Developments in the Electricity Markets in the UK: the move towards BETTA

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ABSTRACT

In the last 15 years there have been many changes in the Electricity Supply Industry in the UK. The first major change occurred in 1990 with the privatisation of the former nationalised industry. Until April 1st 2005, there were significant differences in the way electricity was generated, transmitted, distributed and supplied in Scotland on the one hand and England and Wales on the other. Since that date, the structure is being progressively integrated into a uniform system covering England and Wales and Scotland. In Scotland, the tradition had always been for vertical integration whereas in England and Wales, generation was always separate from distribution and supply to consumers

At privatisation two vertically integrated companies were formed for Scotland, while in England generation was initially in the hands of three generators (one of which only ran nuclear stations) and 12 regional electricity supply companies. Throughout the 1990s, it was the generators who largely controlled the wholesale prices of electricity as there was no demand side bidding. This was done through an Electricity Pool. In Scotland there was no Pool System. Progressively further generators entered the market in England and Wales, sometimes as completely new entities and sometimes by purchasing generating plant from the fossil fuel generators.

In parallel with the privatisation, deregulation took place and this progressively allowed consumers to purchase electricity from any supplier. Since the middle of 1999 all areas of England and Wales have been deregulated. Also during the 1990s the regulators for the electricity and gas markets, OFFER and OFGAS respectively, were merged into a single regulator – OFGEM (the Office of Gas and Electricity Markets). Subsequently the consumer watchdog functions of the Regulator were transferred to a separate organisation Energy Watch which now provides protection for the consumer.

On 27th March 2001 a significant change took place in England and Wales with the Introduction of the New Electricity Trading Arrangements (NETA). This had a profound way in which the markets operated and saw both generation and demand side bidding setting the wholesale price of electricity. Other developments in the electricity market were the introduction of the Renewables Obligation on 1st April 2002, in the last few months the European Union Emission Trading System, and finally BETTA – the British Electricity Transmission and Trading Arrangements on April 1st 2005.

This paper reviews these recent changes, expands on the general review of the last 20 years given by Tovey (2003, 2004). Those papers also contain a more detailed review of the structure of the electricity companies and a review of the impacts of the Renewables Obligation.

INTRODUCTION

For the last two decades, the total UK demand for electricity has been rising at 1.8% per annum, and in the last few years this rate has increased to over 2% (Fig. 1). The net demand for the whole UK now stands at 381.3 TWh per year (DTI, 2004), an increase of 3.05% on the year before. Of this figure, just under 50 TWh was generated in Scotland (Scottish Executive, 2004) but only two thirds of this was actually consumed in Scotland. 16 TWH of this figure was transferred over inter-connectors to the Northern Ireland Grid (400 MW inter-connector capacity) and the England and Wales Grid (1200 MW inter-connector capacity). Historically, Scotland has also been a net supplier of electricity to England and Wales Electricity Grid.

The structure of the electricity supply industry in Scotland has always been different from that in England and Wales. In Scotland, both before privatisation on 1st April 1990 and since that time, there have been two vertically integrated companies, which have covered all aspects of electricity from generation, through transmission and distribution, to supply of electricity to customers. Initially, the companies were State Monopolies, covering specific regions of Scotland, and since that time there have been two privatised companies – Scottish Power and Scottish Hydro-Electric. The latter is now part of the Scottish and Southern Group. Some significant changes took place in the way electricity is transmitted in Scotland on 1st April 2005.

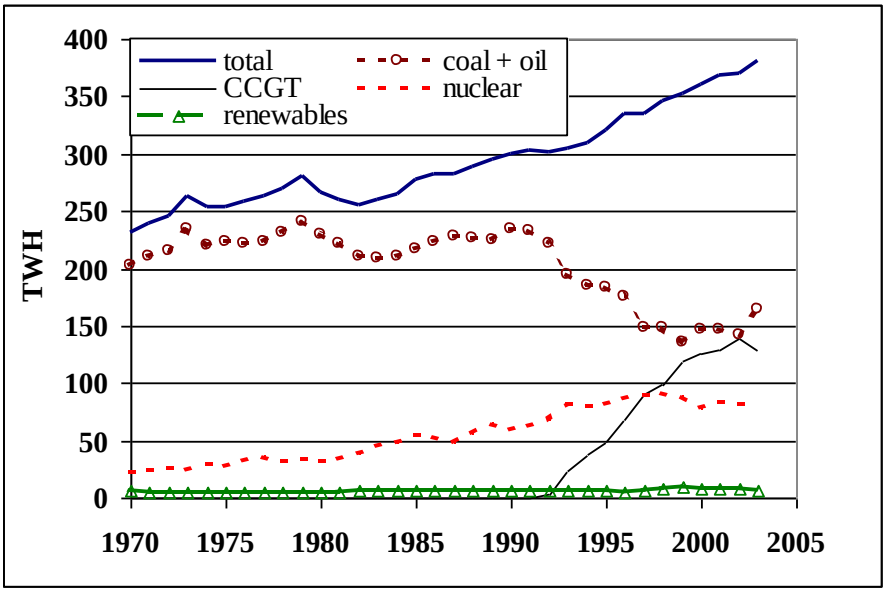


Fig. 1. Electricity generated in the UK 1970 – 2003 showing also the variation in fuel source over the years.

Before privatisation there was a single Generating Company (Central Electricity Generating Board: CEGB) in England and Wales which generated and transmitted electricity but did not sell electricity to consumers. Instead the CEGB sold the electricity to 12 regional Electricity Boards who distributed and supplied electricity to consumers only within their region. The situation prior to privatisation is summarised in Fig. 2 while details of the different Regional Electricity Boards in England, Wales and Scotland are shown in Fig. 3.

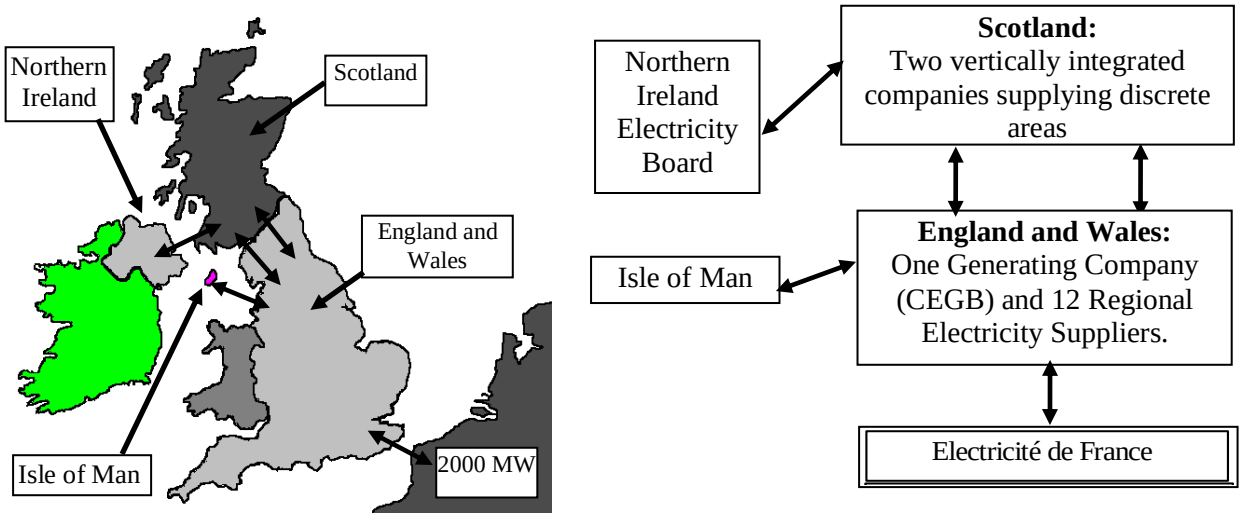


Fig. 2 Summary of Electricity Supply in UK before privatisation

Two other regions of the United Kingdom are connected via inter-connectors, but continue to remain separate in terms of operation. These are Northern Ireland which is connected to the South of Scotland and the Isle of Man which is connected to the England and Wales Grid with a capacity of

40MW. The most northerly group of islands – the Shetlands (not shown in Fig. 2) has an isolated island system, while the Hebrides and Orkney Islands are connected to the Scottish Hydro Network. Currently there is also a 2000 MW inter-connector with the Electricité de France. Further inter-connectors to Norway rated at 1320 MW and to the Netherlands, also of 1320 MW, are under consideration.

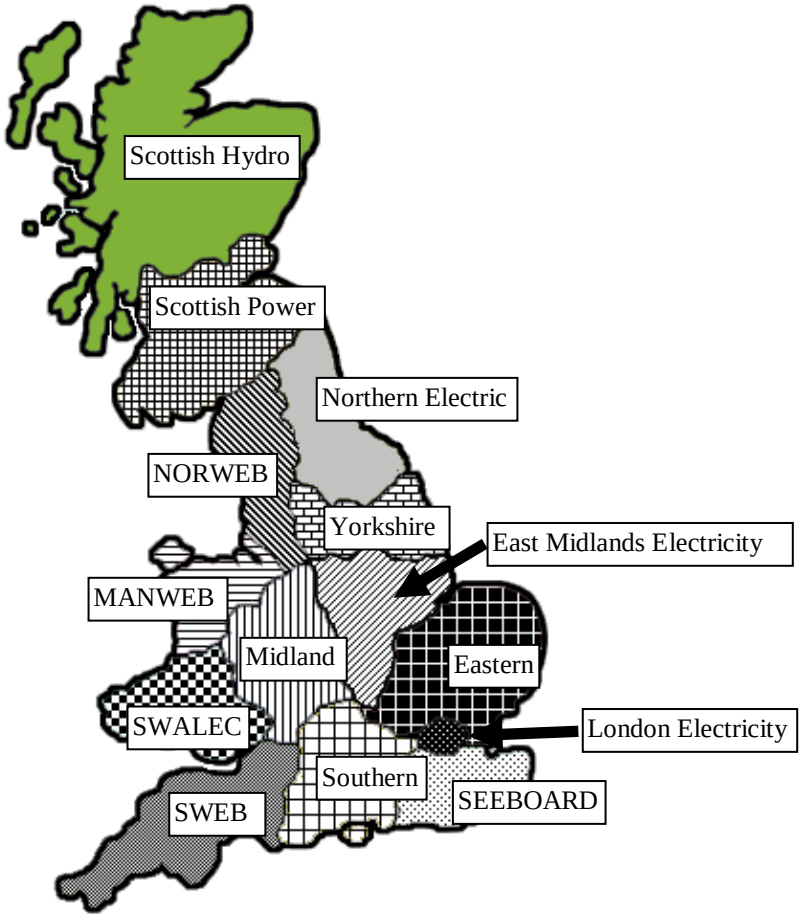


Fig. 3. The Regional Electricity Companies (REC) at the time of privatisation in 1990. Both Scottish Power and Scottish Hydro were vertically integrated with generation and supply. In England and Wales, the companies only supplied electricity, none generated electricity (after Tovey 2004).

FUELS USED IN THE GENERATION OF ELECTRICITY IN THE UK

While there are normally major flows of electricity from Scotland to England and Wales, there are also significant flows of power south of the border. This is because the majority of the generation is in the north and most of the demand is in the south. Since 1990, when coal represented 65% of the generating capacity with oil at 11%, nuclear at 21% and gas less than 1%, the proportion of fuels used has changed significantly as shown in Table. 1. While the total nuclear generation in the UK is just over 20%, in Scotland it is over 40%. With 10% hydro generation in Scotland only 50% of electricity generation comes from fossil fuels.

After a prolonged period of reduction in the use of coal, there was a significant shift in 2003 with an increase in the amount of coal burnt and a consequential reduction in gas burnt in the generation of electricity. The situation changed back towards gas in 2004, but in the first few months of 2005, the continued high prices of gas has once again seen an increase in the coal burn. The proportion of electricity obtained from France declined in 2003 due to the high summer demand in that country and for the first time, the UK was a net exporter of electricity in the third quarter of 2003. The total generation of electricity from renewable resources in 2004 was 3.9%, well short of the UK Government target of 4.9% for the year long period from April 1st 2004.

Table 1. Fuel used in the generation of Electricity in the UK

	1990 (at privatisation)	2001 (at start of NETA)	2002	2003	2004
Coal	62.9%	37.4%	35.4%	38.1%	36.5%
Oil	10.6%	1.7%	1.5%	1.9%	1.1%
Gas (CCGT)	0.7%	31.5%	33.6%	31.6%	34.7%
Nuclear	20.5%	24.5%	24.3%	23.7%	21.1%
Hydro	0.6%	0.4%	0.5%	0.3%	0.5%
Other Renewables	1.1%	2.3%	2.5%	2.7%	3.4%
Other Fuels		1.2%	1.3%	1.5%	1.9%
Imports (France)	3.8%	1.1%	0.9%	0.2%	0.8%

The UK has been one of a very few countries that saw a substantial drop in emissions from carbon dioxide. This was almost entirely due to the change in fuel mix for the generation of electricity. In the last few years, this trend has reversed and though emissions are still well below 1990 levels, the rises call into doubt the UK's ability to meet it's target reductions by 2010. Indeed in 2003, a rise of 5% occurred in the electricity supply industry. The UK National Allocation Plan published at the end of April 2004, (DEFRA, 2004) will have severe impacts of the Electricity Supply Industry. The Plan allocates a 16.4% reduction in emission for this industry from 2002 levels, the largest reduction of any industry in the UK.

There is very little centralised combined heat and power (CHP) in the UK (unlike Russia), and no scheme is associated with the major electricity companies. There is no infrastructure to deal with city-wide schemes for heat supply, nor is there any likelihood that large city wide schemes will now be built in the UK. There are, however, many small institutional CHP schemes in Universities, Hospitals etc, but these mostly have capacities less than 10 MW, with an average size of just 650 kW. Unlike Russia, there are no central heating facilities for towns and cities – each building generally has its own heating supply.

Nuclear generation is provided by reactor types unique to the United Kingdom. With the exception of one pressurised water reactor (PWR), the nuclear reactors are all gas cooled. They are either of the older MAGNOX variety or the newer Advanced Gas Cooled Reactor (AGR). The MAGNOX reactors are now approaching 40 years in age, and most of these will be closed within the next 5 years. Currently there are no plans to build new nuclear reactors in the UK. The year 2004 saw a significant drop in the output of the nuclear stations and this is likely to drop further with the scheduled closure of all the Magnox Stations in the next 4 – 5 years.

CHANGES TO THE SUPPLY OF ELECTRICITY TO CONSUMERS

There have been two distinct stages in the supply of electricity since privatisation in 1990. Though large consumers (>1MW) were able to choose any licensed supplier from 1990, and medium consumers (> 100kW) from 1994. The Electricity Supply in the UK was fully deregulated for all 20 million domestic customers over a period of nine months from 5th September 1998. After Deregulation, all customers had the choice as to from whom they could purchase the electricity. In many cases, the alternative suppliers were other Regional Electricity Companies, although there emerged an increasing number of independent companies for whom there was no historic geographical base. Many of these new companies have suffered in an increasingly competitive market and some have gone into receivership, while others have been purchased by one of the larger companies.

Before deregulation prices were regulated by the formula

$$RPI - X + E + F,$$

where

RPI represents the Retail Price Index (i.e. a measure of the inflation from one year to the next),
X was a factor set by the regulator which initially was 5 – 8%, but reduced progressively,
E was the efficiency factor, and
F represented the fossil fuel levy which was used to promote renewable generation.

Further details on the operation of this formula may be found in Tovey (2004).

While the regulator OFFER (Office for Electricity Regulation) initially took on the responsibility of both regulation and acting as a consumer watchdog, by 1999 it had been merged with the Gas Regulator (OFGAS) to form OFGEM (the Office of Gas and Electricity Markets). In 2000, the functions of the Consumer Watchdog were transferred from the Regulator to a separate body: Energy Watch. Energy Watch is funded by the Department of Trade and Industry costing approximately £13million pounds. This money is obtained from the Regulator from income obtained from licences issued in the Electricity generation and supply industry.

In 1999 it became possible for all customers to purchase their electricity either from one of the regionally based electricity companies or from an increasing number of licensed suppliers. In almost all cases, the local electricity companies tariffs were amongst the most expensive and this was seen as an incentive for consumers to switch supplier. However, many consumers still have not changed and there are still significant savings for the domestic consumer – up to £100 a year that may be made by wise switching of suppliers. At present there is a 28-day rule which means that consumers may not switch more frequently than this period.

Several internet based companies now provide a service for consumers to compare prices between suppliers and also provide an easy method for consumers to change from one supplier to another. As a result of privatisation and deregulation the price of both gas and electricity to the domestic consumer has fallen in real terms. Electricity, despite recent rises is still cheaper than it was (in real terms) in 1970 while for gas, the price is only 70% of the price in 1970 (Fig. 4).

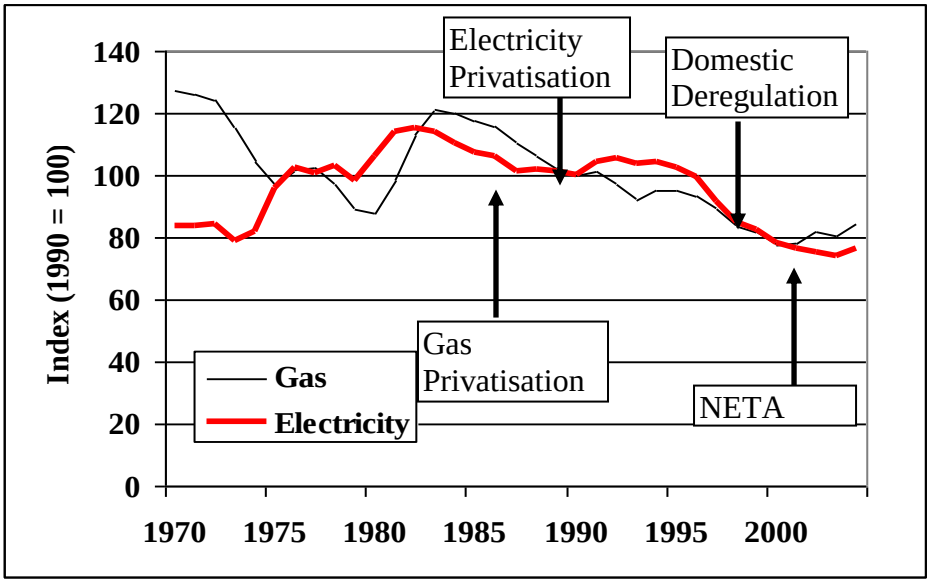


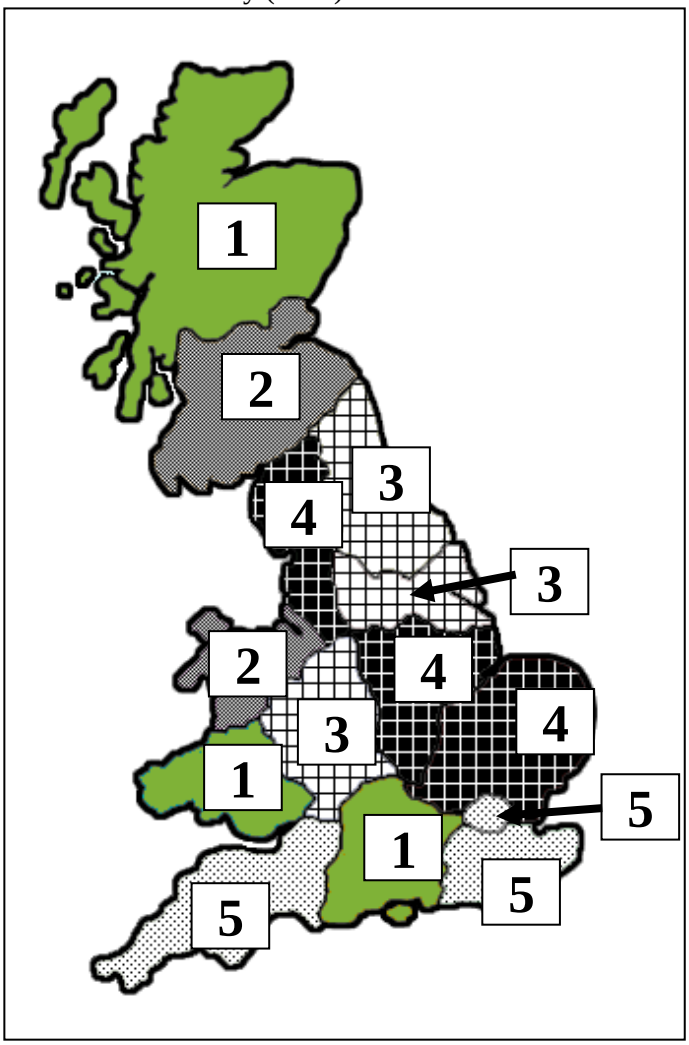
Fig. 4. Changes in the real price of electricity and gas from 1970 to present day (1990 prices are set to index value 100). The key dates in both markets are highlighted. Deregulation had a more profound effect on electricity prices than on gas.

CHANGES IN STRUCTURE OF COMPANIES IN THE ELECTRICITY INDUSTRY

At the onset of privatisation, the supply of electricity was dominated by 14 Regional Electricity Companies (RECs) who also acted as the Distributed Network Operator in their own area. Progressively there was vertical integration with generating companies such as PowerGen (part of E.ON) acquiring East Midlands Electricity and National Power acquiring Midlands Electricity Board. Subsequently there was a take over by over some RECs by others (e.g. MANWEB was acquired by Scottish Power), while in other cases there was a direct merger (e.g. Scottish Hydro and Southern Electricity). Foreign Companies then took control in some areas – e.g. Electricité de France successively acquired London Electricity, SEEBOARD and SWEB.

Further restructuring took place such that there are now just 6 major players in the retail of electricity which have a regional base: nPower (3 regions), PowerGen (3 regions), Electricité de Farnce

(3 regions), Scottish Power (2 regions), and Scottish and Southern (3 regions). In addition British Gas has a substantial presence in the electricity market across the country having entered the area following deregulation. Further details of these changes, many of which have taken place in the last few years are summarised in Tovey (2004).



Electricity Supply Areas in 2004

1. Scottish and Southern Group: now supplies in following geographic areas:
   - Scottish Hydro Electric
   - Southern Electric
   - South Wales (SWALEC)
2. Scottish Power Group: now supplies in following geographic areas:
   - Scottish Power
   - MANWEB
3. nPower: now supplies in following geographic areas:
   - Midlands
   - Yorkshire
   - Northern
4. PowerGen: now supplies in following geographic areas:
   - East Midlands
   - Eastern
   - NORWEB
5. Electricité de France: now supplies in following geographic areas:
   - London
   - SEEBOARD
   - SWEB

Fig. 5. The situation in 2004 with regard to geographic supply areas. This figure should be compared with Fig. 3 to see changes in the last 14 years. The companies in areas 1 and 2 are UK owned while the parent companies for areas 3 and 4 are both German owned, and the parent company for areas 5 is French. For more details of the changes that have taken place see Tovey (2004).

TRANSMISSION AND DISTRIBUTION OF ELECTRICITY IN THE UK

Until April 1st 2005, the transmission and distribution systems in the UK differed between England and Wales on the one hand and Scotland on the other. In both regions, distribution at lower voltages has been and continues to be the responsibility of the Distribution Network Operator (DNO). Following privatisation the DNO in each of the 14 sub-regions of both England and Wales and Scotland were the responsibility of the REC. In England and Wales, transmission included all voltages of 275 kV and above (i.e. 275 kV and 400 kV), while voltages of 132 kV and below were the responsibility of the DNO. In Scotland, the situation was more complex with generally voltages of 132 kV and above being classed as transmission and lower voltages as distribution. The differences in approach between the two regions of the UK has meant that much work has been necessary to integrate the two systems into the British Electricity Trading and Transmission Arrangements (BETTA).

Fig. 6 shows the transmission network in the UK as of April 1st 2005. The majority of transmission in England and Wales is at 400 kV with 275 kV being used in the urban areas. In Scotland there is little transmission at 400 kV but a substantial amount at 132 kV. With BETTA, the two inter-connectors will become part of the integrated GB Transmission System.

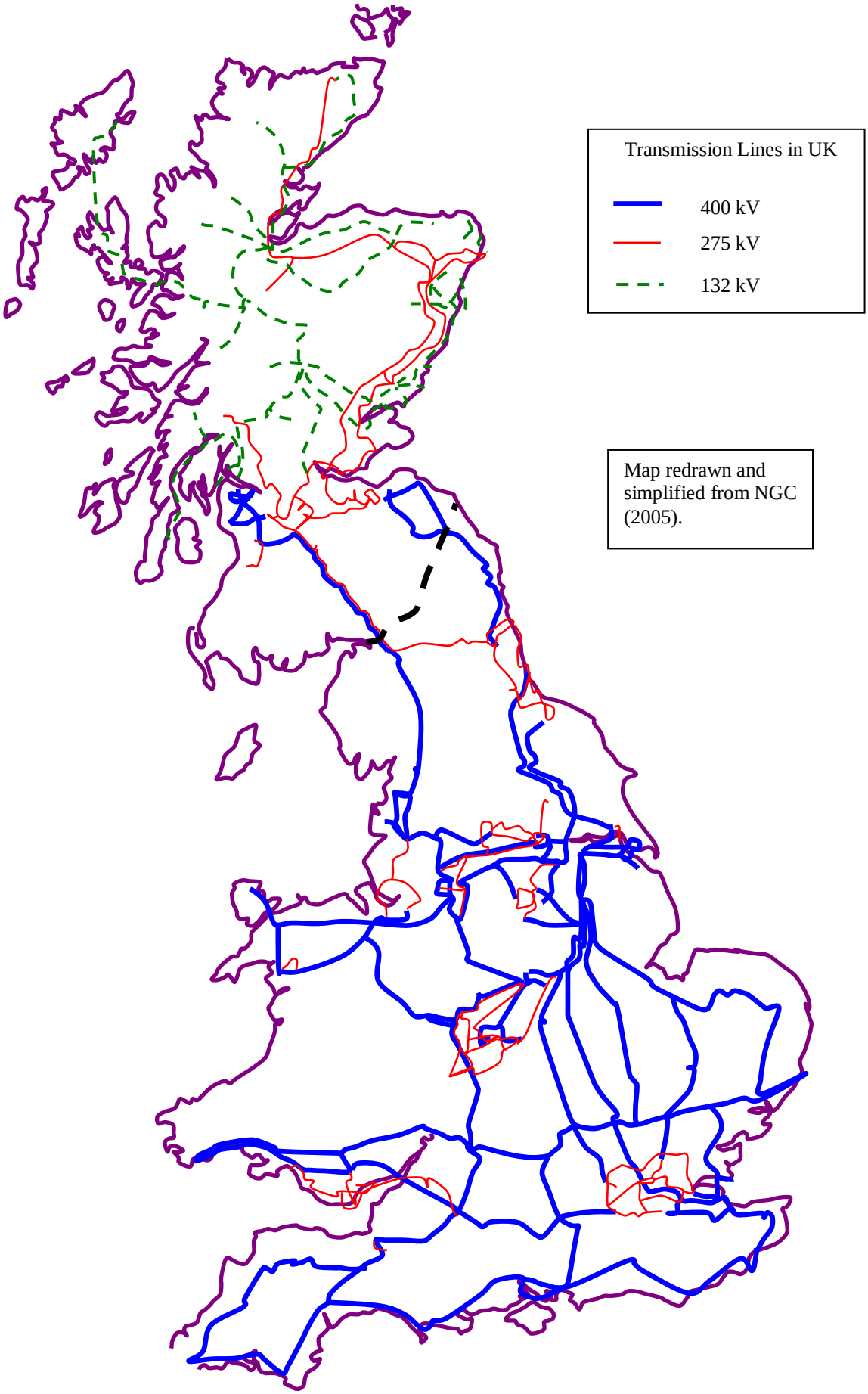
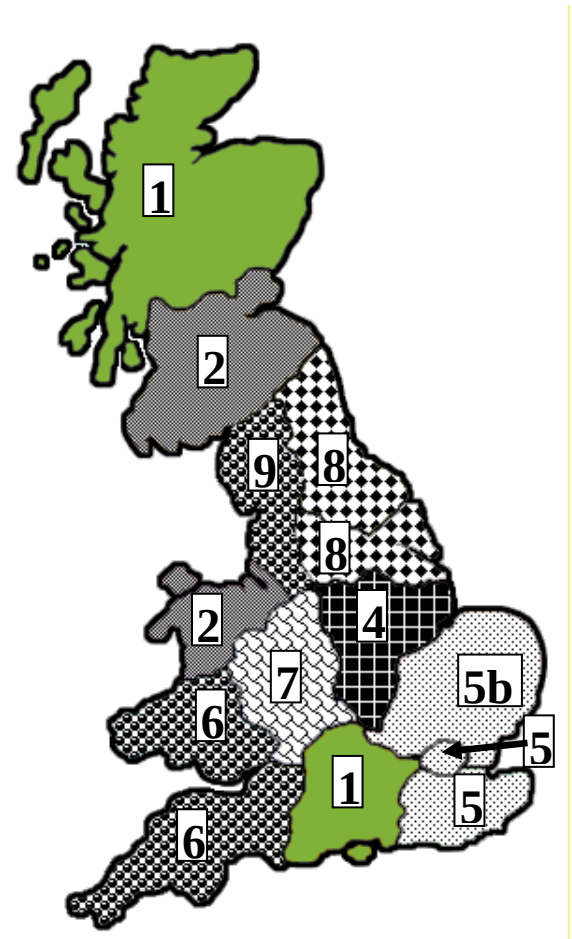


Fig. 6. The Transmission Network in England, Wales and Scotland. The majority of transmission in England and Wales is at 400 kV with 275 kV used in urban areas such as London, the Midlands, Merseyside etc. In Scotland a much of the transmission is at 132 kV.

Major changes in the ownership of the Distribution Network Operation have taken place in the last few years. Many of these changes were discussed in Tovey (2004). In the last year, E.ON (the parent company of PowerGen), acquired the Aquila Network in the midlands Electricity Area and merged it with its operation in the East Midlands Area under the trading name of Central-Networks (Fig. 7). In only seven of the original 14 areas is the DNO the same company as the Regional Supplier.



Distribution Network Operators 2005: Note the numbers are the same as the groupings in Fig. 5.

1. Scottish and Southern: note the SWALEC area is operated by Western Power (6)
2. Scottish Power
4. PowerGen (E.ON UK) only in East Midlands area under the name Central Networks following merger in 2004 with Midlands Distribution Network. The Eastern area network is operated by EDF (5b), while their NORWEB area is operated by PPL
5. Electricité de France (EDF). The London and SEEBOARD areas are the same as the supplier areas. However, the SWEB area network is operated by PPL, and EDF are also the network operator for region 5b
6. Western Power Distribution: PPL – an American based company operating the networks in the SWEB, SWALEC, and NORWEB areas.
7. Recently (2004) merged with East Midlands under the name of Central-Networks owned by Powergen (E.ON UK).
8. Northern Electric and Yorkshire Electric Distribution: both owned by Mid American Energy.
9. United Utilities: a UK company

Fig. 7. The Distribution Network Operators in April 2005. Note the significant changes compared to Figs. 3, and 5. Only 50% of the areas now have the same geographic supplier and network operator. See notes for changes in ownership in last 12 months

THE ELECTRICITY MARKET AFTER PRIVATISATION

Following privatisation wholesale electricity prices in England and Wales, but not Scotland were determined using an Electricity Pool through which all electricity was traded. The POOL with generating side bidding, but no demand side bidding. Full details of how this system worked are given in Tovey (2003), but the following is a short summary of the operation of the POOL.

All generators above a certain threshold were required to bid into the POOL, and all successful generators were paid the System Marginal Price (SMP) – i.e. the price of the highest successful bid irrespective of what their actual bid was. It was thus quite possible for a generator to bid £0 per MWH and this would guarantee that the operator would generate and would be paid at a price determined by the SMP. Because there were vertically integrated companies in Scotland, they were not involved in this bidding (at least as far as their own customers were concerned). The lack of competition in Scotland has meant that customers north of the border are paying higher prices than those south of the border.

To ensure system stability there was provision for both capacity to be made available and to in part of the country where there was a shortage of power to "constrain-ON" certain stations and to "constrain-OFF" stations where there was a surplus of electricity. The System Operator could pass on the charges from non-optimal despatch of electricity to the customer and there was little incentive, other than by

regulation, to ensure that the costs incurred and prices charged to cover these costs were as low as possible. The main players in the POOL towards the end of the 1990s are shown in Fig. 8

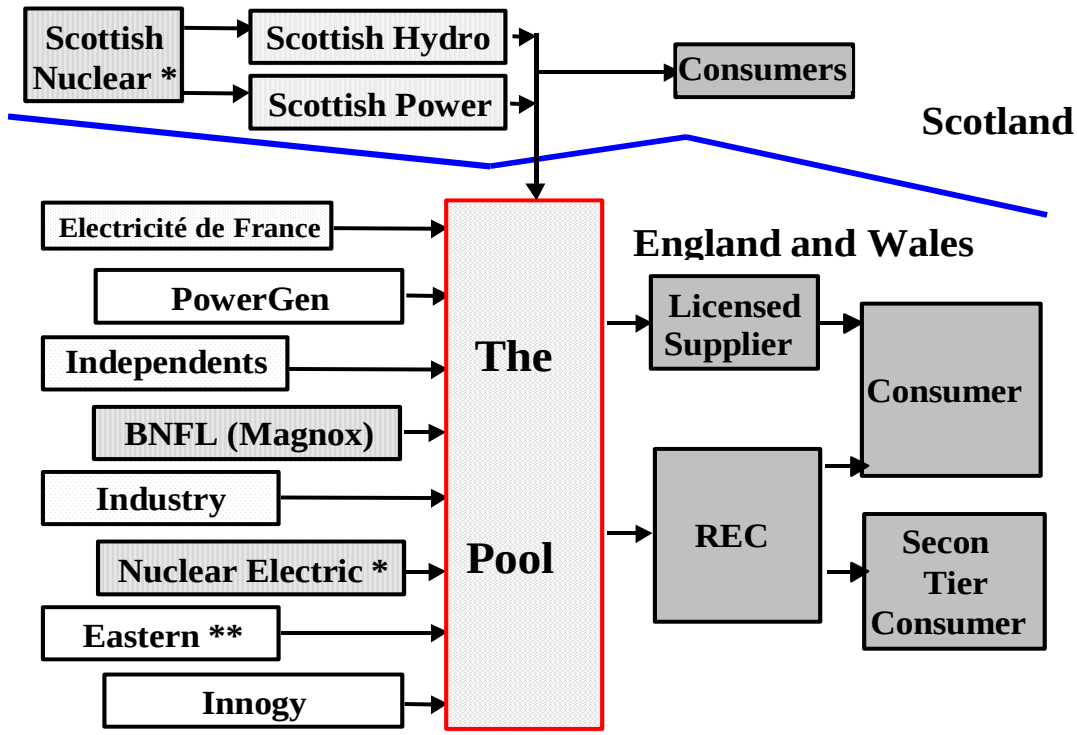


Fig. 8. A Schematic of the POOL in the UK in the late 1990s. The actual list of generators varied from year to year, the situation represents the position in about 1998.
* Nuclear Electric and Scottish Nuclear are both part of British Energy
** Eastern Electricity became a player in the market after both National Power and PowerGen were required by the Regulator to disposed of some of their generating capacity following irregularities in the fixing of prices in the POOL

THE NEW ELECTRICITY TRADING ARRANGEMENTS

The New Electricity Trading Arrangements (NETA) came into force on 27th March 2001 and represented a major change in the way electricity was traded in England and Wales but not Scotland. Tovey, (2003) gave an in depth review of the operation of NETA, while much technical information about specific operational detail may by found in a series of papers from the Regulator (e.g. OFGEM, 2000). From 2001, major discussions took place to incorporate trading in Scotland within the same system as in England and Wales. This new system which went live on 1st April 2005 is known as the British Electricity Trading and Transmission Arrangements (BETTA). Currently there is a transition to full integrate the GB wide scheme. In England and Wales, the changes were somewhat marginal affecting primarily transmission, while in Scotland major changes have taken place. The following is a brief summary of how NETA works. This will be followed by the recent changes needed in the move to BETTA.

Under NETA (and BETTA), and unlike the POOL mechanism, most electricity (>95%) is traded outside the NETA Balancing Mechanism through bilateral agreements or trades through a broker.. Both generating and demand side bidding takes place and this effectively prevents some of the price fixing problems which arose in the POOL. The System Operator (National Grid Company. NGC) is not involved in these transactions but it is a requirement that the volume of trade (not the price) is notified to NGC. Trading may be done for any time period in the future and it is not unusual to see the volume of electricity traded for a particular half hour period take place several times over. NETA favours those generators and suppliers who can guarantee specific levels of generation or supply in advance. It also favours those generators and suppliers who can guarantee agreed flexibility in output / demand at short

notice. Conversely, those generators or suppliers who cannot guarantee specific levels of generation / demand suffer financially. Situations such as equipment failure etc. can lead to substantial losses for the companies involved. System Security is maintained by the Balancing Mechanism.

Trading takes place in half-hour blocks for each day of the year for each Balancing Mechanism (BM) unit. A generation BM unit will typically be a single generating set in a power station. Small generating sets can be consolidated into a single BM unit. On the demand side, a BM unit might be a single large customer or a collection of smaller customers. The final trading position of each BM unit must be declared by 1 hour before the start of the actual half hour period in question. Prior to June 12th 2002, this period was 3.5 hours. This cut-off time is known as "***Gate Closure***". Thus Gate Closure for the half hour period from 12:30 – 13:00 will be at 11:30. The final trading position is known as the Final Physical Notification (***FPN***).

If a generator or supplier deviate from the agreed ***FPN*** level, they will be subject to charges by the System Operator for any shortfall or excess causing this imbalance. If a generator produces more than the agreed amount of electricity, or a supplier has a demand less than the agreed amount, then the generator / supplier is paid at the System Sell Price (SSP). If the generator falls short in his commitment, or a supplier has too much demand, then they are charged at the System Buy Price (SBP). In the early days of operation of NETA, the system Buy Price was high and reached over £100 per MWh while the System Sell Price was relatively low. In the four years since NETA began the two prices have converged as shown in Fig. 9. Since the System Buy Price is normally noticeably higher than the System Sell Price, most generators and suppliers tend to err on the side of having too much electricity on the system. Part of the reason for the convergence was a change in the method by which the System Sell Price and System Buy Price was calculated. Since late 2004 there has been a general increase in both the System Buy Price and System Sell Price reflecting changes in the wholesale market prices, but also the preliminary measures to adopt BETTA came into force in September 2004 even though the "Go-Live" date was 1st April 2005.

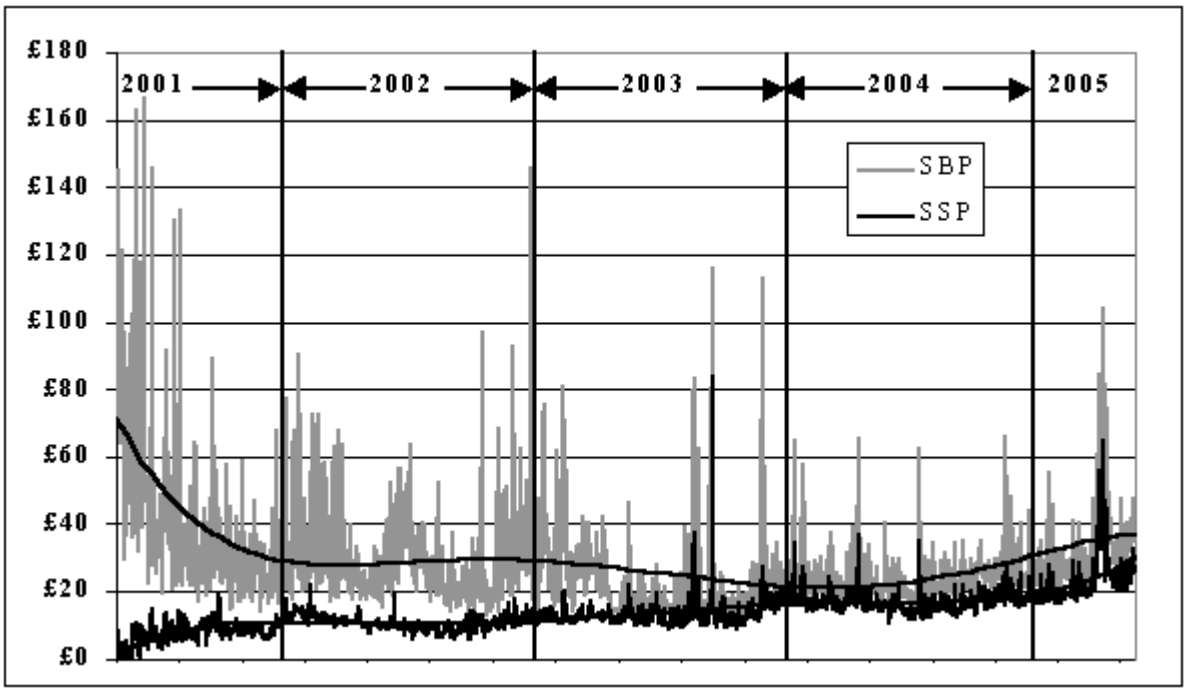


Fig. 9. The average daily System Buy Price (SBP) and System Sell Prices (SSP) since the start of NETA. There has been significant convergence of the two prices, although there are still days when the two prices differ significantly. The last data points on the right refer to 19th April 2005. Data from Elexon (2005).

To ensure system stability, the System Operator requires the flexibility to adjust the availability of electricity to account for unexpected changes in demand (from weather changes, unexpected events such as popular television programs, unexpected equipment failures, or interruption to the transmission network). This is achieved by inviting the BM units to modify their ***FPN*** level to either increase or

reduce the amount of electricity on the system. To increase the amount of electricity on the system involves an ***OFFER*** to provide this increase. This may be done by either increasing the generation output or by reducing the demand. Any changes made under such an ***OFFER*** will result in the relevant BM Unit being paid for the change. Conversely if the amount of electricity on the system is to be reduced, the BM Units can make a ***BID***. For a generating BM Unit this will mean a ***BID*** to reduce generation, whereas for a demand BM Unit this will represent a ***BID*** to increase demand. Agreements for such ***BID***s will result in the relevant BM Units paying for this modification of level to the ***FPN*** level.

In many cases, a generator or supplier may ***BID*** or ***OFFER*** different prices for ranges of deviation from ***FPN***. Thus a ***BID*** to deviate by say 25 MW might be £30 per MWh, but a deviation between 25 and 50MW might be £40 per MWh. Normally the System Operator accepts the cheapest ***OFFER*** or ***BID*** so as to keep prices down, but sometimes system constraints may prevent this. There is no obligation for a BM unit to participate in the Balancing Mechanism, but some companies specialise in providing BM Services and can make 25% or more by this means. Details of how these ***BID***s and ***OFFER***s work (including graphical explanations) may be found in Tovey (2003).

Once an ***OFFER*** or ***BID*** has been agreed between the System Operator and the relevant BM Units, it cannot be cancelled. Instead there is provision for ***UNDO BID***s to cancel an ***OFFER***, and ***UNDO OFFER***s to cancel a ***BID***. This is illustrated in Fig. 10 where it is noticed that ***any UNDO OFFER*** or ***UNDO BID*** will not be at the same as the original ***BID*** or ***OFFER*** and thus this will be a net benefit to the BM Unit concerned and a penalty on the System Operator. In this way there is a control on the operation of the System Operator which was not present in the POOL.

The ***OFFER***s and corresponding ***UNDO BID***s and the ***BID***s and ***UNDO OFFER***s, are normally submitted in pairs and agreed as ***BID – OFFER*** Acceptances or ***BOA***s (Fig. 10).

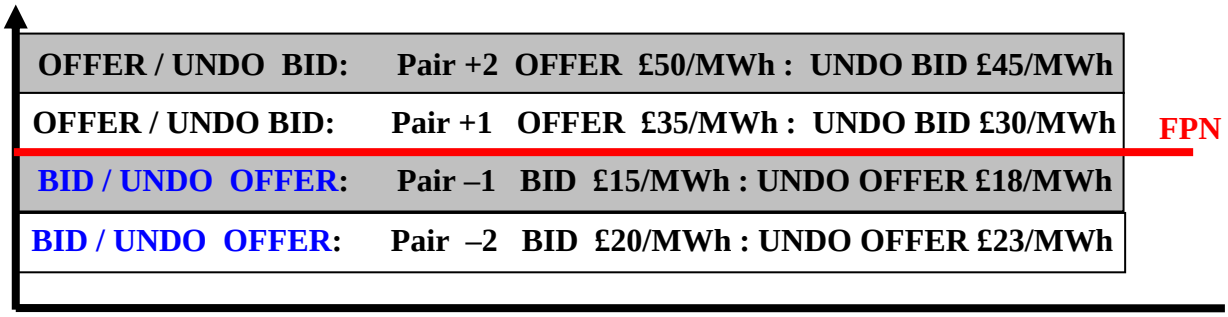


Fig. 10. Examples of ***BID / OFFER*** Pairs: Note the undo BIDs and UNDO offers are usually priced to be beneficial to the BM Unit.

BALANCING MECHANISM CHARGING

While system stability may be achieved using the balancing mechanism, there is a further possibility where the System Operator may contract with either a Generator or Supplier to specifically provide balancing services. Indeed in April 2004 Ironbridge Power Station had one 500 MW unit providing such services. Such units may run at half load so that their output can be readily increased or decreased. Separate calculations are made for these services under the "Balancing Services Adjustment Data" (**BSAD**) and are accordingly factored into the calculations. This is used to determine the overall state of the electricity market in any half hour. This is achieved by comparing the total **BSAD** purchases and ***OFFER***s with the total **BSAD** sales and ***BID***s. This will determine whether there is a net surplus of electricity on the system (i.e. the system is "long") or whether there is a deficit (i.e. it is "short"). This represents a change from when NETA was first introduced.

The calculations of the System Sell Price (**SSP**) and System Buy Price (**SBP**) now depend on whether the system is "long" or "short" and whether the relevant BM unit has an imbalance in the direction of the overall system or the reverse.

When the electricity on the transmission system is in the same direction as the imbalance for a particular generator or supplier (e.g. both the system and the BM unit are "long") then the **SSP** and **SBP** are

calculated using the volume weighted average of the net **BSAD** sales and accepted ***BID***s (if the system is "long"), or the corresponding net **BSAD** purchases and accepted ***OFFER***s if the system is "short". These two situations are illustrated for a generator in Fig. 11.

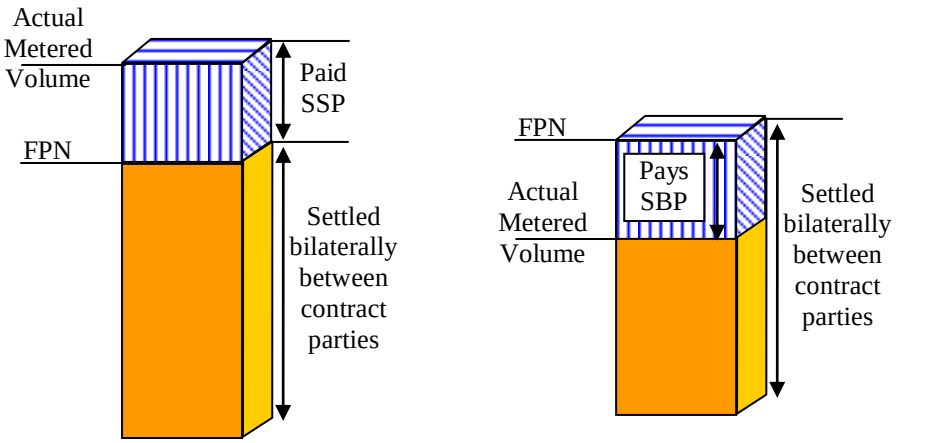


Fig. 11. Situations where BM unit has an imbalance in same direction as overall system.

When the transmission system and the BM unit have imbalances in the opposite direction – i.e. the system is "long" and the BM unit is "short" and vic-versa, a different procedure is adopted for the calculation of the imbalance charges both the **SSP** and **SBP** are calculated from the volume weighted average prices of the short term trading market occurring in the three days before the half hour in which the electricity was physically dispatched.

IMPACT of NEW ELECTRICITY TRADING ARRANGEMENTS on COMPANIES

During the 1990s there was a substantial investment in new combined cycle gas turbine generation (see Table 1) and consequently by the start of NETA there was a considerable over-capacity of generation. At the onset of NETA, the wholesale prices for electricity were already 20% below the levels in 1998, and a further 20% fall occurred in the first year of NETA (Fig. 12).

While this was hailed as a success, unlike the situation with the POOL, which was generally favourable to generating companies, NETA appeared to have a disproportionate effect on the companies who only had concentrated solely or mainly on the generating side of the industry. Vertically integrated or supply only companies were much more resilient.

Prices remained at low levels for the following 12 months (Fig. 12). Several companies experienced financial difficulties around this time e.g. AES (solely a generating company) while the vertically integrated company which had only recently acquired Eastern Electricity became insolvent and ceased trading. One reason that TXU was particularly affected was that the generating capacity was entirely of coal (which was then more expensive than gas), and furthermore the stations were the three oldest coal fired power stations in England and Wales and all were over 40 years old. A further company, British Energy (the company which operates the more modern nuclear stations - i.e. the Advanced Gas Cooled Reactors and the Pressurised Water Reactor) required significant Government assistance to continue trading. Those companies which at the time were integrated vertically, were to some extent been cushioned by these changes, but even they have found it necessary to mothball relatively new (<8 years old) generating plant.

In the summer of 2003, National Grid Transco expressed concern over the magnitude of the capacity reserve for the winter of 2003-2004 following the mothballing of plant. This reserve had fallen to 16%, well below the normal level of 20 – 24%. Past experience indicates that when this reserve falls below 20%, problems occur in guaranteeing supply. Following this warning, and the subsequent rise in wholesale prices, several mothballed plants were re-commissioned and the level of reserve now stands at

just over 20%. It is clear that market signals alone are not sufficient to ensure adequate capacity and it required intervention by the System Operator to ensure supplies were maintained over the winter period..

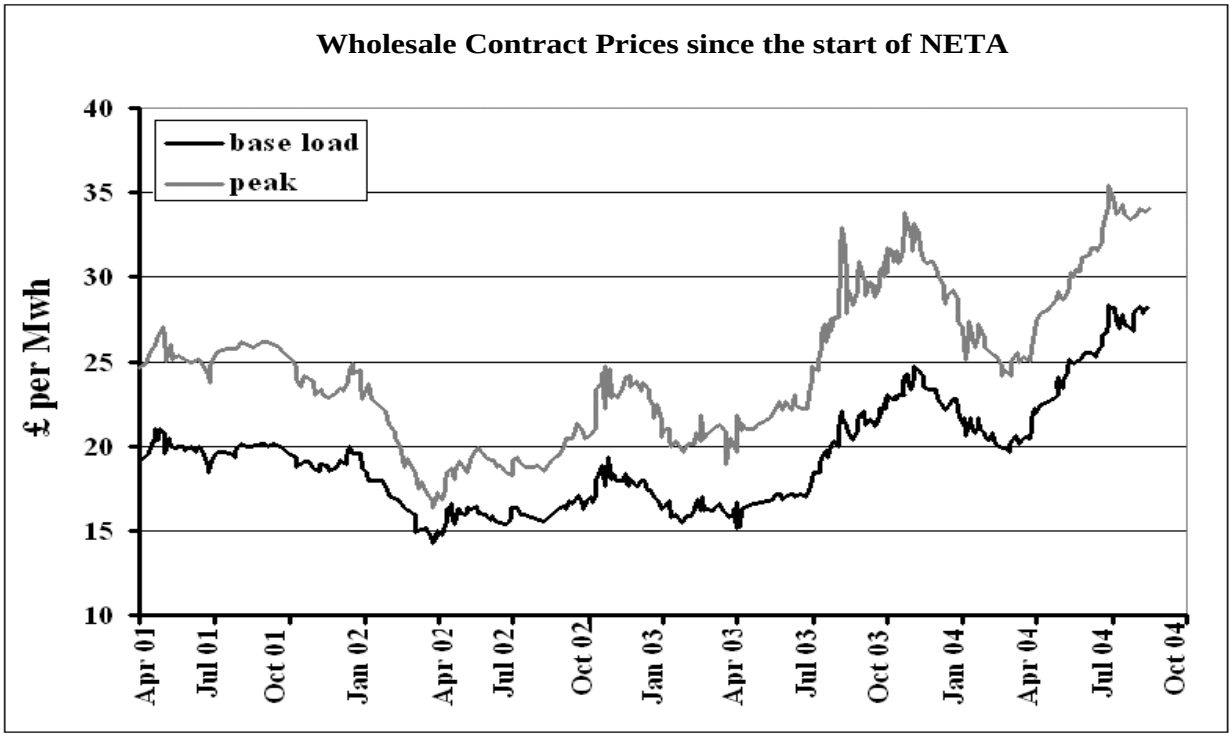


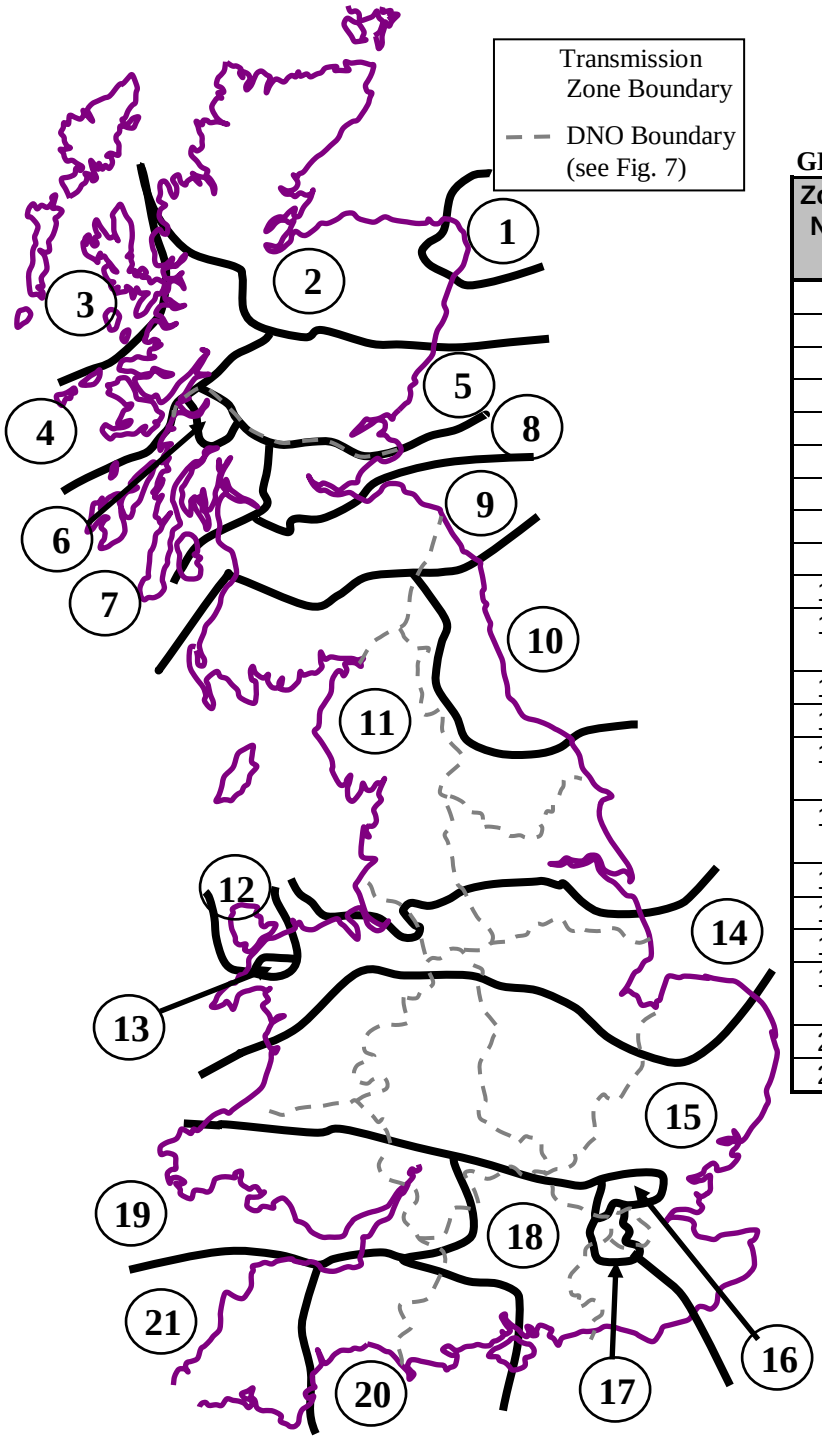
Fig. 12. Wholesale prices of electricity since the start of NETA. The rise in late 2003 reflected the changes in the price of gas. Data from Elexon (2004)

THE BRITISH ELECTRICITY TRADING AND TRANSMISSION ARANGEMENTS (BETTA).

The purpose of the move from NETA to BETTA has been to bring Scotland in line with England and Wales. The overall effect of this will be to see a reduced price for customers in Scotland, particularly in the North of Scotland. At the same time the connection charges for generators in Scotland will change. On the one hand they will have easier and overall cheaper access to the larger demand area in England and Wales. On the other hand the charges to generators will still be higher in Scotland than in England and Wales. Several other issues needed attention as the system under NETA was expanded to incorporate Scotland. The start of transition towards BETTA began in autumn 2004 and the "Go-live" date was 1st April 2005. Transition arrangements are still in place and will remain so for some time.

Fig. 13 shows the newly defined transmission zone boundaries and the charges associated with both generation and consumption of electricity across the UK. Because of the surplus of capacity in Scotland the connection charges in Scotland are all over £10 be MW, while in England and Wales the charges are all under this level and in some areas where there is a significant deficit (e.g. the South West) generators will be paid for connecting to the system. The aim of these prices is to send signals to try to encourage future generation development in the areas of particular need. Despite the higher charges in Scotland, these have come down significantly in many regions since BETTA came into force as issues such as inter-connector charges no longer apply. Indeed in zone 3 (Western Islands including Skye), the connection charge has come down by just under 40% from £38 per kW to £23.10 per kW.

The charges for transmission for consumers are allocated differently from generators, and are based on the historic Regional Electricity Boundaries. Charges are uniform within each boundary. Again as a consequence of the surplus of generating capacity in the North of Scotland, the transmission losses for those customers is low and this is reflected in a near zero charge (Fig. 12). On the other hand the trans-



GENERATION: ZONE Charges

Zone No.	Zone Name	Zonal Tariff (£/kW)
1	Peterhead	£18.16
2	North Scotland	£20.93
3	Skye	£23.10
4	Western Highland	£18.92
5	Central Highlands	£15.36
6	Cruachan	£15.85
7	Argyll	£13.44
8	Stirlingshire	£12.61
9	South Scotland	£11.82
10	North East England	£8.09
11	Humber, Lancashire & SW Scotland	£4.91
12	Anglesey	£6.12
13	Dinorwig	£8.71
14	South Yorks & North Wales	£3.12
15	Midlands & South East	£1.32
16	Central London	-£5.71
17	North London	-£0.22
18	Oxon & South Coast	-£0.70
19	South Wales & Gloucester	-£2.55
20	Wessex	-£4.95
21	Peninsula	-£8.04

Data for both generation and demand transmission charges derived from NGC (2005).

DEMAND ZONE CHARGES

Zone Name.	Half Hour Zonal Tariff (£/kW)	Non Half Hour Zonal Tariff (p/kWh)	Zone Name.	Half Hour Zonal Tariff (£/kW)	Non Half Hour Zonal Tariff (p/kWh)
Northern Scotland	£0.04	0.01	Midlands	£15.03	2.06
Southern Scotland	£4.11	0.56	Eastern	£14.03	1.91
Northern	£7.39	0.97	South Wales	£18.32	2.37
North West	£11.14	1.46	South East	£15.99	2.17
Yorkshire	£11.18	1.49	London	£18.52	2.45
N Wales & Mersey	£11.21	1.51	Southern	£17.83	2.45
East Midlands	£13.47	1.80	South Western	£20.49	2.73

Fig. 13. The Transmission Zone Boundaries in operation since the start of BETTA on April 1st 2005). Any generator within the zone pays (or is paid) the connection charges shown. The Demand Transmission charges are paid according to DNO area. For Half Hourly metered consumers these are charged on a capacity basis otherwise they are charged on the units consumed.

mission charges for customers in the south west of England are relatively large at 2.73p per kWh. These transmission charges are separate from the distribution loss charges which are the responsibility of the relevant DNO. The differences in the definition of transmission and distribution between England and Wales on the one hand and Scotland on the other have required significant reconsideration of certain issues. For instance all large generating stations in England and Wales are connected directly to the transmission system and the generating units and station loads are treated as separate BM units. In Scotland some of the large stations are embedded in the distribution system and operate with a net transfer of energy – i.e. the station load is subtracted from the generated electricity.

Prior to BETTA, there were three separate transmission systems: a) the England and Wales System operated by the National Grid Company (NGC – and part of National Grid Transco); b) in the South of Scotland by Scottish Power, and c) in the North of Scotland by Scottish Hydro (a part of Scottish and Southern). Each of the above transmission companies were also the System Operator in their respective areas. Following BETTA, there is now a single Great Britain (GB) System Operator which is NGC, and three separate transmission licence holders namely, National Grid, Scottish Power, and Scottish Hydro. Though National Grid is both the System Operator and a transmission licence holder, the Regulator will ensure that there is no discrimination against the other licence holders. The former inter-connectors between Scotland and England and Wales are now part of the GB transmission system and are no longer treated separately. This is simplifying the way in which the generators in Scotland can access the electricity market in England and Wales.

OTHER DEVELOPMENTS IN THE ELECTRICITY MARKETS IN THE UK

Two other significant issues are affecting electricity supply in the UK. On April 2002, the Renewables Obligation was introduced whereby each supplier of electricity is required to supply a target amount of electricity from a renewable source in each year. This target value is being increased each year up to 2010 when it will be 10.4% (DTI, 2001). The current target (April 1st 2005 to March 31st 2006) is 5.5%. Suppliers failing to meet their obligation pay a buy-out fine currently standing at 3.233p per kWh. These fines are then recycled to the suppliers in proportion to the actual percentage they generated. Since there continues to be a significant shortfall in renewable generation, the certificates proving renewable generation are trading well about the face value at around 5 to 5.5p per kWh. Fuller details of the operation of the Renewables Obligation were given in Tovey (2004).

The second development has been the introduction of the European Union Emissions Trading System on January 1st 2005. The UK set particularly tough targets for the electricity supply industry at 132.2 million tonnes of carbon dioxide per year (DEFRA, 2004). This represents 26 million tonnes less than in 2002. When allowance is made for the increase in demand since 2002 and the continual drop in nuclear generation, a shortfall in carbon emission credits of around 35 – 37 million tonnes is predicted. At the current trading price (mid April 2005) of 17.5 Euros a tonne, this will increase the price of a unit of electricity by around 0.11p or rather over 1%. If trading prices rise towards the buy-out price of 40 Euros a tonne, then the rise will be double that predicted figure. From 2008, the buy-out price is scheduled to rise to 100 Euros a tonne and this will provide further pressure and upward movement of prices.

CONCLUSIONS

The Electricity Market in the United Kingdom continues to evolve. The recent key changes in the Electricity Market may be summarised as:

1. Following a significant fall in wholesale prices during the first year of operation of NETA, wholesale prices have, in general, tended to rise in the UK partly following the trend in wholesale gas prices.
2. After a continued shift away from coal generation from 1992, there was a 7.6% shift back towards coal between 2002 and 2003 and a consequential fall in gas generation. Between 2003 and 2004, coal again fell by over 4%, nuclear by 10.9% while this was compensate by a rise of nearly 10% in gas generation. In recent months (late 2004 and early 2005), the gas prices have been volatile reflecting the changes in the oil market, leading to volatility in the mix of gas and coal in the fuel.
3. After several years of significant changes in the structure and ownership of companies in the electricity supply industry, only one significant change tool place in 2004 – 2005. The Aquila

Distribution Network in the Midlands area was acquired by PowerGen (E.ON) and was subsequently merged with the corresponding network in the East Midlands to form Central-Networks.

4. The British Electricity Trading and Trading Arrangements (BETTA) came into force on 1st April 2005. BETTA extended the use of the New Trading arrangements in England and Wales to Scotland. In Scotland, significant changes took place with the introduction of BETTA while in England and Wales the changes were confined primarily to transmission arrangements.
5. Since the introduction of BETTA, the Great Britain System Operator is the National Grid Company, formerly the System Operator solely for England and Wales.
6. The Transmission Licence of the NGC in England and Wales has been separated from the duties of the National Grid Company as System Operator. Separate transmission licences exist for the two separate areas of Scotland: i.e. the Scottish Power Transmission Licence (SPTL) area and the Scottish Hydro Electricity Transmission (SHETL).
7. The former inter-connectors between England and Wales, and Scotland have now become part of the GB System and are no longer subject to separate charges.
8. New transmission connection charges throughout England, Wales and Scotland are now in place. Connection charges for generators are higher in Scotland where there is a surplus of generation and lower in England and Wales, particularly in the south. In the extreme far south west of England and Wales where there is a significant deficit in generation capacity, the connection charges for generators are negative – i.e. they get paid for connection. Despite the much higher connection charges in Scotland they are up to 40% lower than they had been prior to the introduction of BETTA..
9. Transmission charges for consumers are now declared throughout Great Britain. These are almost zero in the North of Scotland, but as much as 2.73p per kWh in the south west of England. Consumers in Scotland have consequently seen a noticeable reduction in their overall electricity bills.
10. The Renewable Obligation is continuing to provide an incentive for generation of electricity from renewable resources. At the same time a trading market has been established with the Renewable Obligation Certificates, which are currently trading at a premium of over 50% over their face value, reflecting the significant shortfall in the actual renewable generation as opposed to the set targets.
11. The introduction of the EU Emissions Trading Scheme on 1st January 2005 will have a noticeable effect on electricity generation in the UK and electricity prices are forecast to rise as a result.

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