very low, the NBP price followed a clear seasonal pattern, independent of the falling oil price. The seasonal pattern indicated gas-on-gas competition was driving prices.

Phase 2: Direct Oil Price Linkage

Following the start of substantial Interconnector flows from late 1999, a clear correlation is observed between oil and gas prices with a three-month time lag. Contractual arrangements for Continental European supplies were passing through to the UK market.

Phase 3: Oil Price Linkage Plus Seasonality

From 2002, a new pattern is observed with a return to seasonality in NBP price, indicating renewed gas-on-gas competition, but with continuing long-term oil price linkage. This change corresponded to the opening of continental European markets in response to the first EU gas directive. Notably, UK gas prices have become much more volatile in this period.

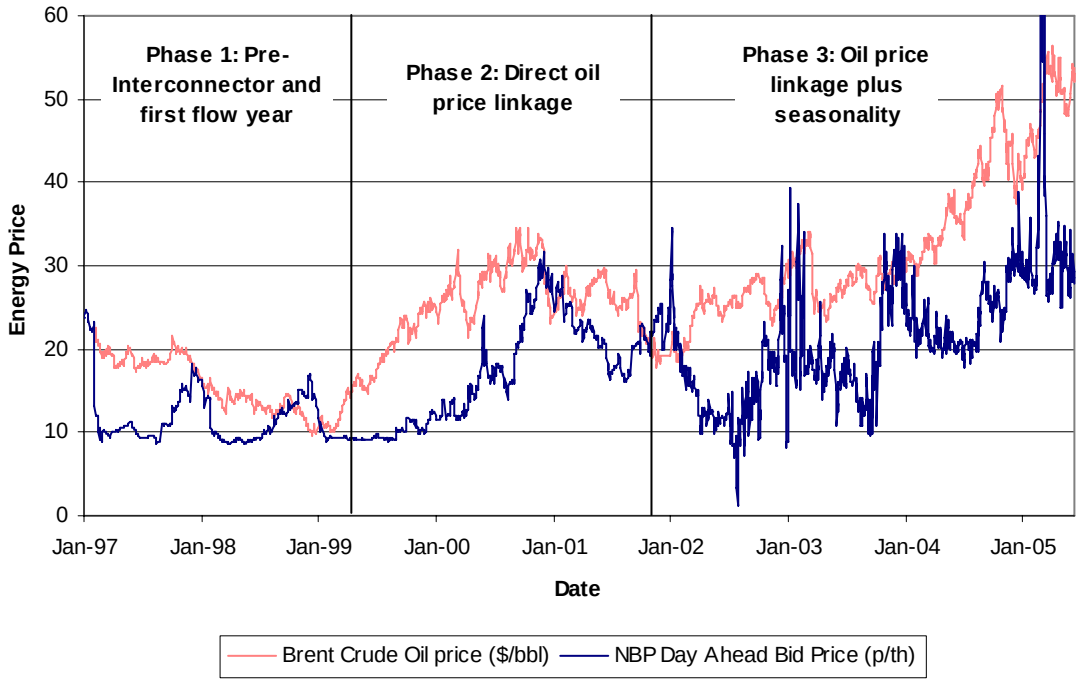

Figure 18: UK NBP Gas Price and Oil Price (Source: Heren and Gas Strategies)

6.4 Development of European Trading Hubs

As discussed in Section 3.2, part of the government's rationale for the Interconnector project included the intention to 'export' liberalisation to Europe. Market opening as required by the EU Gas Directives has led to the development of a number of hubs at key trading points in Continental Europe. The most successful of these are the Zeebrugge hub and more recently the TTF virtual balancing point in the Netherlands.[38] Other hubs, such as Baumgarten, Emden and Zelzate are primarily logistical, but without the commercial or legal infrastructure to serve as a trading hub.

The connection to the Interconnector has enabled the Zeebrugge hub to develop quickly, and with a structure influenced by the UK model. In infrastructure terms, the Zeebrugge hub meets the physical requirements for a successful hub: the confluence of a number of major supply and distribution pipelines, access to storage and sufficient buyers and sellers to generate liquidity. In addition, the operational and commercial arrangements have led to the progress of the Zeebrugge hub towards a liquid trading point: most of the lines connected to the hub offer third party access to market players; a master contract is used to standardise the product traded at the hub; a gas management system is in place to automate the trading process; and independent price reporting services provide price transparency.

[38] A Picture Of The European Gas Trading Market in 2005, Nigel Harris and Mary Jackson, *Pipeline & Gas Journal*, August 2005.

7 FLOW CONSTRAINTS AND OUTAGES

In the event that Interconnector users are unable to flow the required quantity of gas through the line, arbitrage breaks down between the two ends of the pipeline and UK NBP and Zeebrugge hub prices diverge. The primary reasons for limitation to flows are system shutdowns (either planned or unplanned), changes in flow direction where shippers are required to pack or unpack the pipeline, or capacity constraints.

7.1 Planned Outages

The Interconnector system is shut down for up to two weeks annually for planned maintenance. Several months notice is given for such an outage. An example of market prices for a planned shut down is shown in Figure 19. NBP and Zeebrugge hub prices diverge: the Zeebrugge hub price approaches the price of continental long-term gas (e.g. Zeebrugge Troll); the UK price falls due to an excess of supply to market. The fall in NBP price, despite ample warning and ability for market players to adjust their trading positions, clearly demonstrates that during normal operation, the Interconnector applies a floor to summer UK gas prices.

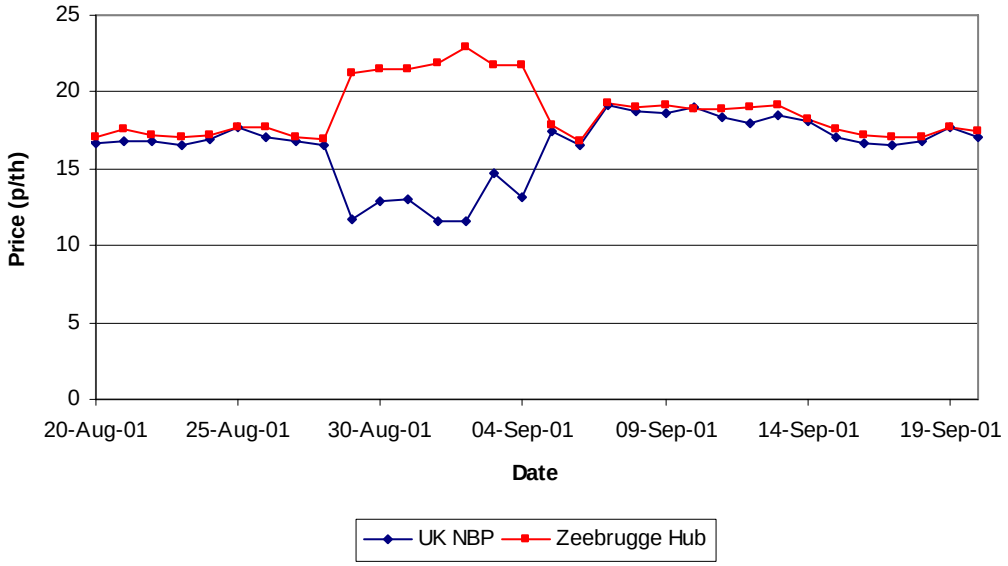

Figure 19: 2001 Shutdown Gas NBP and Zeebrugge Hub Prices (Source: Heren)

7.2 Unplanned Outages

The most common cause of unplanned outages is gas quality issues, although plant failure does occasionally occur.

As a midstream transportation line, the Interconnector is designed to transport sales quality gas from one network to another.[39] Gas is not homogeneous; it can vary in composition and physical properties. It is also possible for the gas to become contaminated at any stage in the transportation chain. Should gas quality fall outside the agreed limits, the Interconnector system is unable to operate. Gas quality has led to a number of unplanned Interconnector outages.

[39] Gas is not treated within the Interconnector system, so quality is set by gas delivered from adjacent networks.

7.2.1 Composition and Physical Properties

Natural gas is composed mainly of methane and light hydrocarbons with some oxygen, nitrogen, carbon dioxide and sulphur. The key physical properties are calorific value (the energy content of the gas), Wobbe index (which affects burner characteristics) and hydrocarbon dewpoint (the temperature at which hydrocarbon liquid will condense from the gas).

Specific ranges for gas components and physical properties were in place in the adjacent markets before the Interconnector came into operation. These specifications are embedded into contracts across the supply chain in each market and defined in government legislation.

Table 3 highlights some of the differences between UK and Belgian gas quality specifications.

	UK	**Belgium**
Gross Calorific value (MJ_{25^oC}/Nm^3)	44.6 max	46.0 max
Wobbe index (MJ_{25^oC}/Nm^3)	54.2 max	56.0 max
Total sulphur content (mg/Nm^3)	50 max	150 max
Oxygen content (ppm)	10 max	2000 max
Incomplete combustion factor	0.48 max	Not specified
Soot index	0.60 max	Not specified

Table 3: Gas Quality Specification Differences (as at December 2005)

So far, there has not been a significant constraint to Interconnector operation due to compliant gas delivery at one end of the line which does not meet the specification at the other.[40] However, most of the restrictions affect UK import rather than export. These differences in quality specification may present a risk to Interconnector operations with higher and more frequent reverse flow periods.

As part of the UK-Belgian treaty for the Interconnector, a commission was set up to take a leading role in safety, metering and quality specification differences. This led to the formation of the European Association for the Streamlining of Energy Exchange (EASEE). In 2005, EASEE Gas agreed a common business practice directive for the harmonisation of energy units between European transporters.

7.2.2 Solids Delivery

It is possible for solids to be delivered into the Interconnector from neighbouring networks in the form of dust particles picked up into the gas stream from the walls of pipelines in the connected transportation network. Since this is to be expected, both Interconnector terminals were designed to filter out any solids. However, once the filter becomes blocked, it must be removed and cleaned, and a standby filter brought into operation. If the filter cannot be cleaned before the standby also becomes full, then an Interconnector outage or flow constraint results. This has happened on a number of occasions when exporting gas from the UK, normally due to cleaning of the lines feeding the Interconnector, or high flow rates resulting in turbulence in the lines and dislodging dust.

[40] Excluding liquids contamination which is discussed separately.

7.2.3 Liquids Contamination

The Interconnector is designed to receive and transport dry gas. If the system is contaminated with liquid, it is extremely difficult to remove, particularly if it has entered the offshore line. This will normally require pigging, which involves passing cleaning cylinders through the line using gas flows. Since the gas used to flow the cleaning device will be off-specification, it must be returned to the source of contamination, or in the case of self-contamination by IUK, a blending or cleaning service must be negotiated.

This situation has occurred twice during Interconnector operation. In July 2002, approximately 20 tonnes of hydrocarbon liquid was delivered from the UK National Transmission System. This is likely to have derived from one of the neighbouring gas processing facilities in the Bacton terminal complex. In September 2003, water entered the pipeline during a maintenance operation to replace a faulty 40 inch diameter valve. In order to safely isolate the valve from the high-pressure gas in the pipeline, a plug was temporarily inserted into the line using water under pressure. During this procedure, part of the internal mechanism of the plug failed which resulted in water by-passing the plug and entering the pipeline.

In both cases, the clean up operation required gas to be flowed from Zeebrugge to Bacton during the summer months. Gas flows were contrary to the previous prevailing flow direction and therefore contrary to the price signal. This resulted in significant losses for IUK shippers who became distressed buyers in Belgium and distressed sellers in the UK. The unpredictability of the clean up operations also led to imbalance penalties for those shippers in both adjacent systems.

7.2.4 Market Impact of Unplanned Outages

The market response to unplanned outages is similar to that for planned outages, but the impact is greater as market players do not have sufficient time to make alternative arrangements for gas purchase or sale.

The major unplanned Interconnector outages have been due to liquids contamination incidents which occurred during the summers of 2002 and 2003 (see Section 7.2.3). During these incidents, shippers were required to flow gas in the opposite direction to the price signal in order to facilitate pipeline clean up. The impact of the contamination incidents in 2002 and subsequent clean up operations on market prices is shown in Figure 20.

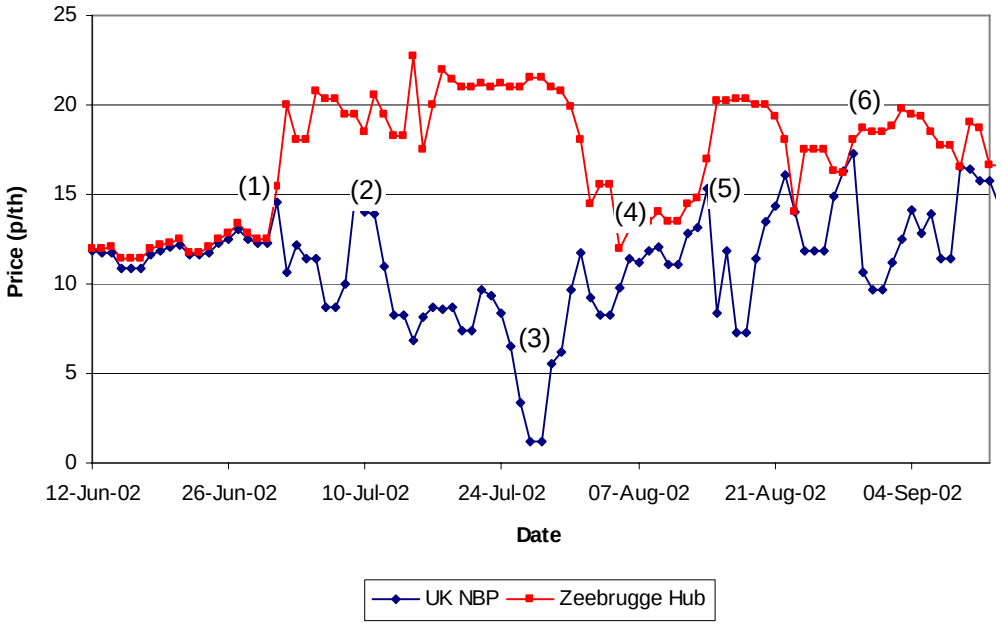

Figure 20: 2003 Liquids Contamination Gas Prices (Source: Heren)

The major events during this period are labelled in Figure 20. The initial delivery of liquids (1) resulted in a shutdown of the Interconnector system and price divergence. Following intial clean up at the terminals, a system restart was planned (2) resulting in an NBP price increase in anticipation of reinstated flows. These subsequently fell once the restart was aborted. On discovery that liquids had entered the offshore line, a pigging operation was planned and executed (3). The associated requirement for shippers to flow against the price signal resulted in a price collapse in the UK to 2 pence per therm. Following the completion of clean up and restart of the system (4) prices converged once more, but diverged again following a second delivery of contaminant liquids (5). The second clean up operation continued until the due date for the annual maintenance shutdown (6).

7.3 Flow Direction Changes

Changes in flow direction cause arbitrage inefficiency due to the requirement to change the pipeline inventory.[41] During this process, pipeline users are obliged to arrange for delivery of gas into and out of the line for operational rather than commercial reasons. Furthermore, the business rules require a notice period before a flow direction change can be effected, resulting in a period during which the flow requirement cannot be transported. NBP and Zeebrugge hub prices therefore diverge before and during flow direction changes.

The impact of changes in flow direction on market prices can be clearly observed during the unexpected transitions during January 2001 which prompted the European Commission Enquiry into anti-competitive use of the line (see Section 3.2.2). At this time, the business rules required that a forecast for the following week be provided each Friday as a basis for flow transition decisions. Figure 21 shows gas prices during the period under investigation together with Interconnector flows.

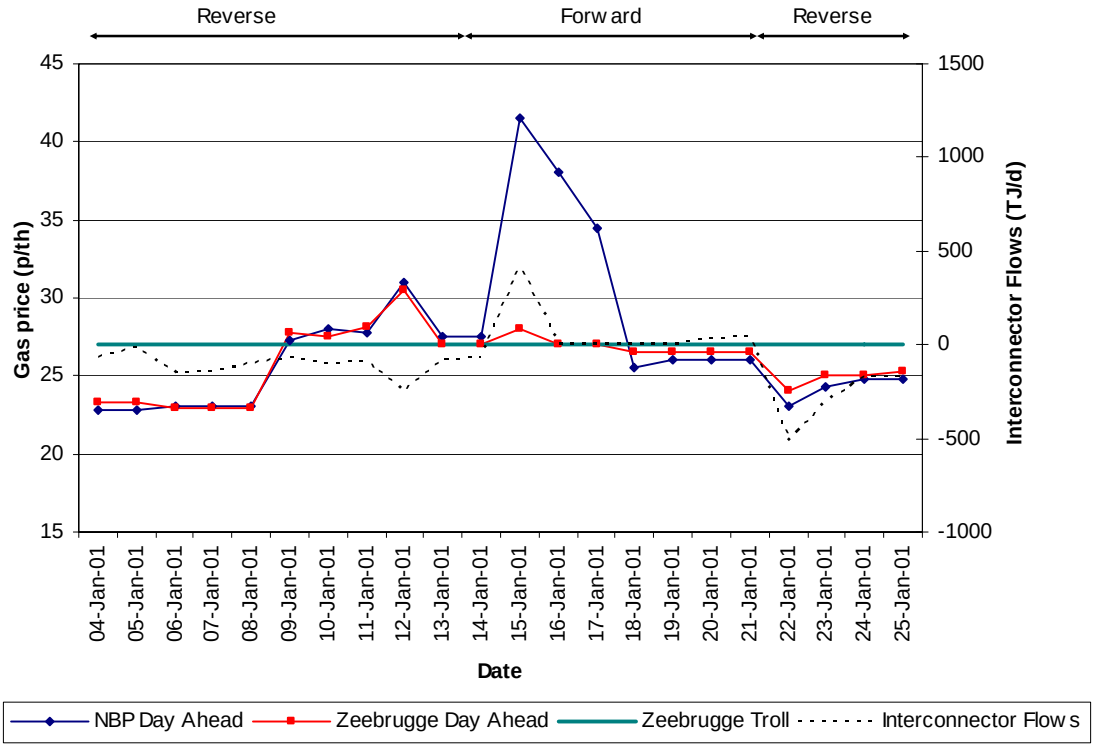

Figure 21: Gas Prices During the January 2001 Unexpected Flow Transition (Source: Heren and *Interconnector)*

[41] This is no longer a requirement following the installation of compression facilities at Zeebrugge in 2005.

During the week commencing Monday 9th January, the Interconnector was in reverse flow mode consistent with NBP and Zeebrugge hub prices at a slight premium to Zeebrugge Troll. However, the previous week, the price signal had been the opposite, suggesting a marginal situation. On the forecast deadline day (12th January), the balance of month trading prices showed a weak price signal for continued reverse flow of 1.5p/th, but the forecast of flows supplied by IUK shippers met the rules for a change to forward flow.

The flow transition itself had a major impact on NBP price as export flows peaked to satisfy the required inventory rise and resulted in an NBP price increase of 15p/th. For the rest of the week, flow rates remained at zero and NBP and Zeebrugge hub prices diverged, with the business rules preventing a change back to reverse flow, even though the price differential demonstrated a requirement to do so, until the next decision point was reached, allowing a return to reverse flow.

The EU Commission reasonably observed that the magnitude of the impact was due in part to the restrictive business rules, which have subsequently been changed (see Section 5.1). The enquiry also concluded that there was no evidence of anti-competitive behaviour. This seems reasonable given the marginal nature of the price signal.

This conclusion is further supported by considering Nominations on the day immediately following the flow transition. Figure 22 presents aggregated the net nomination for each shipper for each flow direction. The chart shows that half of the capacity is being used for forward flow and half for reverse flow. The small net reverse nomination was reduced to zero to maintain the forward flow direction. The use of export capacity against the prevailing price signal can be justified by long-term export arrangements.

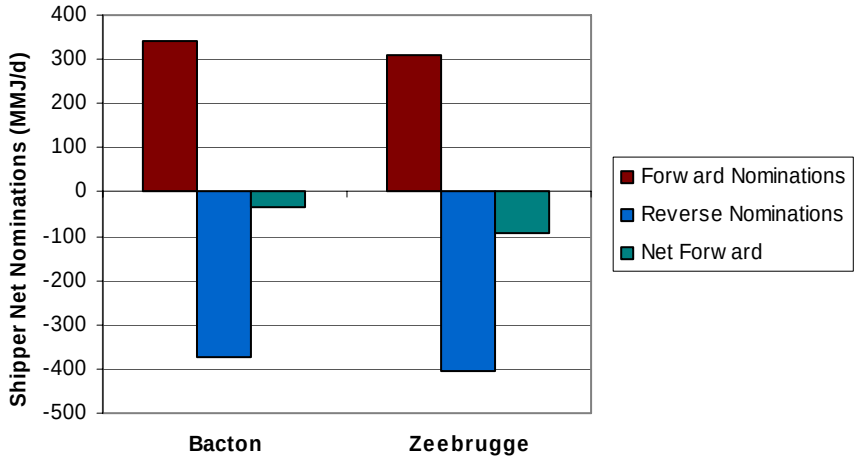

Figure 22: Shipper Nominations on 16th January 2001 (Source: Interconnector)

7.4 Capacity Constraints

Price splitting between the NBP and Zeebrugge hub has also been observed during periods of normal operation. When forward (UK export) flows are sufficiently high during the summer months, the available capacity for transportation of gas in response to market signals is insufficient, and the link becomes capacity constrained. A price differential of between 2 and 10p/th can be observed from June to September 2003 in the absence of any operational constraints. This period coincided with record Interconnector flows which reached a plateau at approximately 18 bcm/y, or 90 percent of capacity (see Section 6.2.1). This indicates that 90 percent of Interconnector capacity is available to market users who wish to use the line to respond to the market signal.

8 REVERSE FLOW ENHANCEMENT

8.1 Development Phases

The original Interconnector infrastructure comprised a compression terminal at Bacton in the UK and a reception terminal at Zeebrugge in Belgium, connecting the sub-sea pipeline to the adjacent gas networks. This arrangement enabled a high UK export (forward) flow capacity of 20 bcm/y, but only a limited UK import (reverse) flow rate of 8.5 bcm/y.

An enhancement project commenced in 2001, to install compression facilities at the Zeebrugge end of the pipeline and pressure let-down facilities at the Bacton end. With gas flowing in the offshore line at higher pressure, a higher capacity can be achieved in the reverse flow direction. The total cost of the enhancement is approximately £150 million.

The first phase of the development was completed in November 2005, doubling the import capacity of the system to 16.5 bcm/y with the installation of the first two compressor units in Zeebrugge. A further two units, due to become operational in December 2006, will increase the capacity further to 23.5 bcm/y. An upgrade of the offshore line operating pressure is also under study which would increase the reverse flow capacity to 25 bcm/y. These figures are summarised in Table 4.

Number of Compressors at Zeebrugge	Effective Date	Forward Flow Capacity (bcm/y)	Reverse Flow Capacity (bcm/y)
0	Current	20	8.5
2	November 2005	20	16.5
4	December 2006	20	23.5
4 (+ pressure uprate)	To be agreed	20	25

Table 4: Enhancement Project Phases (Source: Interconnector)

8.2 Capacity Sales

The additional capacity made available by the first two enhancement phases was fully subscribed by a limited number of existing shippers (see Table 5), although the capacity was also marketed to non-capacity holders. The small additional capacity from the pressure uprate has not yet been marketed.

Phase 1 Subscribers	Phase 2 Subsribers
BG Group	Distrigas
Centrica	Gaz de France
Distrigas	Gazprom
Gaz de France	EDF
Gazprom	
Ruhrgas	

Table 5: Shippers Subscribing to Enhanced Capacity (Source: Interconnector)

Figure 23 shows reverse flow capacity holding in each of the three development phases, grouped by primary industry activity. Capacity subscription is split between the different industry groups with a combination of producers and marketers purchasing additional reverse flow capacity. The industry sector diversity is largely maintained.

However, when capacity holding is grouped by location, a significant change is observed. Whereas the initial capacity holdings were evenly distributed between UK based and mainland Europe based organisations, the latter take the lion's share of reverse flow capacity by the end of the enhancement process. Following the second enhancement phase, 70 percent of total capacity rights (forward and reverse) will be held by European rather than UK organisations, which will inevitably change the momentum of the shipper community. It is likely that future business rules development will reflect the requirements and interests of gas importers to a greater extent.

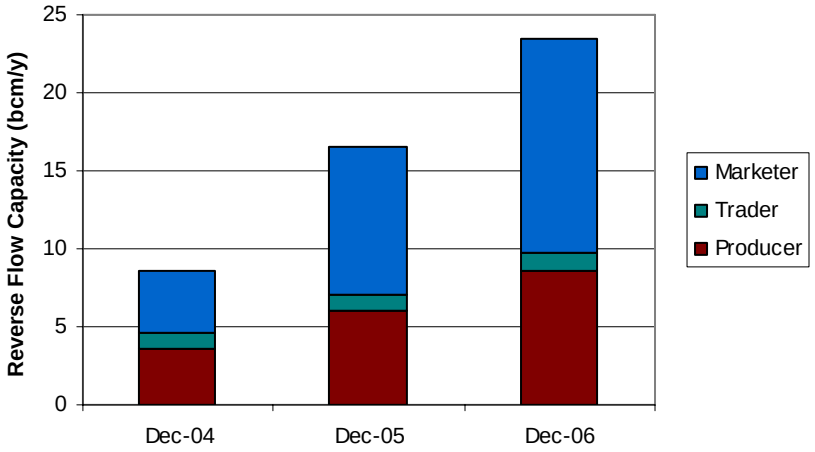

Figure 23: Enhanced Reverse Flow Capacity Holding by Industry Group (Source: Interconnector)

8.3 Motivation of Capacity Holders

In contrast to the original 1994 investment, the enhanced reverse flow capacity holders had a common motivation to purchase Interconnector capacity.

At the time of capacity marketing in 2002 and 2003 for the respective phases, a clear trend was emerging in the UK supply-demand balance for natural gas. From 1998, the rate of discovery of new reserves (proven, probable and possible) fell significantly behind the rate of production.[42] This generated clear evidence that the UK's gas self-sufficiency was unsustainable, with a forecast need for imports to meet demand. Forecasts of supply and demand at the time consistently predicted an impending gap and highlighted the requirement for additional import infrastructure.[43]

In a marketing brochure circulated throughout the European gas industry, IUK commented that 'the predicted shortfall in UK gas supplies will create new opportunities for Continental suppliers via the Interconnector, and require UK suppliers to consider alternatives to UKCS production'.[44] Based on the organisations that chose to participate in the enhancement, it is evident that the former group were the primary users of additional import capacity. This is not surprising since Interconnector import capacity is only useful to those either with gas, or a supplier, on the Continent.

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[42] DTI Energy Statistics (www.dti.gov.uk/energy/inform/energy_stats/gas/index.shtml)

[43] Transco 10 year Statement, 2002 (www.transco.uk.com); Information Paper by UK Offshore Operators Association, UKOOA, October 2003 (www.oilandgas.org.uk).

[44] UK import capacity enhancement: Request for expressions of interest, Interconnector (UK) Limited, June 2003.

8.4 Competing Import Projects

IUK was the first to market UK import capacity in response to the forecast supply shortfall. With most of the infrastructure already in place, the company was able to offer import capacity with minimal project risk and a short construction period at low cost compared with alternatives. It therefore made an attractive option for shippers seeking such capacity.

Since commitment to the Interconnector enhancement was secured, a number of additional projects have been sanctioned, changing the supply-demand balance outlook significantly. The number and scale of the proposed import projects have resulted in a net oversupply position for the UK as shown in Figure 24.

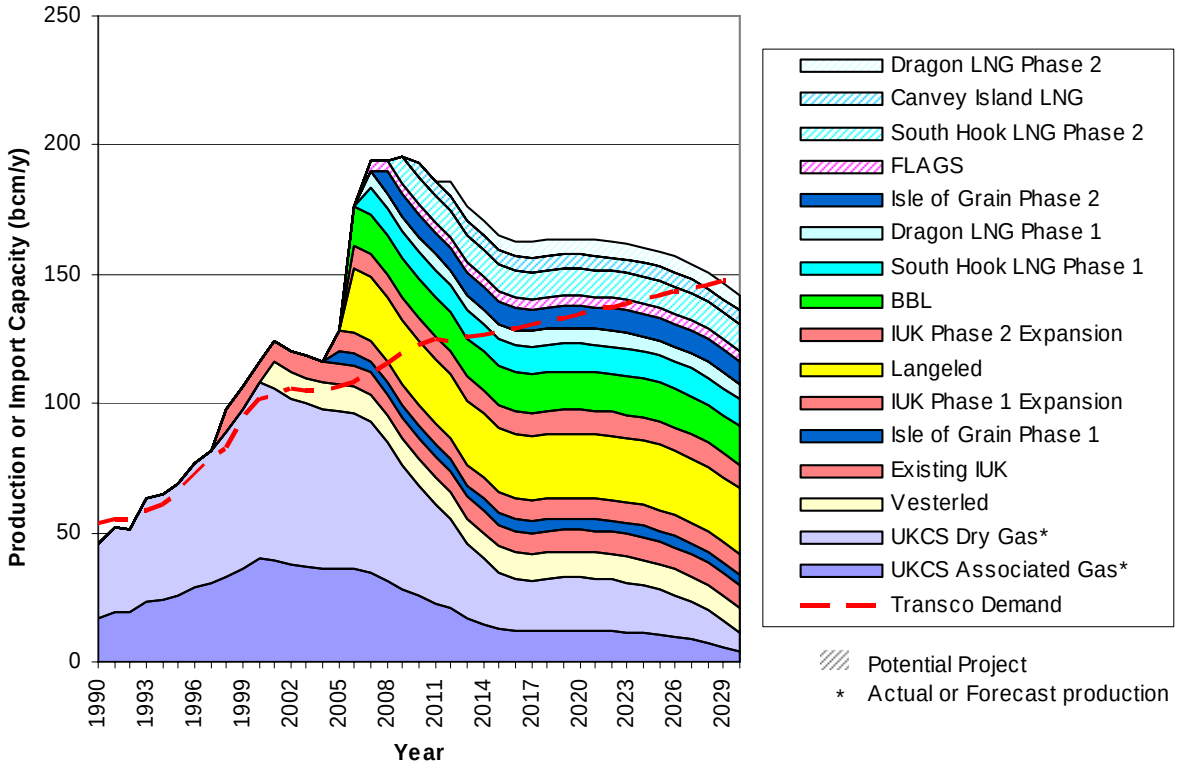

Figure 24: Forecast Demand and Supply Capacity to to 2030 (Source: NGT[45])

The UK demand and UKCS gas production data represent historic actual and forecast UK demand as published by National Grid Transco (NGT). The capacity of existing and future import routes are stacked above the UKCS production base to illustrate how the supply gap has been filled for the foreseeable future. The projects plotted in a hashed format are unconfirmed projects. There are three clear phases: between 2005 and 2010, there is an investment phase during which new infrastructure comes on line in response to a demand for import capacity; between 2010 and 2020, there is a period of plentiful supply; following 2020, the capacity excess begins to drop, suggesting a further investment phase.

[45] Transco 10 year Statement, 2005 (www.transco.uk.com)

Considering import capacity on an annualised basis is misleading since the capacity needs to be in place to meet the winter peak capacity and not just the annual average[46] since the UK has limited storage capacity. However, in 2010, the available import capacity still exceeds the NGT 1-in-20 year peak demand figure.[47]

This import capacity excess will inevitably have an impact on Interconnector operations. Under present proposals, the UK-Belgium Interconnector is the only line with the capability to export as well as import. If the market is flooded with gas, significant sustained export flows can be expected through the Interconnector for the foreseeable future, with import flows during the winter peak demand months. However, operators of the competing import infrastructure may have sufficient flexibility to turn down, with LNG importers, for example, able to redirect cargoes to higher priced markets during low demand periods.

8.5 Electricity Market Exposure

The new compressors at the Zeebrugge terminal will be driven by four 35 MW electric motor drives. The usual power source for gas transportation compressors is natural gas, bled off from the process stream and combusted in a gas turbine, as is the case at the Bacton terminal. The use of electric motors was an innovative solution made possible by recent developments in large motor technology.

The key benefits of electric motors are lower environmental emissions, lower noise, lower maintenance, lower capital cost and higher reliability. However, the need to purchase electricity has added a new and potentially costly exposure to Continental power prices for shippers using Interconnector transportation capacity. While long-term supply contracts may be possible to provide some certainty over transportation cost, the volatile nature and size of the Interconnector load will result in spot price linked balancing penalties. For IUK, there is a significant challenge to secure power supplies at a price which ensures Interconnector import capacity remains attractive, and for IUK shippers, there is a new exposure to incorporate into their portfolio optimisation activities.

[46] Peak demand is the greatest demand for gas in any day in the year. This occurs during the winter period where demand is higher for residential heating. Due to seasonality of demand, peak demand is much higher than the annual average.

[47] The National Grid Transco (NGT) 1-in-20 peak demand is a published demand figure representing the highest anticipated daily demand in a 20 year period.

9 SUMMARY & CONCLUSIONS

9.1 From Concept to Reality

The Interconnector pipeline was born out of a British government intiative to provide an outlet for excess gas produced from the UK Continental Shelf to provide a floor under UK gas prices in the wake of the national gas industry privatisation and liberalisation. In spite of the initial model, a more diverse group of participants joined together to form the company which would own and operate the bi-directional gas connection linking the gas grids in the UK and Belgium. These participants included a number of mainland European organisations, whose stakeholding in the line has since increased through capacity trading and the purchase of additional reverse flow capacity.

9.2 Impact of the Interconnector

The absence of a natural gas interconnection between the UK and the rest of Europe was a glaring missing link in the European network. Its creation was an event of regional and pan-European significance which changed not only the physical structure of European gas markets, but also the commercial structure.

It is now clear that the Interconnector serves primarily as a trading, not a bulk transportation, facility. This fact was underlined at an early stage by the transition to reverse flow after only two months of operation. Flows have continued to be both bi-directional and increasingly volatile, driven primarily by the arbitrage between seasonally variable UK NBP prices and oil price linked Continental supplies.

The primary price impact of the Interconnector in the UK has been a return to indirect oil price linkage in UK gas prices. Shorter-term impacts on the UK market are also evident whenever the Interconnector is unable to deliver the flow requirement due to an outage, change in flow direction or full use of available capacity. In particular, the price impact of the unplanned outages due to liquids contamination during 2002 and 2003 created significant market distortion as shippers were required to flow against the prevailing flow direction to facilitate the clean up operation. Since the source of such liquids contamination is outside the control of the pipeline operator, the issue has not been fully resolved and the risk of such events recurring remains.

Despite limited competition in European markets and inflexibility of supplies, the Interconnector has still had an impact on mainland European markets. For the first time, the potential to buy and sell between markets has required Continental players to pay attention to the NBP prices. The Interconnector has also been essential to the development of the Zeebrugge hub, although to date this has remained an outpost of the NBP in terms of price with only limited impact on Continental wholesale prices.

9.3 Project Evaluation

The UK government set out to create a link that would hold up UK prices, stimulate inward investment and increase the speed of liberalisation on the Continent. These goals were achieved up to a point, but the use of the line for imports and the resulting oil price linkage was not part of the original plan. Higher UK gas prices have benefited those with gas to sell, but overall, the UK economy would be strengthened by lower energy prices, a clearly stated government goal. However, the Interconnector has delivered security of supply for the UK, ensuring a smooth transition from the tail end of a period of surplus into the current phase of net imports. Without the Interconnector, winter supplies of gas to the UK would have been constrained during the winters of 2004/5 and 2005/6.

As a business, the Interconnector is financially viable with a guaranteed future. The financial structure provides a low risk income stream for the shareholders. The relatively limited changes in shareholding are testimony to its value.

The original participants have thus achieved a healthy return from their shareholding, but this return must be offset against the costly obligation to pay for capacity on a long-term 'send or pay' basis. However, the direct profitability of the investment is in many cases less important than the indirect gains. UKCS Producers, initially the dominant group, have clearly benefited from higher UK gas prices in part created buy the Interconnector, and achieved their short-term goal of finding a home for surplus UK gas, thus maximising the net present value of their UKCS investments. A clear evolution of ownership and utilisation from UK based producers to predominantly European traders, marketers and producers suggests that those with gas to bring in to the UK have the most to gain from Interconnector capacity and shareholding in the long run. For all those involved, the creation of the Interconnector has had a significant impact on the markets in which they operate. The opportunity to influence how the Interconnector works has potentially been as valuable to some as the investment itself.

9.4 Evolution & the Future

The Interconnector is in effect a living experiment. The pipeline connected gas markets of different size and structure and from the start, the impact on those markets was uncertain. The rules for using the line, and flow patterns observed, have continually evolved in response to the changing environment created by the line itself.

The Interconnector pipeline has passed through a number of development phases. In the early years, capacity was underutilised as the markets and players adjusted to the new reality. From 2000, seasonality and market responsiveness increased and the Interconnector became an important supply and price equaliser. Extensions to the business rules and physical infrastructure between 2001 and 2005 made the system larger and more sophisticated. In the winter of 2005/6, the pipeline served as the saviour of the UK gas market, the recently enhanced import capacity bridging the gap between supply and demand. In stark contrast, the scale of new competing import infrastructure investment is likely to result in a return to UK export mode for substantial portions of the year by 2008.

In conclusion, there is no single way to describe the role of the Interconnector. It has evolved through many different guises in the past and will continue to surprise in the future. Although the infrastructure will be expanded to its full potential in 2006, IUK will continue to evolve and adapt to market conditions at either end of the pipeline.

10 REFERENCES

10.1 Interviews

Several individuals who played a key role in the Interconnector project kindly agreed to give their time for interviews. The information from these interviews is a major source of information presented in this paper. The author wishes to thank the following for their important contribution:

- Roger Cornish, Managing Director, Interconnector (UK) Limited
- Tony Mulcare, Chairman and former Legal Manager, Interconnector (UK) Limited
- James Alcock OBE, former Chairman, Interconnector (UK) Limited
- Jean Vermiere, Director of Interconnector (UK) Limited and Distrigas
- Hari Kambo, Finance Director, Interconnector (UK) Limited

10.2 Additional References

In addition to references quoted in the text, the following sources were also used in the preparation of this paper:

- 'Developing European Gas Markets: Strategic Importance of the Interconnector', James Alcock OBE, AIC Conference 3−4 April 1995.
- Financing Multi-Ownership Projects – The UK-Continent Gas Interconnector, Motspur Park, The Financing and Economics of Gas and Electricity Projects Conference (IBC), July 1995.
- 'Linking the European Gas Pipeline', Roger Cornish, *World Gas Yearbook 1998* pp.31−4.

10.3 Further Information

Further information about Interconnector (UK) Limited is available from the company's website: www.interconnector.com.

Links to Interconnector shippers and shareholders are available at the following web address: www.interconnector.com/links.htm.