



Appendix V: National report for the UK

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International Energy Agency Demand-Side
Management Programme
**Task VIII: Demand-Side Bidding in a Competitive
Electricity Market**

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1 Summary

This report summarises the views and opinions of market participants in the UK towards demand side bidding. The information was collected using questionnaires, to obtain an overview of the experiences of DSB in the UK.

There are already several ways in which large customers can participate in DSB in the UK, however there are little or no opportunities for smaller customers.

The way that electricity is traded in the UK is set to change in October 2000. In setting out the vision for future electricity trading, the UK Regulator has always stressed the importance of demand side participation, particularly in revealing a market price that reflects the customer view.

The jury is out on whether demand participation will materialise – there are many barriers, some technical, some perhaps cultural. It is to be hoped that the new trading arrangements have opened the door to such participation and that if demand wishes to play the barriers are rapidly removed.

2 Structure of the Electricity Market

2.1 The Structure Prior to Privatisation

Prior to privatisation, the publicly owned UK electricity industry comprised i;

- The Central Electricity Generating Board (CEGB), the owners of all major generation plant in England and Wales and operators of the National Grid (the high voltage transmission system in England and Wales).
- 12 Area Boards in England and Wales, distributing electricity to customers within their own region.
- The South of Scotland Electricity Board.
- The North of Scotland Hydro-Electric Board.
- Northern Ireland Electricity Services.

The last three companies owned generation plant as well as distributed supplies to customers within their region.

2.2 The Move Towards Privatisation

The first significant step towards privatisation came with the Energy Act of 1983 ii. This gave powers to independent generators to require the Area Boards to purchase electricity from them, and gave them the right of access to the transmission and distribution network to supply directly to customers.

In February 1988 the Government published the White Paper “Privatising Electricity” which gave details of the planned break up and sale of the CEGB, and the sale of the Area Boards. The National Grid was to become a separate company owned jointly by the regional distribution companies, and a system of regulation was to be introduced to ensure fair competition.

This was soon followed, in March 1988, by the White Paper “The Privatisation of the Scottish Electricity Industry”. Both Scottish companies were to be sold, with each remaining as both generation and distribution companies.

The Electricity Bill, setting out the privatisation programme, was presented to Parliament in November 1988.

In January 1989 National Power, PowerGen and the National Grid Company (NGC) were set up as separate divisions of the CEBG.

With minor modifications to include the promotion of efficient use of electricity, the Electricity Bill was formally accepted by Parliament in July 1989, and became the Electricity Act.

The first director of the regulatory body was appointed in September 1989, and work commenced on establishing the regulatory body, to be known as the Office of Electricity Regulation (OFFER).

Privatisation became effective on 31 March 1990, known as Vesting Day. On this day the nationalised framework ceased to exist. The industry in England and Wales then comprised;

- 12 Regional Electricity Companies (RECs), taking over the assets of the 12 Area Boards.
- National Power, PowerGen, and Nuclear Electric, taking over the generating assets of the CEBG.
- Scottish Hydro-Electric, Scottish Power and Scottish Nuclear.
- National Grid Company, jointly owned by the 12 RECs.

OFFER began its regulatory function and new arrangements for trading of electricity became effective. The Nuclear companies remained as Nationalised companies.

In 1995 the National Grid Company, which had been jointly owned by the 12 RECs, was floated as an independent company. This was followed in 1996 by the sale of the non Magnox nuclear stations as British Energy.

Since privatisation there have been numerous take-overs and mergers of the RECs, and the enforced sale of generating capacity from the two major generators to encourage competition. Independent generators are also being encouraged to enter the market, in part as a result of continued support for renewable energy under a series of Non Fossil Fuel Obligations (NFFO).

There have also been various changes to how electricity is sold. Prior to the 1983 Energy Act, electricity could only be purchased from the Area Board whose franchise region you were in. Post 1983, it was possible to purchase directly from independent producers, but it wasn't until after privatisation that liberalisation of the market really began to take effect. Right from Vesting Day when privatisation took place, users of over 1 MW of electricity could purchase from any supplier or direct from generators. This lower limit was reduced in April 1994 to 100 kW. Since 1998, a completely open market was gradually phased in, with individual customers, no matter how small, able to purchase electricity from any supplier.

2.3 Current Structure of the UK Electricity Industry

The RECs continue to own the local distribution network in their franchised area and are obliged to supply electricity to customers within their area. However, other suppliers are now able to compete with them for customers.

In England and Wales, generators and suppliers trade electricity through the Electricity Pool. The Pool is regulated by its members and operated by the National Grid Company which also owns the transmission network. Commercial contracts between generators and suppliers can also be set up independently of the pool, and these help to remove uncertainties in future prices in the Pool. Electricity de France (EdF), together with the generation businesses of Scottish Power and Scottish Hydro Electric, are external members of the England and Wales Pool. Each of these has a number of commercially negotiated contracts to sell electricity to suppliers in England and Wales.

Electricity trading arrangements, including the Electricity Pool are regulated by Ofgem (formerly OFFER). Changes to the pool trading mechanism are soon to take place.

There remain 12 RECs although ownership is now in fewer hands following mergers and acquisitions.

The electricity supply industry in Northern Ireland is also in private hands. Northern Ireland Electricity plc is responsible for power procurement, transmission, distribution and supply in the Province. Generation is in the hands of three private sector companies who own the four major power stations. There is a link (re-established in 1996) between Northern Ireland and the Irish Republic

About three-quarters of the non-domestic market and about a half of all electricity is now sold in a competitive marketⁱⁱⁱ. OFFER estimates that in 1997/98 customers accounting for 53 % of the output in the 100 kW to 1 MW market in England and Wales chose to take their supply from a company other than their local REC.

Since Vesting a number of new companies have entered the generation market. In 1997 these companies produced just under 20 % of the electricity generated in the United Kingdom. However the major generators remain, namely PowerGen, National Power, Nuclear Electric, Magnox Electric, Eastern Generation, Scottish Power and Scottish Hydro. Imports from EdF via the 2000 MW cross channel interconnector account for some 5 % of generation.

There are currently 16 nuclear power stations operating in the UK with 35 reactors. They are currently operated by a mixture of private and government-owned companies. The older magnox reactors are operated by Magnox Electric (the Government transferred its shares in Magnox Electric to British Nuclear Fuels in 1998). British Energy, now a private company, owns and operates the non magnox reactors.

In 1999, the OFFER was merged with the Office of Gas Supply (Ofgas) to form the Office of Gas and Electricity Markets (Ofgem), to form a single body responsible for the regulation of both electricity and gas supply in the UK.

2.4 Electricity Generation Mix

The make up of power generation has changed markedly since privatisation. This is shown in Tables 1 and 2, which are compilations from UK Energy Statistics over the last ten years^{i,iii,iv}. Table 1 is generating capacity in MW and Table 2 is actual annual generation in GWh. There has been a major change in the mix of generation since privatisation. In particular the growth in gas fired combined cycle gas turbines from zero in 1989 to 25 % of generation in 1997. This has occurred mainly at the expense of coal fired conventional generating plant. The values for generation from coal are included in Table 2 for the years 1993 to 1997 (the method of presenting data has changed slightly during this time and the coal figures are only separated out from conventional generation from 1993).

Nuclear generation has grown throughout this period as new plant, approved in the late 1980s and early 1990s, comes on line. There is unlikely to be any further new nuclear plant in the foreseeable future.

Table 1. UK generator capacity (MW)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Non-Renewables										
Conventional steam	53193	54448	55469	54644	51520	47841	44239	41710	41553	40521
CCGT				76	331	1279	5613	8517	9185	12674
Nuclear	7229	8308	11083	11353	11353	11353	11894	12037	12762	12946
Gas turbine + oil	3041	3313	3356	3130	2968	2539	2248	1895	1890	1518
Hydro - pumped	2788	2788	2787	2787	2787	2787	2787	2788	2788	2788
Renewables										
Hydro	1375	1375	1388	1410	1419	1432	1425	1425	1428	1494
Renewables other than hydro	4	4	2	125	157	220	317	369	405	557
Total	67630	70236	74085	73525	70535	67451	68523	68741	70011	72498

Table 2. UK generation (GWh)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Non-Renewables										
Conventional steam	237181	234953	245390	244420	232277	202651	189809	186442	177765	149436
of which coal						170276	161739	157240	145830	119793
CCGT			292	622	3400	23418	37873	49657	67112	88474
Nuclear	63456	71734	65747	70543	76807	89353	88282	88964	94671	98146
Hydro - pumped	2121	1910	1982	1523	1697	1437	1463	1552	1556	1486
Others (oil/gas engines)	464	529	432	356	358	359	244	190	226	459
Renewables										
Hydro	4933	4749	5027	4612	5416	4302	5094	4838	3361	4127
Renewables other than hydro	670	710	687	787	1071	1582	2213	2404	2695	3214
Total	308825	314585	319557	322863	321026	323102	324978	334047	347386	345342

2.5 New Electricity Trading Arrangements

The way that electricity is traded in the UK is set to change in October 2000. The New Electricity Trading Arrangements (referred to as NETA) consists of forwards markets where generators, suppliers and customers agree bilateral energy contracts up to 3.5 hours ahead of the time of delivery. A balancing mechanism (or market) where only the System Operator can accept bids to resolve constraints on the transmission system and to balance generation and demand in real time then follows this. In setting out these trading arrangements, the UK Regulator (Ofgem) has always stressed the importance of active demand participation, particularly in revealing a market price that reflects the customer view.

3 Experiences with Demand Side Bidding

A range of different DSB products is currently operating in the England and Wales Electricity Market. The DSB products fall into the following four categories:-

- Ancillary services
- Constraints services
- Pool trading
- Supply contracts

Most of these products are offered to customers by one of the UK Supply Companies (Yorkshire Electricity), who act as the 'middle man' between the seller and buyer of the product.

3.1 Ancillary services

The System Operator for ancillary services is required to maintain the quality and security of the supply in England and Wales. Customers participate by providing capacity for frequency response and standby reserve.

3.1.1 Frequency Response

As part of its statutory requirement, the System Operator has to provide electricity supply transmission at a frequency of 50Hz, or one per cent either side of this.

To achieve this it needs to have mechanisms in place to respond immediately if the frequency fluctuates unexpectedly, for example, if a generating plant fails.

Large customers capable of instantaneous shutdown can secure an income from automatic load management when problems occur with system frequency.

The Supply Company rather than the customers meet the cost of the communications and control system.

There are currently 33 sites in the UK that offer a total capacity of approximately 160MW to assist the System Operator with maintaining the system frequency between the required limits. The number of interruptions any individual customer experiences depends upon the setting of the frequency relay which automatically disconnects the customer's load if the frequency falls

below the set value. Typically, customers may expect an interruption up to once a month. Customers must be able to offer a minimum of 3MW of reducible load from a single site, restricting participation to large industrial customers. The types of customers providing the frequency response service to the System Operator includes cement mills (crushing equipment), steel making companies and cold storage units.

3.1.2 Standby Reserve

To meet its obligations the System Operator needs to maintain a careful balance between electricity generated and demand from customers. While experienced at forecasting demand to meet supply, the System Operator is always at the risk of unforeseen circumstances - such as the failure of a power station - leading to system imbalance.

To counterbalance, standing reserve contracts are awarded to customers that can reduce their demand or start up standby generation at short notice, for the period of the system shortfall.

Approximately 655 MW of reserve capacity is available to the System Operator from the demand side. This is offered by large industrial customers, e.g. water companies, chemical plants and steel making companies. In 1998/1999, the System Operator paid a total of £11.5 million to the demand side for standby reserve and frequency response.

3.2 Pool Trading

When the England and Wales electricity Pool was established, only the generators were directly involved in setting the marginal price of electricity. Direct participation from the demand side was seen as an essential step to improve price setting, and therefore a Demand Side Bidding Scheme was introduced into the Pool in 1993.

The scheme operates as a demand reduction scheme, which treats an offer of a demand reduction from the customer in a similar fashion to an offer of generation from a generator.

The customers have at least 12 hours' notice to reduce their load. They must be able to offer a minimum of 10MW of load but do not have to reduce all of this. They agree the periods in which they can offer demand reduction. Load management control is manual. Customers receive payments for all periods of offered demand reduction that are not used by the Pool (availability payments). However, they do not receive any payments if they are scheduled to reduce load, but instead benefit (along with all other customers) due to the reduced price of electricity.

A maximum of 40 customers is permitted to participate in the scheme. Currently 38 customers actively participate, between them offering approximately 1500 MW of 'negative' generation into the pool.

3.3 Constraints Services

The System Operator is responsible for transmitting power from the generators to the grid supply points of each electricity distribution company. It manages thousands of miles of high voltage lines across the country, as well as hundreds of substations and interconnectors.

The amount of electricity that can be delivered to any part of the country depends on the capacity of the network in that particular area. Occasionally the System Operator can suffer from bottlenecks as a result of planned maintenance work or local faults. Hence, its ability to transfer the required amount of electricity is restricted by the network in a certain area.

When the demand for electricity exceeds the capacity of the network, the System Operator relies on companies offering constraint services to reduce the local demand to a manageable level. The System Operator currently has access to approximately 250MW of reducible load in areas prone to constraints, and customers can generally expect up to 6 interruptions per year. The System Operator estimates that a maximum of 2,400MW of demand-side response has been delivered at one time.

4 Views towards Demand Side Bidding

In setting out their vision for future electricity trading, Ofgem have always stressed the importance of active demand participation, particularly in revealing a market price that reflects the customer view.

In view of the importance ascribed to such demand participation, it is now an opportune moment to take stock of the new electricity trading arrangement (NETA) proposals from a demand perspective and ask, 'will demand really be free to actively participate?'

Obviously Suppliers and large customers will have to be proactive in securing energy contracts in the forward markets, that is if they want to avoid exposure to imbalance.

However, will there be sufficient counter-parties willing to trade in the forward markets? There are two aspects to this: (i) the potential competition from the System Operator (NGC) in the forward markets and (ii) the relative attractiveness of the Balancing Mechanism in preference to forward markets for generation and demand.

4.1 System Operator actions in the forward markets

Ofgem published a consultation in December 1999 that included thoughts on how the System Operator might contract for 'balancing services', which would include the current ancillary services, Balancing Mechanism actions and reserve. The consultation suggested that Ofgem were in favour of the System Operator being able to purchase energy in advance of the Balancing Mechanism. If approved, this would seem to put the System Operator in direct competition with Suppliers and customers for generation contracts.

This also seems to run counter to the concept of customers determining their own prices in bilateral negotiation with generation.

If demand cannot determine its own price in the forward markets, because of the intervention of the System Operator, how easy will it be for demand to compete with generation in the Balancing Mechanism?

4.2 Attractiveness of participating in the Balancing Mechanism

The risks of entering the Balancing Mechanism are that the bids or offers will not be accepted by the System Operator if it is priced out of the market, has the 'wrong' dynamics or is in the 'wrong' location. This could be a particular problem if the System Operator has already contracted with much generation ahead of the Balancing Mechanism and that generation is despatched up or down during the Balancing Mechanism in preference to explicit bids and offers from the demand side.

There is also the risk that, even if the System Operator has not contracted in the forward markets, Generator bids and offers might be preferred by the System Operator to those from demand in the Balancing Mechanism. This might encourage some generation to deliberately avoid contracting in the forward markets, preferring the option of contracting with the System Operator in the Balancing Mechanism where it has a competitive advantage.

There appear to be a number of barriers to early active demand participation:

- a possible Generator-centric culture at System Operation;
- the design of the Balancing Mechanism has been accomplished starting with Generators, not demand in mind – e.g. dynamic parameters, negative values for demand might add confusion and complexity – if Ofgem had truly wanted to encourage demand participation and encourage a culture change they could have started off by assuming demand was positive and generation negative;
- the Stage 2 (1998) trading arrangements are not totally compatible with the new trading environment – though it has to be said that the NETA Programme is attempting to address some aspects of this;
- small volumes of active demand and the location of that demand could make demand unattractive to System Operator; and
- the use of dynamic radio control of demand (teleswitching), perhaps one of the best means of immediate demand participation by Suppliers on behalf of smaller customers, may be curtailed depending on how issues relating to the control of teleswitches and imbalance costs are resolved in the new trading arrangements.

Most of these issues are being addressed. It is particularly important for demand participation that the System Operator incentive scheme is appropriately structured to ensure that due attention is paid to the demand side. However, some of the above issues may take a considerable time to resolve to put demand on an equal footing with generation.

In the meantime, this may make the Balancing Mechanism an attractive place for at least a proportion of generation and not for demand.

This could mean that, along with the System Operator contracting for Balancing Service Contracts in the forward markets, Suppliers and customers are faced with an undersupply of willing counter-parties in the forward markets with a consequential upward pressure on forward market prices.

5 Barriers to Demand Side Bidding

There are already several ways in which the large customers can reduce their spending on electricity. Quite apart from the competitive purchasing which is available, many of them can:

- Load manage against Pool prices as a Pool member, or through a supplier
- Load manage against the System Operator's peak demand charges (known as Triads in the UK)
- Take up ancillary service contracts
- Use existing demand-side bidding arrangements

and, in certain cases

- Take advantage of the on-site , local generation trading arrangements

5.1 Customer Participation

The full participation of customers within any market is vital if the companies supplying that market are to face competitive pressures. Since privatisation of the electricity industry in the UK, while industrial customers have been able to shop around for supply, generators have faced very limited competitive pressure due to the monopolistic nature of the Pool system. This system of price setting, with its associated components, has resulted in wholesale electricity prices consistently rising despite significant reductions in the prices of primary fuels. Since the underlying price of the contracts market is determined by the generators, even customers who wish to contract every year at fixed price are exposed to the Pool year on year, which leaves them unable to influence the price.

Energy intensive companies can play a role as "negative" generation or load shedding capacity and the choice to shed load is a financial one. Major energy uses are very sensitive to the price of power in their long-term decisions, such as where to locate or whether to expand or contract operations. However, in the short run, the costs associated with shutting off a plant and the fact that most other operational costs are fixed, means a relatively large price signal is needed to make production interruptions economic.

It is against this scene that many industrial customers are able to load manage to avoid peak demand charges (triads). This ability to reduce demand has benefits for all other electricity customers in terms of the reduced need to reinforce the system and should therefore be actively encouraged. However, customers would still be willing to undertake to disrupt production at other times, if the benefit this provided was correctly recognised. This means that most large users would expect during the course of their normal operations to load manage for a variety of incentives and often over a varying time scale. The flexibility of some users allows them to make a decision about load managing on the day rather than the day before.

The System Operator's Ancillary Services scheme has tried to account for the different characteristics of many energy users. The System Operator has encouraged the role of Agents to discuss specific opportunities and to develop innovative customer solutions where aggregation of load can deliver an acceptable service. Yorkshire Electricity has been particularly active in this area, working closely with customers and the System Operator. With reference to frequency response provision, the technical requirements are that the load will be disconnected within two seconds of the frequency detection relay operating. Special

arrangements in terms of software control have been necessary to meet this operational timescale and be compatible with the consumers' capabilities and processes.

In technical and safety terms these services are not possible without close liaison between the supplier and customer. Additional to the technical requirements has been the merging of electricity supplier/service provider commercial activities, which has enabled the service provision to be offered at competitive rates.

6 Discussion and Conclusions

Increasing the role of the demand side was a key factor in deciding the structure of the new trading arrangements. Active demand side participation is seen as a way of stimulating rivalry between suppliers, who would thus be encouraged to offer attractive supply contracts. Rivalry between suppliers would then lead to more competitive purchasing of electricity, which should then reduce the monopoly currently enjoyed by generators.

However, it is difficult to see how the new trading arrangements will open the way for smaller customers, particularly domestic customers to actively participate. Currently, the only mechanism for domestic participation is restricted to those with electric storage heating, where suppliers use radio control (teleswitches) to avoid consumption at times of peak demand. The UK regulator himself even stated (in July 1999) that "...it is therefore unlikely that there is much potential for further load management..." involving the domestic market. It would appear that active demand participation will be initially restricted to those customers with half-hourly meters, which currently accounts for some 49% of the total electricity consumed in the UK.

The jury is out on whether demand participation will materialise – there are many barriers, some technical, some perhaps cultural. It is to be hoped that new trading arrangements have opened the door to such participation and that if demand wishes to participate the barriers can be rapidly removed.

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- i. Digest of United Kingdom Energy Statistics, 1991.
 - ii. Privatisation of the electricity supply industry in the UK, A chronology, OFFER, October 1994.
 - iii. Digest of United Kingdom Energy Statistics, 1998.
 - iv. Digest of United Kingdom Energy statistics, 1995.