



# Auctions to gas transmission access: The British experience

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***Tanga McDaniel and Karsten Neuhoff<sup>1</sup>***

## ***Abstract***

When access to monopoly owned networks is constrained auctioning access rights can increase the efficiency of allocations relative to negotiation and grandfathering when there is sufficient competition among network users. Historically, access rights to entry capacity on the British gas network were granted by the monopoly network owner via negotiation; rights were later based on regulated tariffs with an increasing reliance on market based constraint resolution by the system operator. In 1999 an auction mechanism for allocating rights was introduced. Comparing the different allocation methods we conclude that where there is competition at entry terminals auctions have been successful with respect to anticipating spot prices, capturing producer rents and reducing the costs of alleviating network constraints. Moreover, auctions are more transparent and better facilitate entry.

## **I. Introduction**

Within Great Britain, the movement towards auctions of entry capacity to the National Transmission System (NTS) has evolved along with changes in the national gas industry and accompanying regulation. In this paper we will use the natural experiment observed in Great Britain to test the hypothesis that: auctioning of well defined access rights is an efficient way to deal with significant transmission constraints *in the presence of competition in production and supply whilst also allowing for non-discriminatory access and entry.*<sup>2</sup>

Auctioning transmission access is only appropriate if the network constraints are significant, such that the transaction costs incurred by all parties for setting up a mechanism

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<sup>1</sup> Department of Applied Economics, University of Cambridge, Sidgwick Avenue, Cambridge CB3 9DE, UK. We want to thank Professors David Newbery and Paul Joskow for their comments and for research support from Transco Plc and UK-Interconnector. Support from the ESRC under the project R000 238563 *Efficient and sustainable regulation and competition in network industries* and ESRC R42200034307, from Gottlieb-Daimler Foundation and from the CMI Electricity Project is gratefully acknowledged. Any remaining errors are our own.

<sup>2</sup> Because of the nature of these auctions (sequential, concurrent, multi-unit demands, common values) the auction itself is unlikely to provide a perfectly efficient allocation of access rights. Thus secondary trading institutions are essential as is a well-functioning spot market.

of property rights are below the costs incurred for constraint resolution by capacity expansion or constraint resolution by spot market interventions of the transmission operator.

Well-defined property rights are required to deal with significant transmission constraints. Property rights to transmission access when there is monopoly ownership of the network can be allocated in one of the following ways: (i) by leaving the access rights with the existing monopolist; (ii) by allowing existing users to continue their transmissions at traditional volumes (grandfathering); (iii) by auctioning the rights. The British experience from 1982 to 1990 shows British Gas (BG), as a vertically integrated monopoly network owner and major gas supplier was reluctant to create competition by granting access to their network. As BG was slowly vertically unbundled following its privatization in 1986, and as its market share in gas supply began to erode, more market-oriented mechanisms were introduced. As we later discuss these mechanisms were easily gamed by the network users the result of which was large costs for eliminating network constraints. Grandfathering of rights discriminates against entrants thereby reducing competitive pressure. In contrast, when there are well-defined property rights, the transmission operator issues transmission access corresponding to the available transmission capacity in the system; appropriately designed auctions accompanied by secondary trading markets can apportion these property rights efficiently.

Whereas up to now the time-horizon of auctions was only half a year, the gas and electricity regulator, Ofgem, suggests introducing long-term auctions and selling 80% of entry rights five years ahead of time (Ofgem 2001/2). Ofgem's expectation is that the transmission operator, Transco, can use information provided by this process to guide its capacity expansion decisions. In a separate study we argue that, in the presence of market power, long-term auctions will provide distorted signals which are likely to result in under-investment (McDaniel and Neuhoff, 2002). This gives the auctioneer an incentive to alter the auction result *ex post*; however, this would not be a sustainable solution because altering the link between auction results and investment *after* closure of the auction to correct for the distortion would lead users to incorporate the possible corrections in their future bidding strategy which would then require even stronger future corrections.

In section two we provide a brief introduction to privatisation and liberalisation of the gas industry in Great Britain and analyse the steps that led towards the current system in section three. In section four we describe the current transmission access design and changes to the design that have occurred since the first auctions of entry rights in September 1999. Sections five and six offer a brief evaluation of the auctions and our conclusions.

In this paper we do not separately address the question of gas storage and auctions for storage as we believe that the additional complexity does not alter the basic economic arguments that we address here.

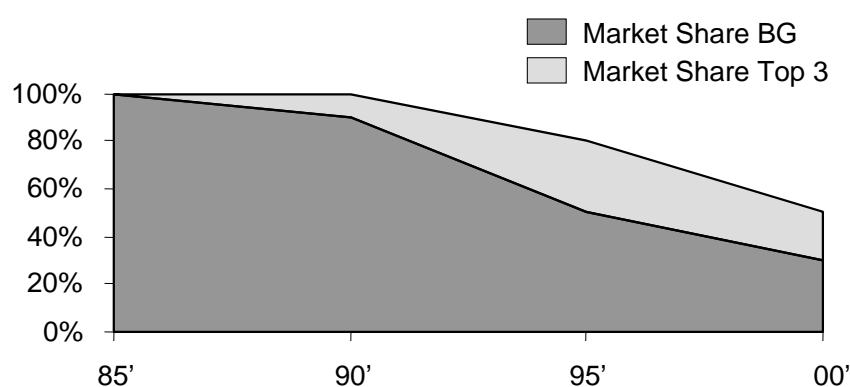
## II. Privatization and Liberalization

### *Background*

We discuss the development of the British gas industry in order to motivate our argument that feasible transmission access designs depend on the existing industry structure and concentration. There is now an independent owner and operator of the transmission network, and competition in gas production and gas supply. The structure of the industry is now such that auctions are feasible. This structure was attained through a long legislative process following privatization in 1986. Prior to 1986 the industry had been in public ownership for just under forty years.

The British gas industry was nationalised in 1949 with the creation of 12 area supply boards, which were later united to become the British Gas Corporation in 1972. In the nationalised framework an integrated high-pressure network was built to directly deliver natural gas from the North Sea instead of coal and oil based town gas and liquefied gas delivery.

The Oil and Gas Act of 1982 was the first step towards industry liberalisation and allowed for access to the transmission network for competing gas suppliers to supply industrial customers with demand above 25,000 therms. The Gas Act of 1986 transformed British Gas Corporation into British Gas (BG) and in the same year shares were offered for sale. Figure 1 shows that BG had at that time 100% of the supply market share, which it retained throughout the eighties.



**Figure 1: Competition in Gas Supply Sector, GB** [source: Oxera 2000]

Following the 1986 Gas Act large industrial customers were legally allowed to contract with independent shippers,<sup>3</sup> and BG was required to provide transmission facilities.

<sup>3</sup> A shipper is anyone who requires capacity on the NTS. Shippers are usually producers, but the term would also be applied to traders if they were bidding in the auction.

However only after inquiries by the Monopolies and Merger Commission (MMC) in 1988 and 1993 and several interventions of the Office of Fair Trading would competition commence. In the enquiries it was found that BG used its monopoly position to discriminate against independent shippers by applying non-transparent, high transmission tariffs for the use of the transmission system and for the use of back up gas. Moreover, BG had discriminated against shippers other than BG in the provision of system reinforcements and connection services.

In 1988 the MMC forced BG to publish information about tariffs it charged to customers and not to contract more than 90% of any new gas field. The Office of Fair Trading ruled in 1991 that BG's gas market share should not exceed 40%; consequently, the monopoly tariff threshold was lowered in 1992 from 25,000 therms to 2,500 therms, allowing small business to freely contract.

Traditionally, transportation and storage formed part of BG's integrated gas supply business. The 1993 MMC report concluded that the lack of effective neutrality of the transportation and storage business "may be expected to inhibit choice, restrict innovation, and lead to higher levels of gas prices to users" (paragraph 2.104). Based on the MMC recommendation the Secretary of State required BG to establish a separate business unit for transportation and storage with full physical separation of people, property and computer systems and information barriers.<sup>4</sup> Transco was established as a business unit of BG in 1994 and has been subject to a separate (RPI-X) price control since 1 October 1994.

The Gas Act of 1996 laid down the framework to open the market even for small consumers, with full domestic liberalisation to be implemented by May 1998. However, already during the 1997 MMC inquiry it became apparent that gas sales and trading, services and retail business had to be de-merged. All companies remained in the same group, Centrica plc, and separation of ownership was only achieved in October 2000 when Transco, the network owner, became part of Lattice Group plc and thus separate from gas supply. By 2000 25% of domestic and 72% of industrial customers had switched gas suppliers (Oxera 2000).

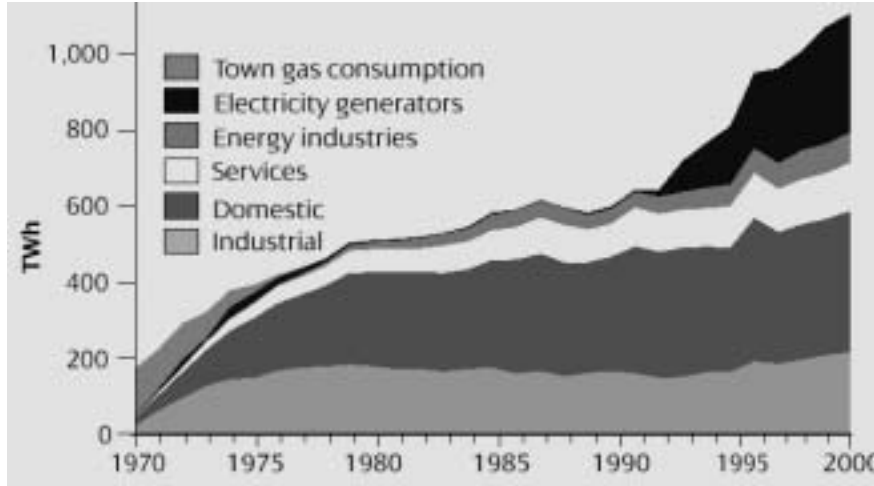
To summarize, British gas was privatized as a vertically integrated monopolist in 1986, but it was not until 1997 that supply and production were unbundled from transport. Following the 1997 MMC reference, supply and production became the responsibility of Centrica and the transport business became the domain of Transco. Both Transco and Centrica remained a part of the same parent company, Centrica, plc. until 2000 when Transco joined Lattice Group plc.

The major contribution towards a lower level of concentration in supply was the expansion of gas demand in the UK of 85% between 1990 and 2000 (Figure 2). 60% of

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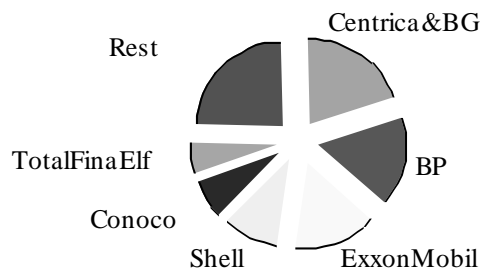
<sup>4</sup> To ensure that trading business would not have access to information provided by its competitors to the transportation business. (MMC 1997)

demand growth was due to new combined cycle gas turbines, which were previously prohibited under EU energy law (UK Energy in Brief, July 2001, DTI).



**Figure 2 UK gas consumption** (source: UK Energy in Brief, July 2001, DTI and national statistics)

The concentration of upstream gas drilling and transport to landing pipelines was and is rather low. Oxera 2000 suggested that in 1985 British Gas produced 22% of total UK gas production, a share that has dropped insignificantly to 21% for the combined output of BG and Centrica (See Figure 3).



**Figure 3: Share of UK gas production** (source: Leading UK Gas Producers, Platts 1998)

A consultation process started by Ofgem in 2001 addressed questions raised by downstream suppliers, specifically, whether up-stream producers can and do exercise market power. Because of transmission constraints producers can have regional market power. One of the reasons why significant constraint costs are incurred only at the St. Fergus terminal could be that competition among producers is stronger at this

terminal and therefore producers cannot reduce output in order to retain transmission rents, as they might be able to do at other terminals.

The above discussion shows the difficulties of introducing competition if a vertically integrated monopolist is in private ownership. We next describe the UK gas network and how the access regime has evolved with increased industry competition.

### *The gas pipeline network*

Figure 4 illustrates the main gas pipeline network in Northern Europe. Most underwater pipelines start from gas fields and transport gas of different consistencies that has to be processed at the beach before it can be inserted to the National Transmission Network. The UK is responsible for 55% percent of North Sea gas production that can be roughly classified as wet and dry gas fields. Wet-gas is produced in the Northern fields that are interconnected to St. Fergus and can be considered a by-product of crude oil production. Therefore producers are reluctant to adjust their output to match demand. The other fields are dry-gas fields, which only produce natural gas, and can therefore be more easily adjusted to accommodate seasonal variations in gas demand.

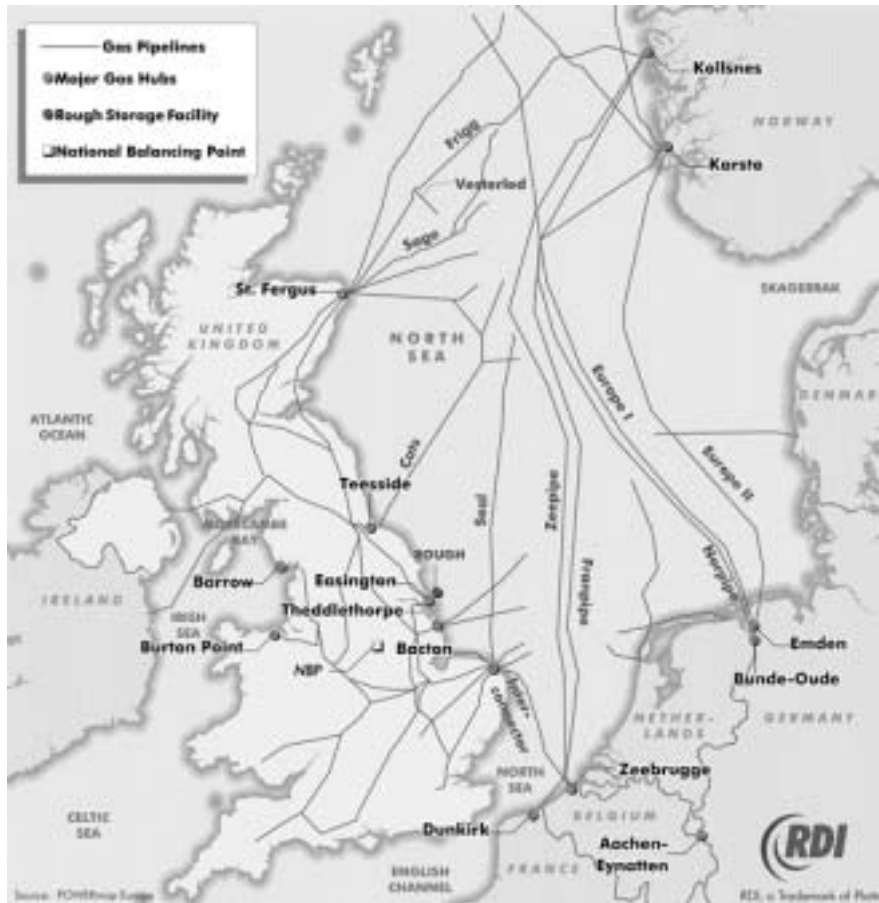
The Frigg pipeline was initially constructed to allow gas from the UK-Norwegian Frigg field to be transported to the UK. The Frigg Treaty of 1997 allowed the usage of the pipeline to import gas into the UK from additional Norwegian gas fields by interconnecting it with other pipelines and using it for new gas exploration.

The UK-Belgium interconnector, opened in October 1998, was initially planned to allow for exports of UK gas to the continent, but is also used on so-called reverse flows for imports into the UK during winter peak demand. Upgrades of compression facilities are planned for 2002 to increase the reverse flow capacity. Two further interconnectors are used for exports to Ireland. Given the level of abstraction of the current study, we simply classify them as additional demand on the National Transmission System (NTS).

The NTS in the UK connects the gas landing facilities and storage facilities to gas customers. Demand for transmission services is volatile over the year and capacity is capital intensive. Therefore it would be inefficient to provide for a network that can satisfy all transmission requests. Over the last years landing gas at the St. Fergus terminal in Scotland was most constrained, with currently binding constraints in Scotland at Aberdeen, Moffat & Woller and Kirriemiur.<sup>5</sup>

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<sup>5</sup> MSEC Network Analysis, Rosemary Jones, System Operation, Transco.



**Figure 4: Gas Pipelines Northern Europe** (Copyright Platts, 2001. Reproduced with kind permission.)

### III. Evolution of access rights regime

Three general methods are available to resolve transmission constraints on the network: (i) inserting gas into the NTS at a different landing— usually from a different gas field; (ii) using storage facilities in import constrained areas to provide gas during high demand days; (iii) offering interruptible contracts to industrial consumers and electricity generators. Interruptible contracts allow Transco to stop supplying gas for up to 45 days per year if system demand reaches 85% of peak demand and transmission constraints prevent delivery. In exchange industrial consumers pay lower capacity charges for access to the transmission network.

#### *1986-1996*

For most of this period BG was a vertically integrated monopolist and dominated the supply of gas as well as controlling the transmission network. Independent shippers supplied only large industrial customers, which usually have a low variance of energy demand during the year. As such the initial regime for using the NTS did not address transmission constraints during operation but required BG to resolve them autonomously. Shippers were only required

to balance (i.e., to match the gas consumption of their customers with the gas shippers inserted at the beach terminals) on a monthly basis. BG would balance the system on a daily basis and resolve transmission constraints using the above described three methods of storage, managing the volume and terminals at which gas was inserted into the network and via interruptible contracts.

Because the industry was dominated by BG this protocol of leaving it with sole responsibility for system balance and resolution of transmission constraints was feasible, but the scope for discrimination and abuse of dominant position were obvious drawbacks. For example, if industrial customers required an increase in the capacity at which they would acquire gas, BG could claim that insufficient capacity was available to ship gas towards the region or to the plant. This permission already served as a tool to exercise monopoly power as “[BG] acknowledged, for example, that problems had occurred in some cases in estimating the capacity available for its competitors when they have sought to supply customers previously supplied by BG.” (MMC, 1993) Subsequently it was decided that shippers could only be charged for costs of capacity expansion of the direct interconnection of the plant (shallow connection charges), but not for system-wide reinforcements (deep connection charges).

As the dominant position of BG eroded with the lowering of the monopoly threshold competitors began to serve customers with increased seasonal variation in demand, who required more balancing and accounted for more constraints on the system. As a result the former constraint alleviation methods were compromised. In any case, this combination of industry structure and access regime was seen as an intermediary stage. The monopolies and mergers commission concluded in 1993: “In the longer term, however, we would regard the ability of competitors to access the transportation network and other facilities such as storage on non-discriminatory terms (including, for example, the balancing regime adopted by BG to ensure adequate availability of gas in the system to meet demands) as essential if competition is to be sustained.”

#### *New Network Code, March 1996*

The network operations of BG became the responsibility of Transco (the new transmission arm of British Gas) in 1994, and the Network Code (the Code) was adopted in 1996. The Code was the industry’s response to a number of factors including: The opening of the domestic market (with volatile demand profiles); falling market share and therefore reduced balancing capabilities of BG; increased pressure for non-discriminatory pricing of transmission services, and the request of independent shippers to profit from provision of balancing services. The Code required shippers to balance gas inserted at terminals and

storage facilities with the gas delivered to their contracted customers. Transco would balance the system if deviations occurred and subsequently charge shippers the resulting costs.

Under the Code Transco continued to use interruptible contracts to manage constraints but it also introduced a new mechanism for buying back excess entry capacity rights. In a three-step process shippers first had to book and pay for annual entry capacity for a specific terminal at a price related to Transco's capacity costs.<sup>6</sup> Second, one day ahead shippers would then nominate how much gas they would flow during the following day in order to finally insert the gas at the day in question.

This system did not *ex ante* incorporate transmission constraints. Shippers could book unlimited amounts of entry capacity, could nominate above their booked capacity at a charge of 73/183 of the annual entry capacity, and could insert gas above the nominated level at the risk of the "overrun charges". However, it provided Transco with day ahead information as to how much gas would be inserted at any terminal. Transco would then use information about large consumers' demand and estimate domestic users' demand based on weather forecast to simulate the next day's gas flows. If constraints were anticipated, then Transco would use a pseudo market instrument called the "flexibility mechanism" to resolve the constraints. For example, if expected gas insertion at St. Fergus would exceed transmission capacity in Scotland, then Transco would sell gas at St. Fergus and buy gas at southern beach terminals. Uncertainty about the functioning of the flexible mechanism meant that Transco retained additional storage at the beginning to allow for balancing, but initial success of the Code allowed most of the storage facilities to be made available to shippers on an annual basis based on regulated tariffs.<sup>7</sup>

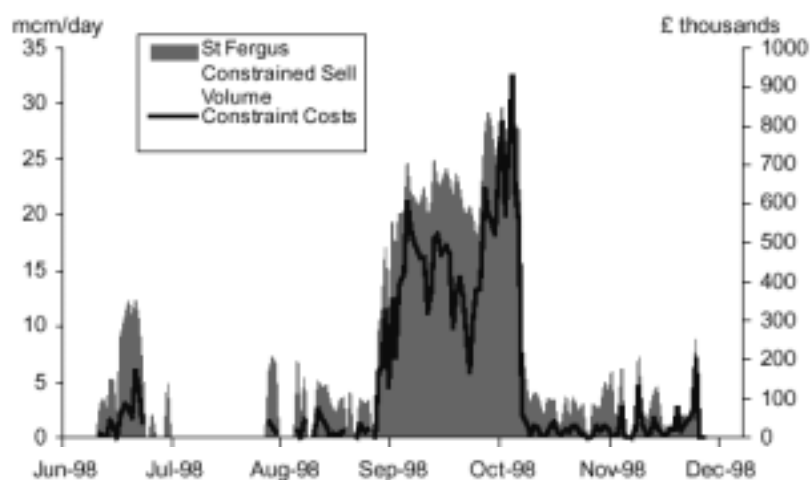
This system appeared to work well during the initial two years until summer 1998 when significant capacity shortages occurred for entry at St. Fergus due to delayed commissioning of additional capacity and construction on existing capacity. As a result "The level of nominations was far in excess of the available capacity, or indeed the level of [additional] capacity originally projected by Transco to be available at St. Fergus" (Ofgem, 1999a). Transco had to sell significant amounts of gas at St. Fergus and acquire replacement at other Terminals, resulting in total balancing costs of £23.1 million during the period from late August to 8 October 1998 (see Figure 5). In this situation shippers faced perverse incentives. Even if they had otherwise not planned to ship gas, they could nominate gas insertions and subsequently submit bids in the flexibility mechanism to reduce the announced insertion. Such behaviour was individually rational: the shipper profited and was only

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<sup>6</sup> This cost was a regulated tariff based on the long run marginal cost of expanding the network to accommodated additional flows at the terminal.

<sup>7</sup> For a discussion of the storage market and the introduction of storage auctions in the UK see Hawdon and Stevens (2001).

exposed to a fraction of the costs he created since balancing costs were smeared among all shippers.



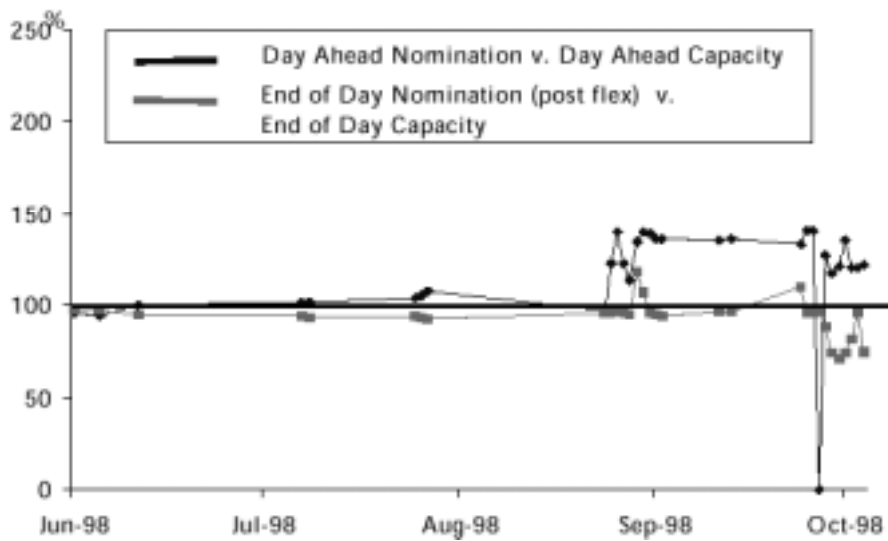
**Figure 5: St. Fergus and Bacton Constraint Costs** (source: Ofgem, 1999)

The design of shipper licences defined in the Gas Act 1986 equips the regulatory body with authority beyond usual competition law to intervene in the case of non-competitive behavior. Specifically, condition 2(2) prohibits shippers from knowingly or recklessly pursuing a course of conduct that is likely to prejudice the efficient balancing of the system. Condition 2(3) requires that the licensee shall not knowingly or recklessly act in a manner likely to give a false impression to a relevant transporter as to the amount of gas to be delivered by the licensee on a particular day to that transporter's pipeline.

Standard condition 9 furthermore requires the shippers to furnish to the Director General with information as he may reasonably require, even if this information is subject to confidentiality provisions; information is excluded only if a court in civil proceedings would not be able to compel the shippers to produce it.

Ofgem concluded in its 1999 inquiry that excessive nominations for gas to be flowed day ahead constituted a breach of the standard conditions 2(2) and/or 2(3). The most impressive part of the evidence was against Elf Exploration. Figure 6 illustrates how Elf nominated excessive capacity once it became apparent in September that Transco would have to use the flexibility mechanism to resolve anticipated constraints.<sup>8</sup> It would be an interesting question to see, whether the evidence available to Ofgem would suffice for the conclusion to stand up to judicial review. In the event, shippers did not have to challenge Ofgem's conclusion, because due to subsequent changes to the trading arrangements in September 1999, Ofgem did not take enforcement action.

<sup>8</sup> Traders of Shell gas were similarly ignorant of the capabilities of regulatory offices, whereas most other shippers behaved according to the spirit of the Network Code.



**Figure 6: Elf Exploration's excess nominations** (source: Ofgem, 1999)

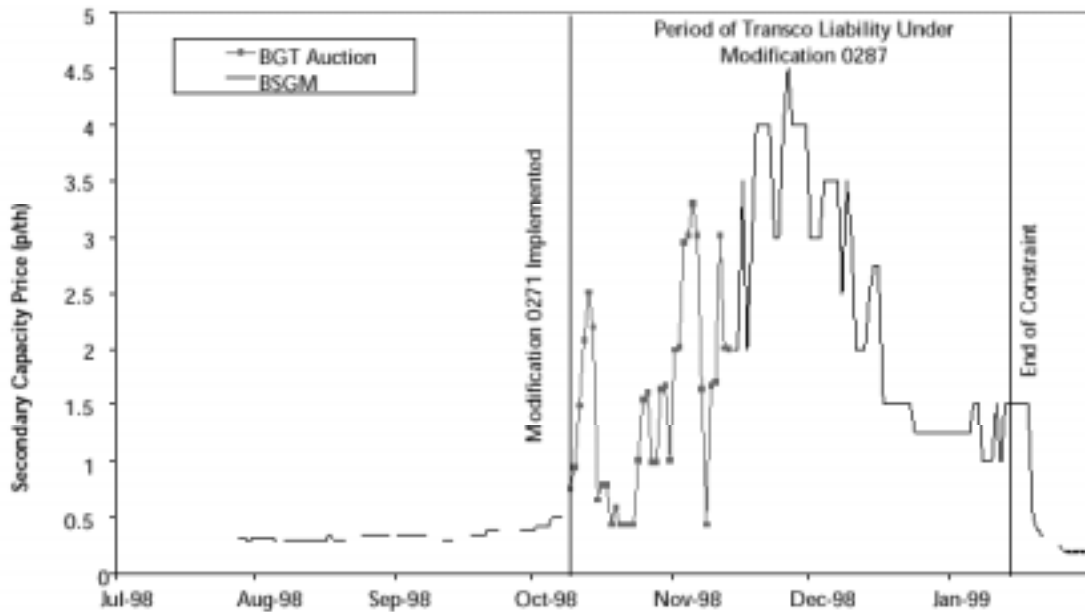
### *Scaling Back*

As a reaction to the increasing costs of constraint resolution with the flexibility mechanism, as illustrated by Figure 5, Ofgem modified the Code in October 1998. Modification 271 required Transco to (proportionally) “scale back bookings to ensure that booked capacity equalled the amount of gas that could be physically evacuated from St. Fergus entry terminal”. Obviously the result was that some shippers did not receive the capacity they required for their contractual requirements, whilst other shippers, at that time in particular BG, still retained unused booked capacity.

BG made it's excess capacity in a day ahead auction until on 11 November 1998 Modification 273 introduced a day ahead auction at entry terminals which allowed unsold or unused physically available capacity to be made available to shippers.

The value of entry rights in the day ahead auction is illustrated in Figure 7, and it can be seen that the prices match the price differences in the day ahead spot market for gas at St. Fergus and gas at the National Balancing Point (as shown in Figure 13). This was a first indication that auctioning of entry rights might be a successful approach. The scaling back approach was considered to be only a temporary solution, mainly because of complaints about the uncertainty shippers face up to the day ahead over whether they will have access to sufficient capacity. The Ofgem inquiry from December 1999 concluded that some shippers had breached their licence conditions during this period by nominating gas flows above the capacity which had been available after their initially booked capacity had been scaled back. The defence brought forward by shippers was that they faced significant uncertainty about available capacity and felt that they had to honour commercial commitments to ship the gas. Even though these shippers could have resolved the conflict between commercial

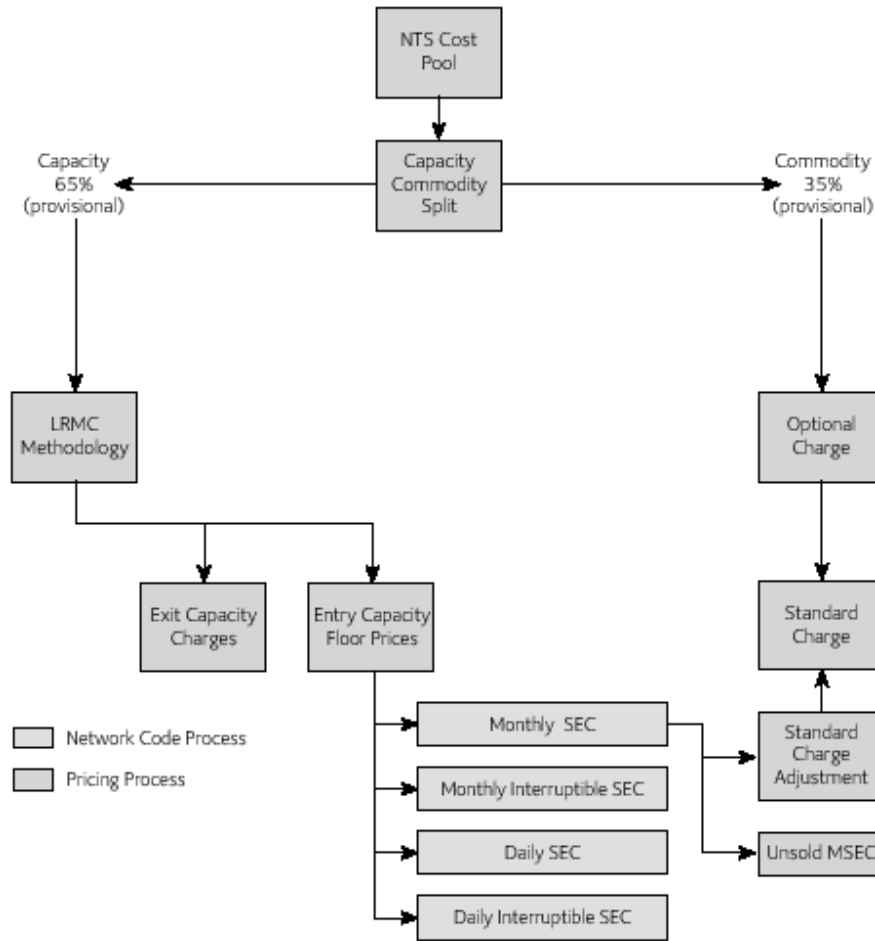
commitments and obligations following from the licence conditions by interacting in the spot market, such a solution would have required significant interactions. The corresponding transaction costs can be considered to be a major disadvantage of the scaling back approach.



**Figure 7: Price in secondary capacity auction** (source: Ofgem, 1999)

#### IV. Auctioning Entry Rights

Charges to use the gas transmission system are split between use of the National Transmission System (NTS) and the Local Distribution System. Only the NTS is relevant for our purposes. Fees to use the NTS are split between capacity (65%) and commodity charges (35%). Capacity charges included both an entry fee (charged at the auction price) and a regulated exit fee (based on a long run marginal cost calculation). The commodity charge is a flat fee per unit of gas transported and is independent of the entry and exit zones. This description is shown schematically in Figure 8.



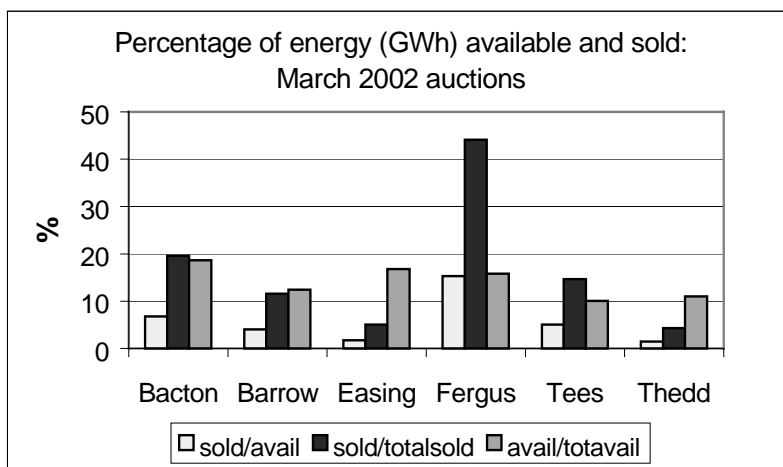
SEC= system entry capacity

**Figure 8: NTS charges and Floor prices (Source: Transco, 2000, Table 3.2.1)**

Transco is a monopolist with regulated revenues. The monthly system entry capacity (MSEC) auctions account for approximately 5 percent of its annual revenue target. Provisions are made for the events of over and under recovery of auction revenues and generally entail revisions to other regulated network charges. Day-ahead and daily auctions form part of an incentive scheme whereby Transco is awarded for increasing available capacity. These auctions do not contribute to the company's revenue target.

### *Description of the current auction approach*

As can be seen in Figure 4 there are six major beach terminals in Great Britain where gas is put into the NTS: St. Fergus, Teeside, Easington, Theddlethorpe and Bacton on the east-coast and Barrow on the west-coast. The auctions for rights to enter gas into the NTS began in September 1999 and originally only included these six beach terminals. The subsequent auctions also included a number of onshore fields, storage and constrained LGN facilities. St. Fergus in Scotland and Bacton in the south-east are the terminals with most demand for capacity. Figure 9 shows the volumes of energy sold and available at these six terminals for the March 2002 auctions. St. Fergus and Bacton account for 16 and 19 percent, respectively of availability. The two terminals also account for the largest share of sales (44 and 20 percent, respectively). The importance of St. Fergus is understood by observing the number of gas pipelines connecting it to gas fields in the North Sea. Bacton is likewise connected to a number of major pipelines, but more importantly, it is the closest terminal to the interconnector linking Great Britain to the continent via Zeebrugge in Belgium. The major characteristics of the auction design and product, the auction rules, and the evolution of the auction design since 1999 are outlined below.



**Figure 9:** Energy availability and sales

### *Auction features*

Product definition. The product sold in the auctions is the right to enter a volume of gas at a given entry point for one month (referred to subsequently as monthly system entry capacity or MSEC). Auctions of MSEC held bi-annually and are for six month tranches; auctions held in March allocate rights for the period April-September, and auctions held in September allocate rights for the period October-March.

Transco discussed selling either twelve, six, or one month capacity rights at each auction; it considered that the monthly option would be best in principle since it would provide the most flexibility to shippers, but this option could not be realised in time for the September 1999 auctions. Six months were preferred to twelve since this would reduce shippers' risk from bidding mistakes and would take account of the different demand profiles of winter and summer.<sup>9</sup>

Transco furthermore assessed how auctions would "achieve an efficient allocation of capacity and to identify the value of information that may be generated by the auction process" (p.34) and meet criteria with respect to: allocative efficiency, ease of use, familiarity, accommodation of complements/substitutes, and system readiness. The accommodation of complements and substitutes between different entry terminals is a further important feature of any design of gas network auctions for periods of more than one month since shippers will value the ability to adjust their demands depending on maintenance, for example, or their need to have rights for consecutive periods.

MSEC auctions are accompanied by daily auctions of firm and interruptible capacity rights.

Auction rounds. The total capacity available at each terminal is divided equally and sold over four rounds separated by one business day. Beginning with the March 2000 auctions, these four rounds were supplemented by a fifth 'flexible' round in which any unsold (aggregate) capacity could be auctioned and subsequently nominated at any entry terminal on the network. As the fifth round is a 'residual' round, the volumes sold are rather low. There is one proviso, however: Transco sets a maximum amount that can be allocated to each terminal in the MSEC auctions. Thus, if a shipper bought gas in the fifth round and wanted to nominate at St. Fergus, she would only be able to do so if that maximum were not binding. In the March 2000 auctions a very small amount of the aggregate residual capacity remained unsold because bids to nominate fifth round capacity to St. Fergus were rejected on the grounds that the maximum allowed MSEC for that terminal had been reached.

Reserve prices. Reserve prices reduce the risk that the network owner will be unable to meet its revenue requirement and are important for capacity auctions in the presence of either market power or excess capacity. Prior to October 1999, entry rights were booked on the basis of regulated prices that were estimates of the long run marginal cost (LRMC) at each entry point. Reserve prices equal to LRMC would reduce the efficiency of the auction if these were above the marginal valuation of shippers. In determining appropriate reserve prices, the estimated LRMC has been used as a benchmark with proportional discounts depending on the

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<sup>9</sup> Transco, "Option for the Mechanism to Allocate Terminal Capacity in October 1999," 1999-06-30.

concentration of bidders at each entry point. At Barrow where there is essentially one bidder the reserve price equals the LRMC and the auctions always clear at this price.

Auction quantities. The amount offered for sale in the monthly auction will affect the amount of secondary trading and the amount of rights that Transco must repurchase in the event of network constraints. This implies that the amount offered for sale in the auction will not necessarily correspond to the amount of physical capacity available either in total or at each entry point. Initially, the baseline level of demand that determined *total* capacity offered for MSEC was calculated using historical information on the average amount of capacity that would be available each month under conditions of seasonal normal demand or SND. The total was then allocated among terminals based on actual flows over the previous three years (Ofgem, 1999b). Ofgem was not satisfied using SND as a measure of available capacity since it was ‘backward looking’ and might not accurately represent the current state of the energy market. The approach was also criticized because the calculations were done by Transco. Through a number of ‘modifications’ to the auction rules the total amount of capacity made available at each has been steadily increased.

If more capacity is auctioned than warranted by downstream demand then Transco must buy back those rights from shippers, possibly at higher prices (see Table 1 in Section V for a discussion of the high buyback costs in October 2000).

#### *Auction Rules*

We follow the Network Code published by Transco in the discussion of the auction rules and procedures.<sup>10</sup> Capacity rights for six separate months are sold at each auction. The auctions are sealed-bid, pay-bid, and concurrent by terminal and month.

Bids Each bid has to include the shipper’s identity, the entry terminal, the month for which capacity is sought and a minimum volume and bid price. Shippers’ bid prices are given in pence/kWh/day, specified to four decimal places, and must not be below the reserve price. The minimum volume for which a shipper can bid is 100,000 kWh/day. Shippers can submit as many as 20 bids for each terminal and each month in each round.

The auctioneer ranks bids, ignoring the entry point, high to low. Bids with same bid price are ranked by bid volume. Then capacity is allocated following the descending bid prices. If the requested amount of the marginal bid exceeds available capacity, then the last bidder receives the remaining amount.

Between auction rounds (before 09:00 the next business day) bidders are informed about

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<sup>10</sup> Transco, *The Network Code: version 2.26*, October 2001 can be found online at <http://www.transco.uk.com/default.htm?netcode/nethome.htm~home>

their winning volumes, the highest/lowest bid price of capacity that was allocated and the weighted average price of accepted bids.

#### *Monthly interruptible capacity*

Like the monthly firm auctions, interruptible capacity is made available each month and is sold in 6 monthly tranches. These auctions are also pay-bid, but occur over two rounds instead of five. The monthly capacity available on an interruptible basis:

$$C_m^I = \text{Maximum physical demand} - \text{available monthly firm capacity.}$$

Capacity in each round equals  $\frac{1}{2} C_m^I$ . The reserve price is  $0.9 \cdot \text{LRMC}$  estimate, and any unsold capacity is made available in the daily auctions.

#### *Short term auctions: daily and within day*

Day-ahead auctions are held for firm and interruptible capacity rights. Reserve prices for the daily firm auctions equal  $0.5 \cdot \text{LRMC}$  at each terminal; for daily interrupt reserve prices are zero. Daily interruptible capacity is

$$C_D^I = \text{unsold monthly interrupt} + \text{use it or lose it capacity.}$$

“Use it or lose it capacity” consists of capacity previously bought by a shipper that has not been nominated for use on the day. The original owner of the rights can *ex post* decide to nominate or to resell the rights herself. In this case the new owner would be interrupted. In June 2000 Transco began to hold with-in the day auctions for firm capacity rights. Reserve prices in these auctions are  $0.5 \cdot \text{LRMC}$ .

#### *Evolution*

While the essential auction design has remained the same, a number of changes have occurred in the auction process since September 1999. The most significant of these changes has been the increase in the total MSEC made available. The total MSEC available in the September 1999 auction was the SND for each month in the October 1999 to March 2000 period. For the March 2000 auctions available capacity was increased from SND to  $\text{SND} + 10\%$ . Because in England total downstream gas demand is lower in summer than in winter, the total MSEC in September 1999 (equal to SND) was still greater than the total in the March 2000 auctions. The available monthly capacity was increased still further in the September 2001 auctions. More recently Ofgem has changed Transco’s licence to encourage a release of capacity that

most accurately reflects system capability. Transco faces incentives to reduce the cost (and so quantity) of buy-backs of capacity in the event of constraints.

As the MSEC has increased, the availability of daily and within day capacity has declined. In particular, the result has been a substantial reduction in the amount of interruptible capacity. Reduced short run capacity availability increases shippers' incentive to secure MSEC. Total capacity available at St. Fergus between October 1999 and February 2002 is shown in Figure 11 of Section V.

Incentives for Transco: The company is incentivised to make available as much capacity as possible. As such it is allowed to retain a proportion of revenues received from daily and within day auctions. Additional capacity sales increase the likelihood of constraints thus Transco has to be exposed to the resulting costs. The company is responsible for 20 percent of the cost of buy-backs necessary to alleviate any constraints on the network due to over-booking of capacity. The total amount of Transco's responsibility is capped annually and monthly, and shippers are responsible for the remainder of these costs.

Over-recovery: To deal with the over-recovery of auction revenue, Transco proposed introducing a buy-back fund that would reduce the amount that shippers are responsible for paying to alleviate constraints. Under this scheme total revenue is divided by six to reduce shippers' share of buy-back costs in each of the six auction months. If there is still surplus remaining it is used to adjust transport charges more generally. The need for a structured approach to deal with over-recovery became apparent only after the second series of auctions in March 2000 when Transco over-recovered 160% relative to its target.

## **V. Evaluation**

From a theoretical perspective a comprehensive analysis of this auction design and the efficiency of the outcomes is problematic for a number of reasons. Most importantly, these are concurrent, sequential auctions with multi-unit demands and common values. As such one does not *a priori* anticipate full efficiency.<sup>11</sup> However, inefficiencies will be reduced if the entry cost for traders is low and there are liquid spot markets.<sup>12</sup>

When bidders in an auction have affiliated values (e.g., the value to any one bidder is correlated to the values of other bidders) and there is a possibility for a winner's curse, then bidding is expected to be more conservative relative to the case in which bidders have private values. Ascending auctions can mitigate the winner's curse (Milgrom and Weber, 1982) since

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<sup>11</sup> Dasgupta and Maskin [1998] show conditions under which multi-unit auctions with common values can result in efficient allocations. Bids are contingent on others' values in their model, however.

the observation of when others drop out of the auction reveals something about their values and so reduces the chance that the winner pays too much. Conversely, open ascending auctions make collusive strategies feasible.

Also contrary to private value auctions, increasing the number of buyers in common value auctions can decrease instead of increase the expected revenue for that seller. That is, increasing the number of bidders can lead to more conservative bidding when values are correlated. The fact that you win an object in common value auctions suggests to you that you likely paid too much since you beat everyone else. The more bidders competing against you, the more likely you are to be cursed if you win.<sup>13</sup> These results suggest a trade off between increasing competition on the own hand, and preventing the winners curse on the other.

We believe that the sealed-bid sequential auction where bidders are given feedback between rounds mimics the properties of the open outcry auction. Specifically, the information obtained between rounds allows shippers to learn about the values of other bidders and therefore decreases the chance that they will be subject to the winner's curse. However, if there is market power at an entry point, multiple rounds can serve to maintain collusion. Given that these are repeated auctions the emphasis should shift over time to give more weight to the problems associated with collusion. Although entry capacity auctions are held for the six major terminals on the NTS significant constraints occur only at St. Fergus. Evidence of this is shown in Figure 10 which shows the percentage mark-up of auction price over reserve price for the March 2002 auctions (the most recent auctions at the time of writing). Apart from St. Fergus the mark-up at the other terminals are strictly below 25 percent and mostly below 15 percent. We take this as evidence of non-binding constraints or extensive market power at these terminals and focus our analysis on the more interesting case of St. Fergus.<sup>14</sup>

In Figure 12 we present empirical results of the auctions. The circles give the price paid for entry rights in the monthly auctions. One notes the strong correlation between simultaneously auctioned months, which is based on the similar information available. Even more obvious in the data is the sharp difference between winter (October-March) and summer

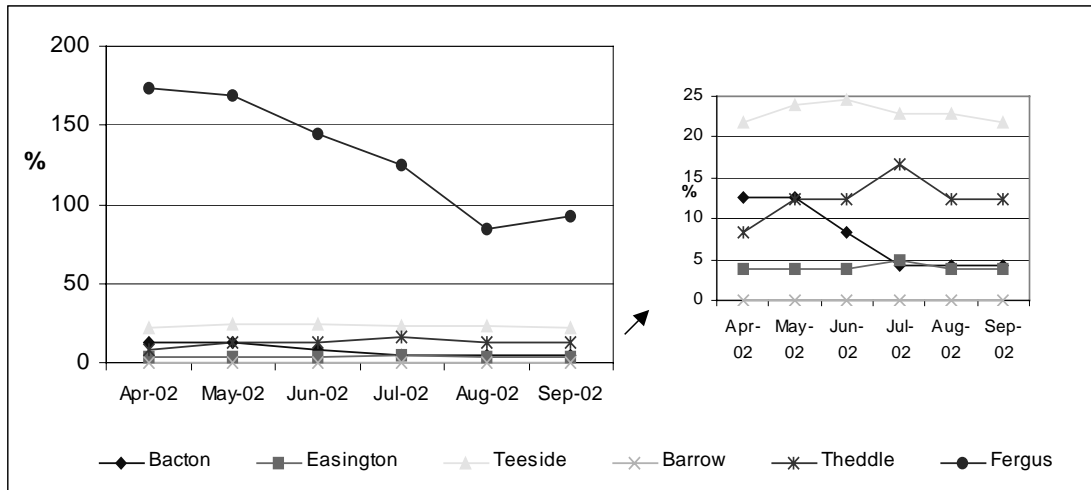
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<sup>12</sup> At this time we do not have full data on the extent of shippers' secondary trades.

<sup>13</sup> See Bulow and Klemperer [2000] for a broader discussion. Bulow and Klemperer also suggest, however, that increases in supply can mitigate the winner's curse by increasing the number of winners and thereby removing or lessening the curse of being among the winners.

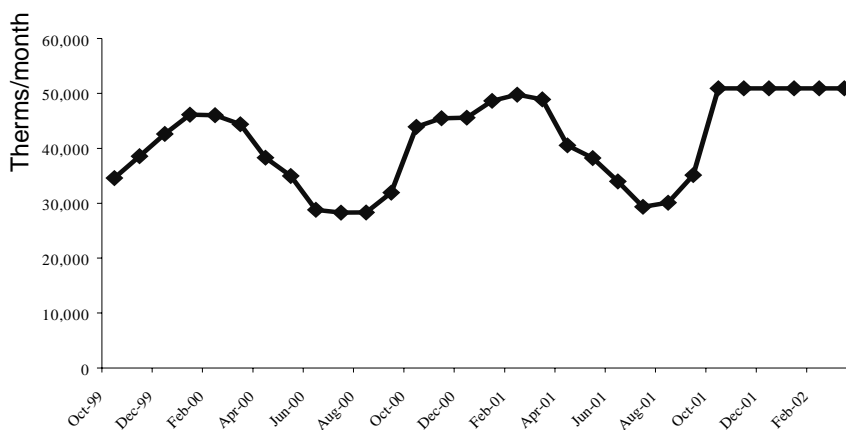
<sup>14</sup> For some of the auctions mark-ups were significantly higher than those shown here (except at Barrow). This is particularly true for the second auction where revenue over-recovery was so great. This auction outcome is discussed more below. We attribute over-bidding at terminals other than St. Fergus in the early auctions to uncertainty about the level of rights to be made available in the spot market since the capacity made available for the first few auctions changed so frequently and with such magnitude.

months (April-September). Figure 11 shows that during summer months less entry capacity is available, because higher outside temperatures reduce transmission and compression capacity and mainly because lower gas demand by consumers and industry reduces the off-take of gas in the north, thereby making constraints in Scotland and Northern England binding.<sup>15</sup>



**Figure 10: Percent of auction price over reserve price: average over four rounds**

Most fields delivering gas towards the St. Fergus terminal are wet-fields, producing oil and gas as ‘by-product’. To reduce the gas-output of such fields would require a simultaneous reduction of oil production. Revenues from oil are bigger than from gas and adapting output quantities is difficult, therefore most oil companies are willing to sell gas, even at a lower price, and are therefore prepared to pay higher prices for entry rights at St. Fergus.



**Figure 11: Available entry capacity in monthly auctions for St. Fergus**

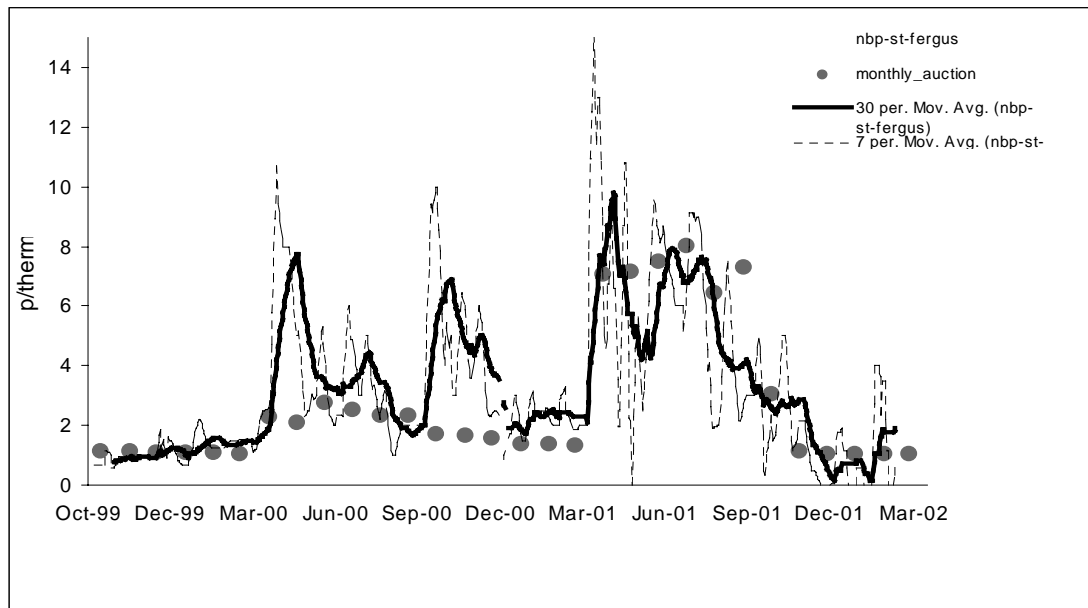
<sup>15</sup> Network analysis of Jones [2001] shows that the relevant (binding) constraints in winter 2001/2002 are expected in diverse locations as Aberdeen, Moffat & Wooler and Kirriemuir.

The black line in Figure 12 gives the 30-day average of the value attributed to entry rights in the day-ahead spot market. Unfortunately results of the daily capacity auctions were not available, and would in any case only cover days with excess capacity. Therefore it was necessary to calculate the daily value attributed to entry rights by comparing the day ahead spot market prices for St. Fergus (before entering the NBP) with the spot market prices at the NBP -implying that the gas is in the NTS (See Figure 13). The resulting price differences are very volatile, therefore we present the 30-day average to allow comparison with the results from the monthly auctions. The graph shows that anticipated entry prices in the monthly auctions are roughly matched by the subsequent realisations of spot prices.

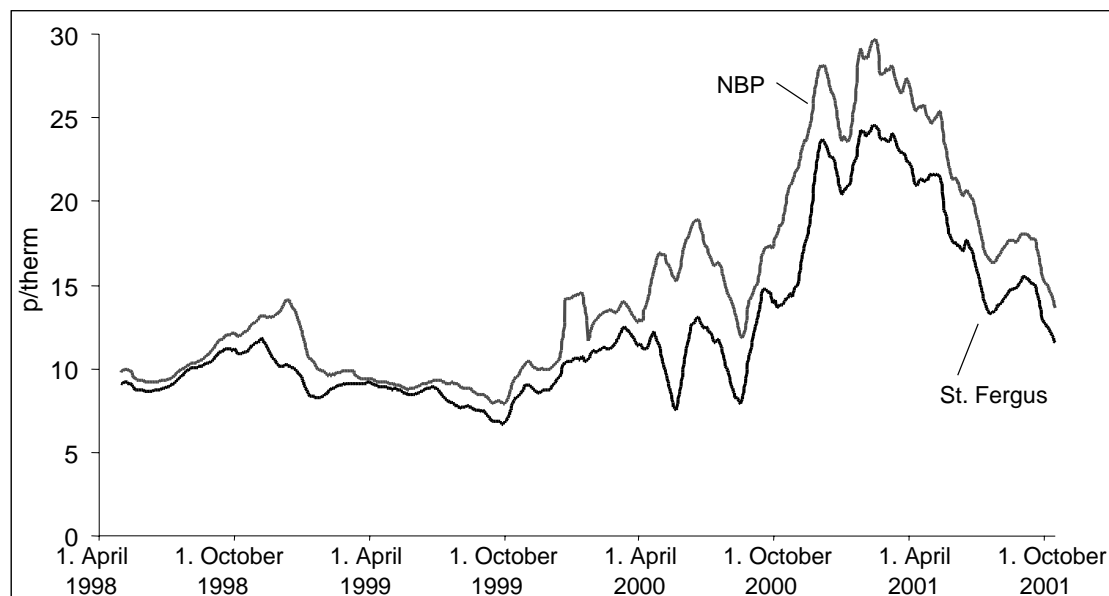
However, starting from April 2000 the day-ahead evaluation of entry capacity was frequently above the price paid in the entry auction. To explain this we look for events that occurred after the auctions for monthly entry rights in March; event happening before the auction should already have been reflected in the prices paid in the monthly auctions. The unexpected oil price spikes of 2000 had a twofold effect on the value of entry capacity. First higher oil-prices during the fuel crisis induced producers in the Northern fields to increase oil-production and accordingly their gas production. Constraints on entry capacity implied that the gas sales could not be likewise increased. Increasing supply while maintaining demand reduces prices, as the drop at St. Fergus spot price in summer 2000 proves (as shown in Figure 13). At the same time gas prices on the continent rise because they are coupled to the oil prices. In Britain gas contracts are not directly linked to oil prices; therefore, shippers want to sell additional gas on the continent via the interconnection from Bacton to Zeebrugge, pushing up British gas prices (once again observable in Figure 13). As access to the network was constrained, higher continental and British gas prices could not feed through to St. Fergus spot prices, and lower St. Fergus spot prices could not balance higher NBP prices. The result is a wedge between prices at St. Fergus and the NBP - and a high value attributed to entry rights.

The next spike for entry rights occurred starting in October 2000. Ofgem claims because of warmer than expected weather demand for gas in Scotland and Northern England was lower, reducing the available entry capacity below the volume of firm rights sold in the monthly auction. Transco had to buy back a significant volume of capacity rights and was paying prices of 18p/therm on average. This price is again above the wedge of spot price differences between St. Fergus and the NBP. The ‘premium’ paid in the buy back market above the spot market can possibly be explained by the additional costs incurred by gas producers when they have to change their production on short notice during the day. Furthermore shippers might have used their market power to obtain higher prices from Transco when selling back entry rights. In a subsequent investigation however Ofgem concluded that no action was required as “shippers and Transco [had] to learn about the

dynamics and operation of the capacity buy back market.” (Ofgem 2001/2)



**Figure 12: Monthly averaged price difference between day-ahead spot market for gas at St. Fergus and National Balancing Point and weighted average prices paid in auction for monthly entry rights.** (Source: Own analysis based on data from Transco plc. and Heren)



**Figure 13: Monthly averages of spot prices at the National Balancing Point and St. Fergus** (Based on Heren data)

However, the main reason for the unexpected price spike for entry rights in Fall 2000 can be seen in Figure 13. The wholesale gas prices in the British market almost doubled, but constrained entry capacity at St. Fergus did not allow producers at St. Fergus to react to

higher demand at the NBP. Therefore the prices of the NBP did not feed through to prices at St. Fergus where spot prices stayed constant. The resulting wedge in prices was reflected in a spike of the value attributed to entry rights.

Since 2001 the monthly auctions returned to being a good predictor for the average value attributed to entry rights. The benefits of auctioning entry rights can be seen by comparing the scarcity of entry rights during the high constraint period in September 1999, when the average difference between spot price in St. Fergus and NBP was 0.7 p/therm and October 2000, when the average difference between the spot prices was 6.7 p/therm. Even though the scarcity of transmission capacity increased tenfold, the costs for buy-backs have fallen. Since the auctions began in September 1999, there has been one instance of seemingly substantial buy-backs by Transco to reduce network constraints. Table 1 shows the costs of buy-backs for the auctions through February 2001. For the five month period, October 2000 to February 2001 these costs reached £11.6 million. This was high enough to prompt an investigation into shipper behavior by Ofgem,<sup>16</sup> yet it is still below the £23.1 million for the five months period August-December 1998 shown in Figure 5. This provides just one example, but more generally, the advantage of the auction approach is the added transparency. Because Transco typically waits until the gas-day to buy-back entry rights, these cost are higher than the prices at which the rights were bought at the auction.

	Number of days requiring buybacks	Average Daily Buy-back vol (GWh)	Weighted average price (p/kWh)	Total cost of Buybacks (£)
April	0	0	-	0
May	0	0	-	0
June	5	11.93	0.21	126,717
July	7	28.2	0.40	783,041
August	10	12.57	0.07	87,259
September	6	18.08	0.19	203,349
<b>Total</b>	<b>28</b>	<b>17.54</b>	<b>0.24</b>	<b>1,200,366</b>
October	20	76.71	0.55	8,514,192
November	8	47.78	0.45	1,723,850
December	5	28.63	0.61	869,433
January	0	0	-	0
February	1	128.53	0.37	475,158
<b>Total</b>		<b>64.35</b>	<b>0.53</b>	<b>11,582,633</b>

**Table 1: Capacity buy-backs April 2000-February 2001** (Source: Ofgem,2000)

Another issue, which arises in these auctions, is Transco's revenue requirement. Deciding how to distribute over-recovery of auction revenues is a problem not normally confronted in private-sector auctions, yet it is important where the auctioneer is a regulated firm. The fact that over-recovery occurs should not be a problem, *per se*, but a well-defined

auction should address this issue at the beginning so that participants know the game they are playing. How to distribute 'surplus' revenues is not a trivial problem since reimbursements can impact shippers' bidding decisions in the monthly auctions. As such, participants should have recourse to a credible dispute resolution in the event, for example, that well-founded assumptions regarding the use of extra-revenue do not materialize. Transco's auction revenues for the period October 1999-March 2000 were £85.62 million (within -3 percent of its revenue target). A similar situation was anticipated for the March auctions. In the event, auction revenues were £228 million or 160 percent greater than target revenues (See Table 2 for the actual and target revenues for the second auctions and the average number of bidders at the six main entry terminals).

The auction rules made allowances for over/under-recovery. Specifically, it was anticipated that adjustments would be made to the generic correction factor in Transco's price control; i.e., the price control contains a revenue under/over recovery adjustment factor such that if the company over-recovers relative to its revenue target in a given year, the target is scaled downward the following year. This would mean a general reduction in transportation charges for shippers in the following year.

Following the large over-recovery from the second auctions, Transco decided to make a one-off adjustment whereby commodity, capacity and transport charges were proportionately reduced. Fifteen percent of the over-recovery went to reductions in transport charges while the remainder reduced NTS capacity and commodity charges (Ofgem, 2000). It seems obvious that such a rebate mechanism would alter bidding behavior if this type of surplus redistribution became the rule. If a portion of entry capacity charges are refunded to shippers they will not incur the full cost of their bids and therefore have skewed bidding incentives. This would bias estimates of the demand for capacity and lead to erroneous investment decisions if long-run capacity auctions were pursued. In the future over and under recoveries will be assigned to a 'buy-back' fund that will reduce shippers' share of constraint costs.

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<sup>16</sup> Ofgem, 2001.

		Bacton	Barrow	Easington	StFergus	Teeside	Theddle.	Total
Apr-00	actual	0.62	0.84	0.34	21.91	1.61	0.54	25.85
	target	0.26	0.74	0.6	9.6	0.79	0.21	12.19
May-00	actual	0.66	0.53	0.3	18.82	1.4	0.45	22.15
	target	0.2	0.4	0.41	7.89	0.76	0.16	9.82
Jun-00	actual	0.63	0.14	0.49	19.72	2.83	0.7	24.51
	target	0.15	0.16	0.28	7.08	0.67	0.13	8.48
Jul-00	actual	1.52	0.07	0.39	18.16	2.72	0.5	23.35
	target	0.1	0.01	0.26	6.89	0.64	0.1	8.01
Aug-00	actual	1.8	0.08	0.35	16.77	2.77	0.45	22.22
	target	0.1	0.03	0.24	6.75	0.67	0.13	7.91
Sep-00	actual	1.71	0.15	0.46	18.51	2.79	0.61	24.23
	target	0.15	0.18	0.32	7.58	0.74	0.15	9.11
Total	target	8.68	7.89	4.9	181.86	19.18	5.45	143.63
	actual	2.81	11.55	6.42	111.84	8.89	2.12	227.96
Average number of bidders (round1-round4)		17.1	1	7.4	19.8	13.9	10.3	
Avg. number of successful bidders (round1-round4)		5.6	1	2.9	9.3	5.8	5.8	

**Table 2: Revenues for the March 2000 auctions, £million** (source: Ofgem, 2000 and Transco data)

Finally, in the international environment the auction mechanism seems to prevail as well. In October 2001 additional pipelines in the North Sea were taken into service to allow the export of gas from Norwegian fields towards the UK, using the St. Fergus terminal. Even so Norway complained that the constraint costs would reduce the Norwegian revenues in the project, it finally supported a project that retains the bottleneck and therefore the capture of scarcity revenues on British soil.

## V Conclusion

We began with the hypothesis that the auctioning of well defined access rights is an efficient way to deal with significant transmission constraints in the presence of monopoly ownership of the network with competition in production and supply whilst also allowing for non-discriminatory access and entry. We have supported this view by describing the evolution of the liberalisation of the gas industry in Great Britain; discussing the short-comings of the previous methods of allocating network access; and illustrating the correspondence between auction and spot prices.

We provide a description though not a thorough evaluation of the specific auction design as a full theoretical model is outside the scope of this paper, and the six available auction data points do not make a full statistical analysis feasible. Also a number of events occurred outside of the auction mechanism which influenced the auction results. Most notably, higher gas prices in continental Europe, the oil price spikes with impacts on wet-gas fields and changes in the allocation of excess revenues from auctions. Comparison between the auction and previous models is limited for a number of reasons. First, the opening of the UK-Belgium interconnector in October 1998 changed trade patterns; second, a continuous increase in gas demand in the UK in parallel with falling production at existing fields, resulted in an increase of scarcity of entry capacity at St. Fergus by up to the factor of ten. Nevertheless, the costs of resolving constraints have fallen significantly - implying that the definition and auctioning of property rights for entry capacity was successful.

We conclude that the current auction improves upon the previous methods historically used in Great Britain to allocate entry rights. We add, however, that this might not be the case if there were not a reasonable amount of competition in the production and supply markets. Also, if there were no significant transmission constraints, then the assignment of access rights via auction would be unnecessary.

Finally, although we are enthusiastic about the use of auctions to allocate entry rights when the network is fixed we have reservations about the appropriateness of using auctions to decide on and fund network investments

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