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THE SEEC UNITED KINGDOM ENERGY DEMAND FORECAST (1993-2000)

Roger Fouquet, David Hawdon,
Peter Pearson, Colin Robinson and Paul Stevens

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Enquiries to:

Director: Peter Pearson,
Secretary: Isobel Hildyard

SEEC, Economics Department
University of Surrey,
Guildford GU2 5XH
England UK.

TEL: +44-483-509379
FAX: +44-483-30377

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EXECUTIVE SUMMARY

Roger Fouquet, David Hawdon, Peter Pearson, Colin Robinson, Paul Stevens

The Aims

The aims of SEEC's energy demand forecasts (1993-2000) are to present the underlying determinants of fuel consumption, such as economic activity and prices; develop a series of simple yet reliable sectoral models of energy demand, which incorporate recent modelling developments; provide forecasts of energy demand and its environmental consequences; examine the effects of the V.A.T. on domestic fuel and increased competition in the electricity sector; and aid the present debate on energy markets.

The Future of the UK Economy and Energy Markets

Our estimates are based on assumptions about the UK economy which are shared by many other commentators. On this view, British economic activity has started recovering from its recession, though growth will only come in the next few years - averaging about two-and-a-half percent per year. Output should continue to expand through the decade, possibly starting to dip at the end.

Inflation will be related to economic activity. The retail price index increase will be below two percent this year and average just slightly over four percent through the decade.

The world oil market will continue to be dominated by high supply and growing demand, predominantly from Asian economies. OPEC's inability to limit quotas and Iraq's return to the international scene will keep prices low - at $14-15 per barrel. The world price of oil and, particularly, government taxation drive individual fuel prices in the UK.

For the last half-century at least, government has designed the structure of UK energy markets. Its choices, even those to privatise and induce competition, will guide supply and prices. The gas market is on the verge of liberalisation: British Gas is losing its supply monopoly and independent and foreign competitors will be allowed to compete. Our analysis assumes no major price effects throughout the decade. Electricity generation should become more competitive; although by how much depends on government's determination to limit National Power and PowerGen's market shares and to encourage entrants. The coal industry at privatisation will probably be broken up into five regional groups - though it is uncertain which ones will attract buyers - leaving it with little bargaining power relative to the major generating companies. Our forecasts also assume that Nuclear Electric - whether in private hands or still under public ownership - will generate power from Sizewell B but not C.

We have used a scenario approach to explore the implications of the uncertainty which surrounds the structure of energy markets and level of energy prices. In scenario 1, we anticipate that, even with low world oil prices and increased competition, the real price of energy in the UK will tend to grow at about five percent per year because of the government's desire to earn extra revenue and meet international environmental requirements.

Naturally, there will be some variation between sectors and fuels. The industrial sector prices will fall in real terms. Domestic sector prices will rise by more than five percent per year in 1994 and 1995 as the V.A.T. on domestic fuel takes effect. The transport sector motor spirit price should rise at an annual rate of about five percent in real terms in-line with the Budget speech at the end of November. Natural gas prices should rise slightly in real terms for the industrial sector but at around six or seven percent per year in the domestic sector. Coal prices will follow a similar pattern. The real price of electricity should fall for industrial users and rise at an average annual rate of four percent for domestic consumers.

Scenario 2 assesses the consequences of removing V.A.T. from domestic sector fuel purchasers. All other assumptions are in-line with the base case. In scenario 3, we ask what would happen if, by contrast, V.A.T.had been imposed at its full rate in 1994. Scenario 4 is a more radical investigation. Here, we explore the effect of substantially enhanced competition in the electricity and gas sectors, but with V.A.T. at its 1993 Budget level. We find that the varied assumptions lying behind each scenario make a significant impact on the size and composition of energy demand in the UK. The model also briefly explores the environmental implications of changes in energy demand.

The SEEC United Kingdom Primary Energy Demand and Emission Forecasts (1993-2000)

		SCENARIO 1		SCENARIO 2		SCENARIO 3		SCENARIO 4	
FUEL (million therms)	1992	1995	2000	1995	2000	1995	2000	1995	2000
Coal	25,188	14,806	14,771	14,850	14,515	15,043	15,681	14,812	15,679
Petroleum	30,886	30,064	32,108	30,101	32,201	30,052	32,147	30,079	32,439
Natural Gas	22,296	32,625	34,271	33,447	37,340	31,594	32,311	32,593	36,315
Other	8,910	9,653	9,078	9,680	8,938	9,810	9,624	9,778	10,482
TOTAL	87,282	87,145	90,230	88,078	92,934	86,549	89,765	87,262	94,915
Carbon Dioxide[1]	159	142	148	143	152	141	147	142	154
Sulphur Dioxide[2]	3,565	2,104	2,048	2,110	2,023	2,130	2,150	2,106	2,169

1 Value for 1991: Measured in Million tonnes of carbon
2 Value for 1991: Measured in Thousand tonnes of sulphur

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1. INTRODUCTION

Roger Fouquet

The Need for Energy Demand Forecasting

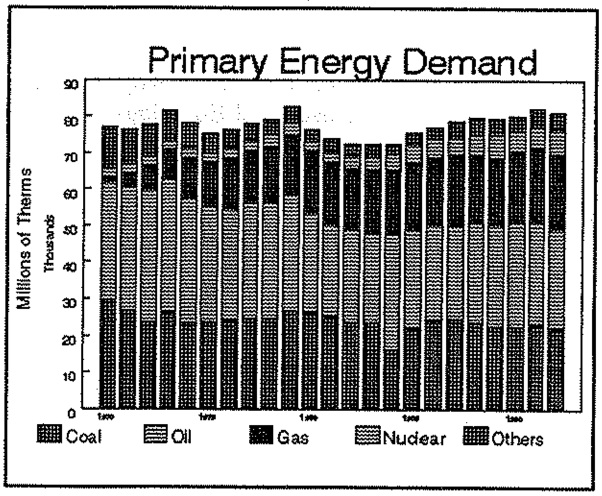
In the final days of 1993, the economy appears to be in a recovery, expanding some sectors' production, consumption and energy demand. But, in 1994, taxation - particularly on domestic fuel - will dampen demand. Furthermore, underlying the expected overall increase in fuel consumption is a major shift in the UK's energy-mix resulting from changes in the structure of the economy and the energy industries, exemplified by electricity generators' preference for natural gas over coal power stations. Increasingly open and competitive energy markets require the assistance of independent forecasts to provide information about the future of energy demand. Surrey Energy Economics Centre presents a picture of energy consumption in the middle of an era of upheaval in UK fuel markets.

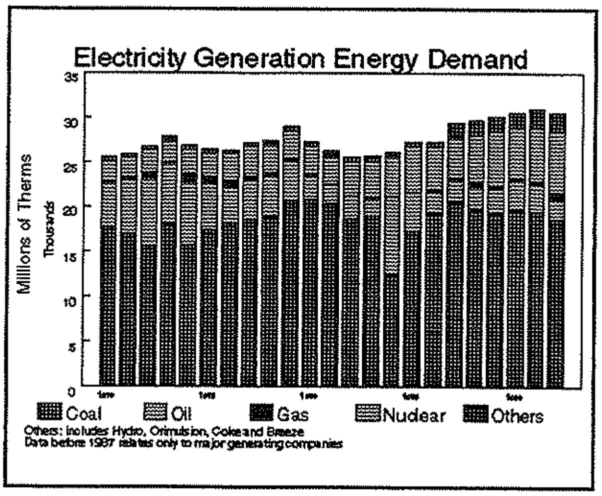
Ever since the Oil Shock of 1973, economists have regularly analysed, discussed and forecast changes in energy consumption and their effects on the economy. Continuing in this tradition, SEEC has developed a series of sectoral models for UK energy demand. Based on recent developments in energy demand modelling and incorporating expectations about economic activity, world oil prices, energy policy in the UK, and their effect on domestic fuel prices, the model generates disaggregated forecasts of UK energy consumption for 1993-1995 and 2000.

The United Kingdom Fuel Mix

In spite of attempts to diversify UK energy sources after the oil shocks, total primary energy demand (amounting to 87,282 million therms or 206.6 mtoe), remains largely composed of three fossil fuels: coal, petroleum and natural gas. Petroleum provides the most, approximately 35 percent of the total, two-thirds of which drives the transport sector. Just under 30 percent comes from coal (and other solid fuels), of which 70 percent is used to generate electricity. One quarter of UK primary energy demand is natural gas, used in various sectors - particularly, the domestic sector - for space-heating. The fourth fuel, nuclear power, provides about eight percent of the total; the rest of the energy comes from French electricity imports and renewable energy sources, such as hydroelectricity.

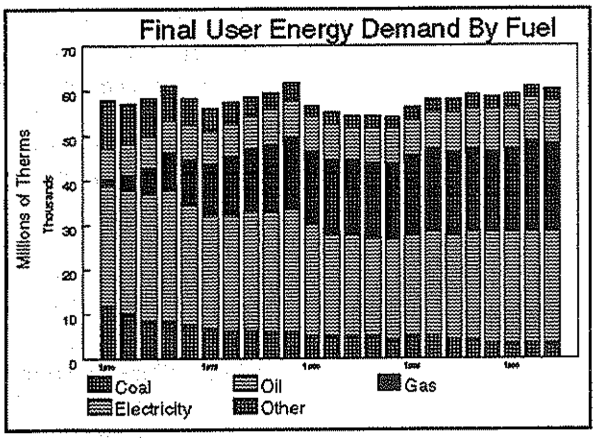
While one-third of UK's primary energy demand is used to generate electricity (30,000 million therms or 75.9 mtoe), most of the rest - over 60 million therms - goes directly to the final user to heat buildings and water, run machines and move vehicles. Just under a third (or 19505 million therms) of final user demand is used by the transport sector - mainly for road vehicles. The domestic sector consumes 29 percent and the industrial sector 25 percent. Smaller sectors, such as public administration and defence, agriculture and services, use the rest.

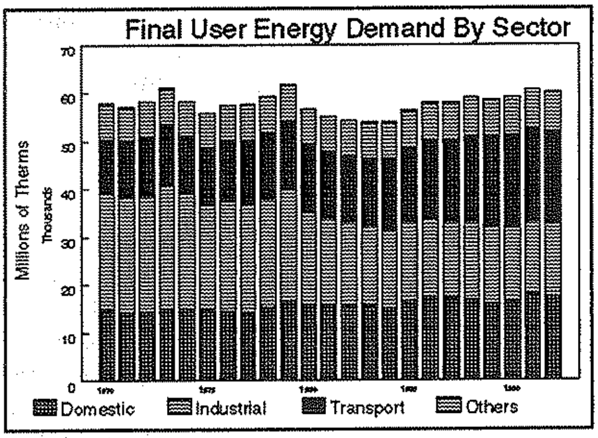




Economic Activity and Fuel Prices

The effect of economic recovery on energy demand will hinge on how it influences individual sectors. Some, like the service or transport sector, may grow more than average as UK's post-industrial economy favours them. While others may be on a continual decline and the recovery provides only a minor boost. And, as each sector changes individually, so will their demand for energy. The iron and steel sector, once one of the UK's largest and most energy-intensive





industries, has been following a declining trend for several decades and will hardly be affected by the recovery. The transport sector, on the other hand, will continue to expand. Its own voracious appetite will generate demand for different fuels from the iron and steel sector. Thus, to appreciate how this expansion will influence and change energy demand in coming years, it becomes necessary to examine sectors individually.

UK fuel prices, also fundamental to the future of energy demand, are governed to a great extent by the prevailing world oil prices and government intervention on individual fuels and sectors. With increasing oil supplies and continuing demand growth in Asia and in the developing countries, the oil markets will undergo periods of over- and under-supply. World oil prices will reflect such market variations, which in coming years will depend greatly on Iraq's exports and OPEC's ability to adjust to them. These prices will influence the underlying rate of change of UK fuel prices.

But, probably more important, in coming years, will be government's influence on energy. Decisions about the structure of coal, gas and electricity markets and taxes on fuels will affect prices. Privatisation and increased competition, many argue, will lead to cuts in production costs and, eventually, prices. While introduction of or increases in taxes on energy, such as V.A.T. on domestic fuel or levies on road fuel, will raise prices to the consumer.

Energy Demand Modelling

Demand responds to these underlying trends. But, the durable nature of energy-using equipment means that the full effect of changes in price fluctuations and growth in economic activity will only feed through into adjustments in consumption patterns over a period of years. The SEEC Energy Model of the UK (SEECEM) allows for both an immediate and gradual effect of underlying forces. Based on the Error Correction Model (ECM), SEECEM incorporates a long-run, non-stationary, but cointegrated model into a short-run, dynamic and stationary framework. The ECM framework, through its estimation of short- and long-run elasticities, ensures that present demand reflects both immediate reactions to change and longer term adjustments to past variations.

In the past, energy demand modellers tended to use long-run models of energy demand, which generated elasticities based on non-stationary data. Non-stationary data - time-series that grow or decline through time - cannot provide statistically reliable estimates which reflect both immediate reactions to change and longer term adjustments to past changes. In recent years, ECM has been proposed as a method of resolving the problem. By cointegrating the long-run model, its errors become stationary. The long-run errors are fed into the short-run model (i.e ECM), which also tend to be stationary - since there is no expected growth in differenced variables. The estimated elasticities do not suffer the unreliability associated with non-stationary data. Thus, SEECEM, while remaining a relatively simple approach, incorporates some of the recent developments in energy demand modelling.

Forecasting Energy Demand

The model generates short- and long-run elasticities for each sector and fuel used within them which, using expectations of price and activity variables, provide the basis for SEEC's energy demand forecast. Looking ahead at the next seven years, with particular focus on 1993-1995, We examine which sectors' energy demand will grow and by how much. The V.A.T. on domestic fuel and increased competition in the electricity supply industry are highlighted, investigating their impacts on demand. We also produce forecasts for the switch in fuels used by power generators.

Combining final user demand and power generators' demand, as well as distribution losses and consumption by energy industries, gives an estimate of UK's primary energy consumption. Alongside these, SEEC produces estimates of petroleum refinery operations, UK's overall energy efficiency and carbon and sulphur dioxide emissions.

The Aims

The aims of SEEC's energy demand forecasts (1993-2000) are to present the underlying determinants of fuel consumption, such as economic activity and prices; develop a series of simple yet reliable sectoral models of energy demand, which incorporate recent modelling developments; provide forecasts of energy demand and its environmental consequences; examine the effects of the V.A.T. on domestic fuel and increased competition in the electricity sector; and, aid the present debate on energy markets.

Paul Stevens begins with an analysis of the World oil prices, with a particular focus on Iraq's role. In Chapter three, Colin Robinson reviews energy policy in the UK. David Hawdon, then, discusses SEEC's expectations about UK fuel prices in coming years, and how they vary among sectors. In Chapter five, he introduces the analysis of final-user demand, which involves forecasts of the domestic, iron and steel, and other industries sectors. This is followed by an analysis of the transport sector by Roger Fouquet. Peter Pearson then discusses the agriculture, public administration and defence, and miscellaneous sectors. In Chapter six, Colin Robinson examines the major changes in electricity generators' demand for fuel that are underway. Primary energy consumption and its environment effects are the focus of Roger Fouquet's Chapter seven. David Hawdon and Roger Fouquet conclude, highlighting the significance of the results. In the Appendix, Roger Fouquet presents SEECEM, its elasticitiy estimates and detailed forecasts.

2. OIL PRICES IN THE WORLD MARKET

Paul Stevens

Forecasting international oil prices has always been a precarious occupation. This is because the determination of oil prices is a complex mixture of price administration in a market context. Furthermore, it is a market where perceptions and expectations, often volatile and ill informed, can easily overrule the market fundamentals. However, in the present context, price forecasting is more difficult than for many years past. The reason is that an absolutely key factor is the question of when and in what form Iraq returns to the international oil market. The forecast therefore considers two options - with and without Iraq.

Without Iraq, the oil market will be comfortably supplied. A number of producers, notably Saudi Arabia, are in the process of expanding sustainable capacity. Demand is growing, especially in the Third World, but supplies should be ample up to 1995. There is a qualification. The system has a higher capacity utilization than at any time since the Second Oil Shock of 1979-81. This means there is vulnerability if any other political shock (Russia, Algeria, etc etc) were to disrupt supplies on a large scale. However, even in that case, surge capacity from a number of sources could rescue the situation for several months. Also, there is the option to allow Iraqi re-entry if economic necessity overcomes political sensitivities. Thus shortage and upward pressure on price is an extremely unlikely option providing there is no substantive change to Saudi Arabia's policy (see below).

The most likely market position will be oversupply. OPEC discipline has been extremely poor since the liberation of Kuwait. This has largely been driven by two factors. First, there is a desire for market share in anticipation of the negotiations to allow Iraqi re-entry. Second, there is an inability for OPEC to create a plausible agreement because the main protagonists are unwilling to play their cards and negotiate seriously until Iraq returns. The result of this indiscipline has been an oversupplied market.

Given Kuwait's determination to recover its pre-invasion production levels and the capacity expansion in other producers, this oversupply is likely to continue. In such a situation, a price collapse along the lines of 1986 cannot be ruled out. However, for reasons discussed below, such an outcome would be unlikely to translate into lower prices to the consumer.

The only possible qualification to this view of down-side pressures on price, assuming no political shock, would be if Saudi Arabia changed its policy. Since 1986, Saudi Arabia has been content to pursue a policy aimed at generating relatively low oil prices, although not at the low levels seen at times this year. It has always had the option to adopt a more aggressive pricing position using its dominance of supply to push prices up. It has chosen not to do so. This is partly because low prices have suited the Saudi strategy of securing volume in both the short and long term. It has also been because of the fear that any cutbacks to achieve higher prices would force the Kingdom back into the "swing role" which it abandoned in 1985.

There are however pressures upon the Kingdom to change this policy. First, its own financial requirements are growing. A production of 7.5 million b/d with a price of \$21 generates another \$8 billion revenue compared to a production of 8 million b/d with a price of \$17 per barrel. Second, there is a growing feeling in the Kingdom that if the producers do not increase prices, then consumer governments will raise price under the excuse of protection of the environment. This would seriously undermine the basis of the Saudi's low price strategy. Finally, the Saudi's must be unsure how far they can rely on the new US Administration whose policy on the Middle East is seriously flawed. In such circumstances, political accommodation of Iran becomes essential. This would require some effort to push prices higher.

The problem is that with Iraq overhanging the market, even a change in Saudi policy might not be enough to raise prices.

When Iraq does return will be a matter of much uncertainty and is having a strong influence in the market. This was illustrated during July when the market decided that the resumption of Iraqi exports was imminent. An Iraqi delegation headed by the deputy foreign minister Riyadh al Qaisi went to New York to discuss terms for the sale of \$1.6 billion of oil for humanitarian purposes under UN Resolutions 706 and 712. The oil traders appeared to believe that there had been a fundamental shift in Iraqi attitudes which would lead them to accept terms previously rejected. This, so they believed, would result in an immediate return for Iraqi oil. The traders also believed that once Iraqi oil began flowing, this would presage a full return of Iraqi exports over time. This was given credence by a report which suggested that

Dr Butros Ghali had promised Iraq an increase in volume after the six months of pumping for humanitarian purposes. Leaks from the New York talks suggested progress was being made. When another point of contention (the monitoring of missiles under UN Resolution 715 was also apparently solved) the price fell to its lowest level for three years which triggered the announcement of an OPEC meeting (subsequently postponed).

However, it is likely that there is a very long way to go before the removal of sanctions against non-humanitarian Iraqi crude exports. There are a whole list of requirements which Iraq has yet to meet. These include disclosure of weapons suppliers; monitoring on all weapons of mass destruction; acceptance of the new Kuwaiti border; release of Kuwaiti prisoners; "progress" on human rights etc. Such a series of hoops presents unlimited possibilities for those hostile to Iraq to prevent any relaxation of sanctions. Given the US's policy of dual-containment it seems implausible that the US will agree to any such relaxation. The regular 60 day UN meetings on sanctions show no signs whatever of any concessions.

Even for humanitarian oil, there is still a long way to go before any oil is actually loaded. The progress in New York on humanitarian oil was on procedural issues. More discussion will be required with many substantive issues outstanding. For example, Iraq will have to agree on unrestricted UN monitoring of aid distribution within Iraq. After all this, a new UN Resolution will be needed since Resolutions 706 and 712 lapsed in March.

The above analysis suggests that while Saddam Hussein remains in power, Iraqi oil will remain absent from the market in any substantial quantities. Almost certainly, the only way Saddam will go is to be assassinated. While this could happen at any time, he could also survive for many years. It is perfectly plausible that even by the end of 1995, Iraq will still be out. When it eventually does return, exports will rise extremely rapidly. It is clear that foreign companies will be allowed entry on very favourable terms. Given the existing proven reserves base, capacity could be expanded rapidly. Iraq's return would presage a longer period of weak prices even assuming OPEC could produce a plausible agreement to allow re-entry. Failure to do so would almost certainly presage a 1986 style price collapse.

Thus, absent a major political upheaval or a major change in Saudi policy, all the signs are for weak international prices to continue.

UK Prices

Lower oil prices are unlikely to feed into lower prices to consumers. Close to the top of the UK Government's policy agenda is the need to raise tax revenue to reduce the PSBR. Clearly, energy is being targeted as one source. It has low collection costs, a large tax base because of its widespread use and, because of relatively inelastic demand, an ability to carry high tax rates. Even if there is a climb down over the extension of VAT, oil products will continue to attract high levels of tax. If the international price were to fall, the Government would quickly increase its taxation in order to absorb a higher share of the rent. This would be done (as was the VAT proposal) under the banner of protecting the environment, especially given that road building is currently a sensitive issue. Even absent a price collapse, the government may still raise as much tax as it can from oil products.

Conclusion

Oil product prices will definitely not fall in real terms. The most likely outcome is a gradual rise in real terms, perhaps some 5 percent per year.

3. ENERGY POLICIES IN THE UNITED KINGDOM

Colin Robinson

For over forty years after World War Two, British governments pursued protectionist policies towards indigenous energy-producing industries: the nationalised coal industry was sheltered from the competition of other fuels and nuclear power was promoted. Increasingly, the principal focus of these policies became the electricity supply industry which was persuaded by governments to burn more British-produced coal and to invest more in British-designed nuclear power plants than it would freely have done. Fuel and heating oils were taxed, coal imports were for much of the period restricted (though not by overt tariffs or quotas), imports of oil from the (then) Soviet Union were at times limited, and there was a virtual ban on the use of natural gas in power generation.

One of the main effects of electricity privatisation was to undermine fuel protectionism. Most of the old policies (apart from the fuel oil tax and support for nuclear power) have not survived or are much reduced in importance. Initial coal contacts with the two major generators (70 million tonnes a year, falling to 65 million tonnes) maintained protection for British Coal from 1990 to March 1993 at a level not much below the previous Joint Understandings. But, as a consequence of these contracts, both the generators and British Coal have large excess stocks. New five year coal contracts are for much reduced volumes (40 million tonnes a year, falling after one year to 30 million tonnes). Coal is now in a much more competitive market, being exposed to competition from natural gas, imported coal, imported French electricity and Orimulsion as well as (taxed) oil.

Protection for existing nuclear power plant remains until 1998. But, after the failure of the attempt to privatise nuclear power, there is considerable scepticism about the likely costs of nuclear electricity. The review of nuclear power prospects will soon begin, but at present, there are no plans to construct more nuclear stations.

Because of these policy changes, consequent on electricity privatisation, the British energy market is becoming more competitive. There will be more competition still if the August 1993 Monopolies and Mergers Commission report on gas is implemented by government. British Gas will have to divest itself by 1997 of its trading activities, becoming an exploration, production, pipeline and storage company. Accounting separation (within BG) of gas transportation and storage is due by the Spring of 1994. Once the conflict of interest inherent in ownership by the major gas trader of the pipeline is removed, entrants to gas supply should find it much easier to sell to consumers. Competition will extend even to small consumers if the government accepts the MMC recommendation that the British Gas monopoly should be removed in stages, being confined to consumers of less than 1500 therms a year by 1997 and abolished by about 2002.

Privatisation was a necessary condition for the recent enhancement of competition in the British energy market and the prospective further liberalisation of the gas market. But much of the liberalisation which has occurred - especially in gas - has been due primarily to action by regulators and the MMC rather than the privatisation scheme. How much farther competition goes depends on action taken by the electricity regulator and on the privatisation scheme for coal.

Although the privatisation scheme for electricity left the two major electricity generators with less market power than the privatised British Gas had in 1986, nevertheless there are growing complaints of non-competitive behaviour by the generators and the Office of Electricity Regulation is considering whether to make a reference to the MMC. At the same time, the long-delayed privatisation scheme for British Coal has been published.

The four principal uncertainties in energy policy are now as follows:

1. To what extent will the government implement the MMC recommendations for gas?

It is very uncertain whether the divestment by British Gas of its trading arm will go ahead by the target date of 1997, even though it seems unlikely to be a vote-loser and might even prove a winner. At the time of privatisation, the economic case for an independent pipeline company was obvious but the government was evidently unwilling to make the split for fear of losing revenues from the sale and discouraging prospective shareholders. However, the revenues have long been gathered in and the initial reaction of the stock market to the August 1993 MMC report suggests that shareholders now do not expect to suffer significantly from the divestment. British Gas evidently has contingency plans for a break up.

Extension of competition to the residential gas market is also problematical though Press reports indicate that the government favours some lowering of the tariff market threshold. On average, one would expect gas costs and prices to fall as competition increases, so that gains to winners would offset losses to any losers. However, there has been a tendency to average prices in the past, so that some consumers (for example, those consuming small amounts and those in remote areas) have in effect been subsidised by others. A more competitive market, with prices moving into closer alignment with costs could result in big price increases for some poor consumers. Although, assuming that there will be overall gains, the problem is clearly soluble, the government is likely to proceed cautiously, especially as the staged imposition for VAT on gas and electricity is due to begin in 1994. Since the government had already indicated, before the MMC report, that it would like to abolish the gas monopoly it will no doubt proceed on that road. One possibility is that it will accept the reduction in the threshold for the monopoly to 1500 therms a year as the MMC suggests, since that will not affect small consumers; but it may simply state a general intention to proceed further without being more specific for the time being.

2. Will competition in electricity generation and supply increase?

The generation duopoly has been subject to much criticism. It is argued that National Power and PowerGen are able to manipulate prices or volumes so as to affect prices in the electricity 'pool' and that fear of their market power is a deterrent to entering electricity generation. Although there are now a number of entrants to generation, many of them are associated (either by equity stake or by contract) with existing members of the electricity industry. Moreover, it is claimed that there are biases in the present electricity market which favour gas and nuclear power as compared with coal so that the decline in coal sales is partly due to these distortions (see Chapter 6).

On the precedent of gas, one might expect a reference to the MMC so as to investigate some of the assertions which have been made about the absence of genuine rivalry in generation (which, if true, inevitably limits competition in supply since independent generators are the most likely suppliers from outside the incumbent generators and suppliers). The Office of Electricity Regulation, which has already issued four reports on generation even though that market was evidently intended to be competitive, has said that it is considering referring the generators to the MMC. If it does so in the near future, one of the incidental effects will be to delay the government's planned sale of its remaining 40 per cent stake in the two major generators. Whether or not such a reference is made, the threat already seems to have affected the behaviour of National Power and PowerGen. The chances are that competition will increase in electricity generation and supply over the next few years, either because there is a reference or because the two big generators behave so as to avoid a reference. In any case, their market shares will decline in the short term as competitors complete plant now under construction.

3. The Form of Coal Privatisation

Government policies over the last few years have made any sensible form of coal privatisation extremely difficult. Privatising electricity before coal, establishing only two generators on which British Coal depends to sell most of its product, announcing coal privatisation in 1988 then leaving the industry in a state of uncertainty about when and how privatisation would be accomplished, continuing to support nuclear power - all have been important factors in the recent decline of British Coal, which have added to the downward pressure on output and employment which would anyway have been exerted as extensive protection was withdrawn and EC environmental regulations affected the industry.

The size of the industry which is sold will be very small compared with what it would have been had coal been privatised soon after Mr (now Lord) Parkinson's announcement of the 'ultimate privatisation' in 1988. British Coal would have liked a 'one lump' privatisation, as the managements of British Gas and CEGB wanted, but only British Gas obtained. However, five separate regions will be offered for sale. The government will presumably now press ahead with coal privatisation. It will need to move quickly or there may be little left to privatise.

4. The problem of nuclear power.

Nuclear power prospects are to be reviewed late in 1993 or in 1994. It seems rather unlikely that the review will recommend the construction of any more nuclear plant for the time being, though Nuclear Electric would like to go ahead with Sizewell 'C' once the 'B' station is commissioned.

Revelations about nuclear power costs (especially de-commissioning) during the electricity privatisation debates made Ministers sceptical about any cost estimates stemming from the industry. In any case, it is one thing allowing a number of nuclear plants to be run by the state for the remainder of their lives as an enclave in a privatised industry. To make a commitment that a state corporation - which has access to lower-cost capital than the private companies in the industry - will build more capacity when those companies already believe they have a surplus seems extremely unlikely. The probability is that the nuclear review will be a holding operation. In the foreseeable future it may be possible to privatise some or all of the nuclear companies: at that stage, they will be able to make their own decisions about new capacity rather than relying on government reviews.

4. ENERGY PRICES IN THE UNITED KINGDOM

David Hawdon

In this section we discuss the development of energy prices in the UK. Since prices vary considerably between the major energy markets - domestic, industrial and transport - it is not sufficient merely to indicate broad trends. For example, prices in industrial markets are far more open to world market influences than in the highly regulated domestic market whilst transport is often subject to taxation by governments for revenue raising purposes. We will distinguish price movements in the individual sectors where appropriate.

Oil Prices

(i) Industrial Oil Prices (Heavy Fuel Oil)

The main influence on fuel oil prices throughout 1993 has been low levels of internationally traded crude oil prices. Low oil prices are due primarily to uncertainty in the market, following the failure of OPEC to restrain oil production in an oversupplied market. High output levels from Iran, Nigeria and, particularly, Kuwait accounted for much of OPECs disarray. Kuwait's aim is to restore its pre-Gulf War level of production of two million barrels per day. The position of Iraq has become of more importance. Although Iraq still has much to do to gain the remission of the UN ban on oil exports, rumours about progress in negotiations over arms inspection are still sufficient to bring the price of oil down sharply in July. In the short run prices of crude and fuel oil are likely to remain weak. In the longer run, however, demand growth, particularly from the Far East due to growth in the demand for electricity in countries like Taiwan, South Korea and the Philippines may help to prevent any catastrophic fall in prices.

The longer term outlook in consumer markets is one of more expensive oil, because of environmental taxation, government revenue raising exercises and because of the eventual narrowing of the world oil supply base.

Prices in 1993 are expected to be around 7% higher in real terms than in 1992 due to the exceptionally low price levels prevailing last year. From 1994 onwards we expect that prices will rise at 5% in real terms in line with the general UK oil price forecast.

(ii) Domestic Sector Oil Prices

Prices of burning oil and diesel used for central heating will follow closely movements in heavy fuel oil prices to industry during 1993. In 1994, prices are adjusted to take account of an expected small underlying rise in the costs of crude oil together with the new 8% VAT effective from April, yielding a total projected rise of 10% (5.5% in real terms). Allowing for the further rise in VAT in 1995, prices are expected to rise by 11.5% (5.7% in real terms).

(iii) Petrol Prices

Petrol price changes will depend on two factors - the extent to which the government is prepared to pursue its 1993 budget policy of steadily increasing the costs of motoring and the magnitude of international oil price movements. In March, fuel duty was increased by 10% resulting in a 5.5% increase in unleaded petrol prices and the road fund licence was increased by 13.6%. At the time the government intended that fuel costs should rise by around 3% per year. Then in November road fuel taxes were increased by between 5.5 and 6.5%. We have incorporated an ongoing real price increase of 5% per annum in our projections.

Gas Prices

(i) Industrial Gas Prices

The one main factor which will affect the price of gas in the longer term is the reaction of the Government to the report of the MMC, which was published in August 1993. Should the present structure be retained, it is likely that British Gas would continue to operate effective barriers against new entry into the industry and be able to pass through cost increases into prices without any development of effective competition. The raising of pipeline charges in June/July by British Gas (followed by an embarrassing climb down) indicates that, left alone, British Gas will penalise competitors' use of its transport facilities. Its high charges for connecting industrial users supplied by its competitors indicate a similar attitude.

It is anticipated, however, that substantial changes are likely to occur in the industrial gas market as a result of the Commission's reports. The introduction of more competitive conditions will increase customer choice of supplier, spur on cost reduction and stimulate innovation. Recent entrants into the UK gas market argue that they can supply gas even to the residential market at lower prices than British Gas.

Competitive pressures in the gas industry look set to rise, as former domestic monopolies throughout Europe and North America seek to develop new markets. We would expect this to exercise a restraining effect on gas prices in the medium term.

In early 1993, gas prices were actually 5% lower than in the corresponding period in 1992. We anticipate a rise of around 3.5% for the year as a whole (-1.8% in real terms), climbing to 7% in 1994 and 8% in 1995.

(ii) Domestic Sector Gas Price

In the domestic sector, gas prices are governed by three factors - the rate of inflation, cost of purchasing gas supplies and the efficiency incentive in the government's regulatory mechanism. Inflation measured by RPI has fallen from peak rates of 9.5% in 1990 to 3.7% in 1992 and is likely to be as low as 1.7% for 1993. This can be attributed to weak demand throughout the economy and to lower unit wage costs. However, low rates of inflation are unlikely to persist. Economic recovery will provide opportunities for some price rises whilst already announced tax increases are likely to add around 3-4% in 1994.

The cost of purchased gas is affected more by developments in the international oil and gas market than by internal considerations. The world market for natural gas is becoming more competitive as privatisation programmes are increasingly adopted. Gas suppliers are freer to choose amongst customers. Although international trade in gas is hampered by high transport costs, the availability of cheap gas in North America and the former Soviet Union will influence the price at which supplies are obtainable within the UK. A further factor affecting gas costs is the efficiency of British Gas. Here, the recommendations of the August MMC report will exert pressure on British Gas's cost base.

Two aspects of the MMC report are however important for future gas prices. The recommended lowering of the X factor from 5% to 4% will enable BG to pass through a higher proportion of any inflation and cost changes. On the other hand the recommendation that BG should lose its status as monopoly supplier to customers taking less than 1500 therms per year by 2000 should if accepted by government, promote competition and hence moderate prices in the longer term. Other recommendations such as the lowering of the rate of return on pipelines may also be expected to reduce pressure on gas prices.

Allowing for VAT increases, gas prices in the domestic market are likely to rise faster than inflation in 1994 and 1995, but to decline thereafter as greater competition is introduced into the market.

Electricity Prices

(i) Industrial Sector Electricity Price

Electricity prices are likely to be affected by three main factors: the increased cost of meeting tighter environmental targets for coal fired power stations; the improved efficiency of nuclear power; and the weaker position of the UK coal industry in negotiations over contracts with the electricity generators.

The two main generators have been able to play a delaying game with British Coal over coal supplies. National Power and Powergen have little incentive to conclude a deal with British Coal, since coal stocks at power stations are high and alternative cheaper supplies are available from Rotterdam. They argue that British Coal's price offer should allow for the cost of stockpiling additional coal and should, therefore, be less than the cost of imports. Further pressure on coal is being exerted by National Power's decision to close the 1,100MW Thorp Marsh plant and its threat to close further capacity over the next two to three years.

The generators have been relatively successful in keeping coal input costs low and this has had an influence on prices. In future, electricity prices are likely to depend much more closely on the development of effective competitive in the industry.

(ii) Domestic Sector Electricity Price

Whilst the regulatory formula governing domestic electricity prices is similar to that affecting gas (RPI - x + y, where y is a cost pass through element and x an efficiency factor), the electricity industry has until recently had little incentive to improve productivity. Prior to August 1993, the value of x was set at zero. However, since August a 2%

efficiency term has been incorporated in supply contracts to encourage energy saving.

Electricity costs are unlikely to rise substantially in the short term. The high levels of coal stocks built up at power stations ensures that intense pressure on input costs can be maintained. In addition the ready availability of coal from world markets provides a buffer against higher coal prices in the UK. The sanctioning of Orimulsion burning provides a further cheap although limited input option. Finally the continuing displacement of coal by gas and nuclear in electricity generation serves to reduce the possible effects on prices of any environmental taxation which may be introduced in the longer term.

Coal Prices

(i) Industrial Coal Prices

Coal prices are unlikely to change much before the uncertainty surrounding UK policy on coal is removed. The Government commitment to saving 12 pits is now under severe threat due to continuing low levels of demand from the electricity producers. At the same time, barriers remain against the liberalisation of the coal market. Government policy is to encourage the development of low cost coal mining in the UK. However, British Coal, by setting up a complicated bidding procedure for its surplus mines, is attempting to reduce effective competition to a minimum. Its intention to vet the technical and financial status of bidders and to determine whether pits would be operated on a long term basis, gives it substantial delaying power. Its policy of selling pits on a piecemeal basis deters those who would wish to bid for viable groups of collieries. Finally, by removing equipment from its mines, it creates extra investment barriers for bidders.

In spite of these attempts to slow the pace of change, it is unlikely that coal prices to the electricity sector will rise much in the face of aggressive buying from the electricity generators. Prices to industrial consumers generally will tend to follow those of heavy fuel oil.

(ii) Domestic Coal Prices

Coal prices are not subject to regulation and we expect only that the VAT increases confirmed in the November 1993 Budget will be passed on to consumers in 1994 and 1995.

5. FINAL USER ENERGY DEMAND - INTRODUCTION

David Hawdon

The SEECEM modelling approach

Three basic principles were applied to the construction of the energy demand model - simplicity of form, focus on relevant exogenous variables and flexible dynamic structure. Simplicity of form was considered important because of the need to communicate results clearly - initially amongst members of the forecasting group, but ultimately to users in the wider energy community who would wish for readily understood results. This consideration led us to the adoption of the double log form -

$$\ln(\text{Energyi}) = a + b.\ln(\text{Pricei}) + c.\ln(\text{Activity}) + d.\ln(\text{Temp})$$

- as the general form of our modelling of fuel i in each market. The double log form derives straightforwardly from a logarithmic utility function and yields easily understood elasticities. A major deficiency is the implied constancy of demand elasticities over all prices. Hence the need to allow for changing values in the proper dynamic framework. It would be possible to impose a more or less reasonable structure on the dynamics of energy demand but we are sceptical about the attempts which have been made to model energy market dynamics. Thus we adopt the freer approach of the error correction/cointegration modelling methodology which has become popular in recent years and been successfully applied in various areas of economic estimation. The essence of the approach is to allow the data to determine the dynamic behaviour of the necessarily aggregated series available in the energy sector. It yields elasticities which change over time whilst preserving a relatively sound underlying economic model. Full details of the error correction model are given in Appendix 1. and results are reported in the individual sector chapters, in the statistical appendix and in Appendix 3.

A further consideration is the relevance of the exogenous variables. The objective of our work is to assess the likely impact of changes in energy policies, tax regimes, domestic economic activity and world oil prices on final demand for energy. We have, therefore, focused rather narrowly on the estimation of own and cross price elasticities, and income or activity effects after taking due account of the influence of weather conditions. This approach makes the process of forecasting rather transparent and should permit interested users to investigate the effects of changed assumptions without much difficulty.

Our data base for estimation spans the period from 1950 to 1992 and represents the results of a major data investigation by members of SEEC. Where possible our estimates use the entire data set, although greater weight is placed on the post 1973 period where this is appropriate. Data for the transport market is of more recent vintage and comes from a variety of sources including the Department of Transport, and the OECD, as well as the Department of Trade and Industry, the usual source of our data. The length of the data set is intended to lend extra confidence to our estimates of long run elasticities.

Assessment of future energy demand

In each of the following sections, the first set of projections are made on the basis of 'business as usual' assumptions (Scenario 1). This incorporates the extension of VAT to the energy market as announced in the 1993 Budget. Alternative scenarios are evaluated and compared with this base scenario to illustrate more clearly the likely effect of the major environmental and policy variables envisaged. The following table collects together the main assumptions underlying the scenarios which are worked out in greater detail for each sector in the next part of our paper.

	Scenario 1 'Business as Usual'	Scenario 2	Scenario 3	Scenario 4
World oil price	$15 per barrel	$15 per barrel	$15 per barrel	$15 per barrel
UK Tax Policy	1994:VAT 8.5% 1995:VAT +9%	No VAT on Fuels	1994:VAT 17.5%	1994: VAT 8.5% 1995: VAT +9%
UK Electricity Market				Electricity Prices: Post-1993: 4.4% to 7% less than Scen 1

UK ENERGY MARKET - DOMESTIC SECTOR

David Hawdon

Recent Developments

The aim of this section is to draw attention to certain important characteristics of the domestic sector energy market prior to discussing the model used for estimating and forecasting energy demand. Since the emphasis of SEECEM lies in explaining market changes and on forecasting capability, an examination of market trends is helpful in fixing realistic bounds for projections.

1. Low growth rate of total energy demand. Unlike the transport sector where growth of personal and air transport have fuelled substantial increases in energy consumption, the domestic sector over the last three decades has exhibited on average less than 1% growth per year. On a therms supplied basis, growth was slightly higher in the seventies (.77% pa) than in the sixties (.13 % pa) or the eighties (.23% pa). Even taking into account the 1991/92 recovery, the 32 year growth rate was only .66% pa. 1991 was very much an exceptional year for the sector and the rapid growth achieved in that year (10.4%) has not been sustained.

2. There are conflicting trends within the total movement of energy demand. On the one hand, energy for basic uses - for cooking, heating and lighting - is being used more efficiently. Ownership of central heating systems increased from 34% of all households in 1970 to 82% in 1992; washing machines from 36.5% to 88% and cookers from 33 to 51% in the same period. Thus energy demand measured in an input sense probably understates the demand for useful energy. On the other hand, some uses of energy, in particular electricity, are associated with power requirements for driving a large number of relatively small appliances. Many of these are closely related to disposable income and likely to be more sensitive to movements in the overall economy than the basic energy uses so that modelling and forecasting is complicated.

3. At the same time as overall demand has expanded slowly, the fortunes of individual fuels in the energy mix have changed sharply. Coal for example declined from 78% in 1960 to 11% in 1990 but appears to have stabilised at this level. Gas rose from 9% in 1960 to 63% in 1990, whilst electricity although also exhibiting strong growth in the sixties has remained at around 20% of the market since then. The relative change in the positions of coal and gas are due largely to two factors - changes in the relative price of gas and the development of the gas central heating market as a superior technology for supplying heat. The stabilisation of market share changes seems also to be associated with the levelling off of saturation levels of the major appliances. Thus elasticities of demand, derived from historic analysis, need to be used with caution in anything other than short term forecasting.

Modelling of Domestic Demand

In the domestic market, the idea of a market in the sense of a separable stage in consumer decision making is problematical. Different fuels are used for different although related purposes. Thus even with basic energy uses like heating one may use one fuel for central heating and another for specific occasional heating. Between other fuels there may be no possibility of substitution - e.g. in power uses, lighting and entertainment related uses. Thus it would seem sensible to treat each fuel as semi-separable where we would expect demand to be related significantly but not exclusively to prices of other fuels together with non fuel prices.

The role of specific appliance ownership is given less of a role in our model than in many energy demand models. Some incorporate separate models to explain appliance ownership and fuel consumption per appliance; demand for fuel being then derived as the product of these two items. However, this approach implies a temporal non optimising sequence - first choose an appliance and then decide on the quantity of fuel it will use - and it is not clear that this is the appropriate procedure. The appliance choice may follow or accompany the choice of fuel, or the appliance may be modified or discarded when the price of fuel alters. Mere possession does not imply fixed ratio usage. There is also a statistical problem with this approach. The ultimate expression for demand contains errors from ownership equations - usually logistic - and utilisation equations - often linear or logarithmic, and little is known about the statistical properties of the combined errors from such a procedure. It is therefore preferable to treat each of the major fuels separately from the point of view of estimation. Less important fuels may be derived as the difference between predictions from individual fuel equations and a total energy equation where data on the fuel is inadequate. Total energy equations can also be used as a forecasting check on the realism of individual fuel model projections.

UK ENERGY MARKET - DOMESTIC SECTOR (Million therms per year)						
	1960	1970	1980	1990	1992	
Coal + OSF	11304	7137	3313	1736	2050	
Gas	1296	3542	8439	10250	11264	
Electricity	1149	2629	2939	3200	3379	
Petroleum	671	1335	1125	989	1124	
Total	14442	14643	15816	16191	17817	
Market Shares						
Coal + OSF	78%	49%	21%	11%	12%	
Gas	9%	24%	53%	63%	63%	
Electricity	8%	18%	19%	20%	19%	
Petroleum	5%	9%	7%	6%	6%	
Growth Rates - annual compound averages						
		1970/60	1980/70	1990/80	1992/90	1992/60
Coal,coke,etc		-4.49%	-7.39%	-6.26%	8.67%	-5.20%
Gas		10.58%	9.07%	1.96%	4.83%	6.99%
Electricity		8.63%	1.12%	0.85%	2.76%	3.43%
Petroleum		7.12%	-1.70%	-1.28%	6.61%	1.63%
Total		0.14%	0.77%	0.23%	4.90%	0.66%

Future Trends

Our results support the view that the demand for coal is negatively related both to disposable income and to relative prices. The relationship has become more pronounced over time. Thus the long run elasticities of -2.02, identical for both income and price, suggest a high degree of sensitivity to changes in these factors. Oil on the other hand has much smaller price elasticities than coal (-0.49 in the error correction model rising to -0.9 in the long run) but the impact of income changes from slightly positive in the ecm (0.02) to small and negative in the long run model. Gas, because of its predominance in the domestic sector, exhibits a significant responsiveness to gas price movements relative to other retail prices as well as relative to other energy prices. Although the long run income elasticity looks reasonable at 1.15, it is difficult to attach any meaning to the small negative ecm elasticity. Electricity's own price elasticity is closes to that of gas while its income elasticity is higher in the ecm but lower in the long run.

Underlying all our forecasts are common assumptions about population growth, PDI change and average annual temperatures. For population we adopt the latest OPCS projections of 0.3% growth per year. Average annual temperatures are assumed to remain constant. PDI is expected to grow at rates well below those of the late 1980s, rising from around 0.1% in 1993 to 2% by 2000. All fuel prices in the base run (Scenario 1)incorporate the effects of VAT increases in 1994 and 1995. Even though fuel prices rise by faster than the rate of inflation over the period as a whole, in 1993 coal and gas decline in real terms. This leads to a coal demand of 1234 million therms by 2000, compared with 1212 million therms in 1992. Most of the growth in energy demand is in the form of gas - from 11263 million therms to 11538. For electricity on the other hand the effects are negative - its relatively higher prices bring electricity demand down from 3394 million therms in 1992 to 2994 million therms in 2000. Total energy demand in the domestic sector is projected to fall from 17441 to 17398 million therms in the period.

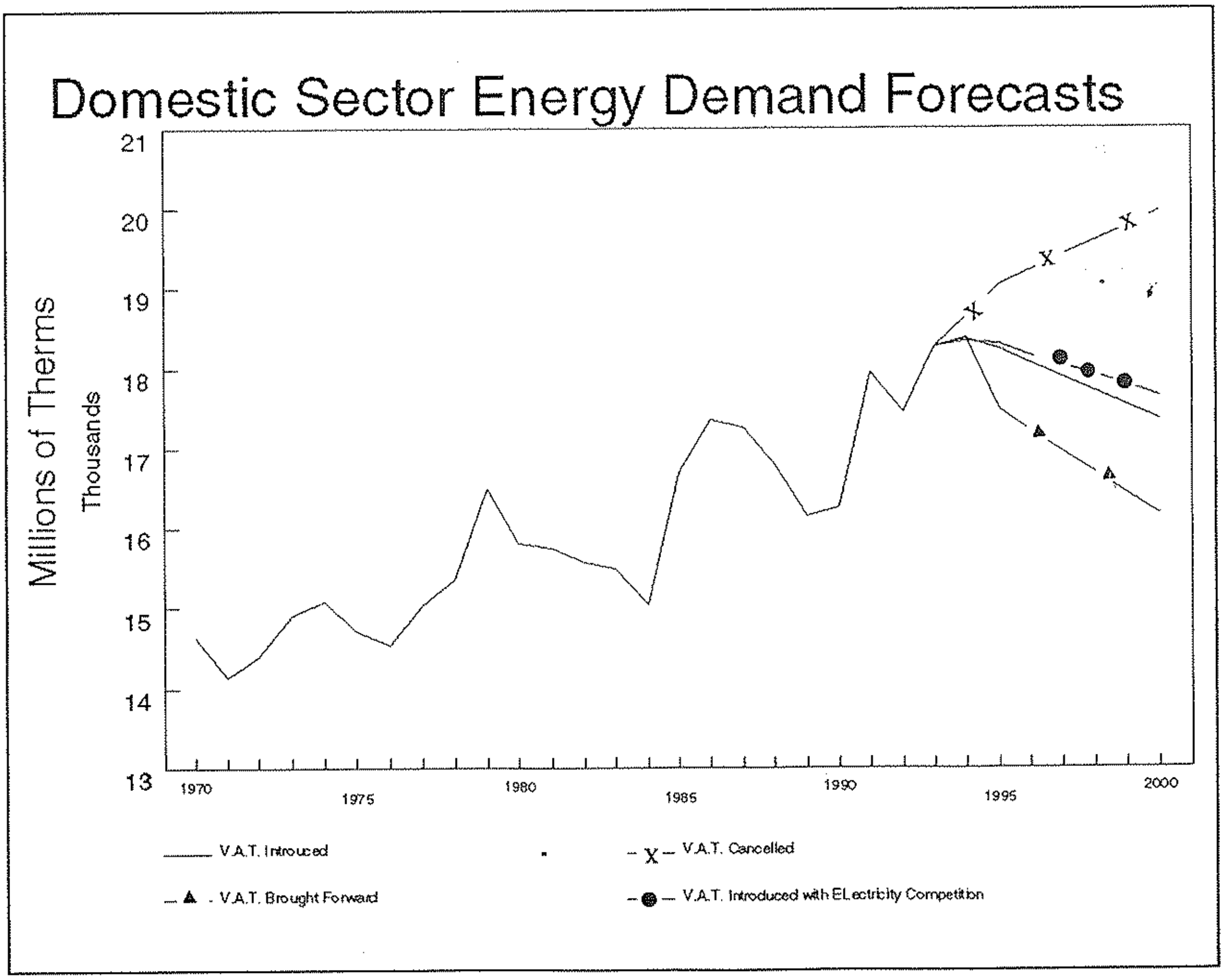
The model enables us to assess the impact of VAT on energy demand. In Table 4.2 we show the results of not imposing VAT on fuel prices (Scenario 2). The main beneficiary is gas whose demand is now expected to grow by 15% compared with 8% to 1995. For the other fuels the effect is minimal; only small changes being indicated for electricity, coal and oil. Overall, an extra 798 million therms (4% higher) would be required by 1995 in the absence of VAT charges, although by 2000 the difference is 2601 million therms (15%)

Our third scenario examines the effect of accelerating the imposition of VAT with the full rate of 17.5% being applied in 1994. Total energy demand falls by 775 million therms in 1995 compared with the phased VAT scenario (Scenario 1) and by 1574 compared with the No VAT scenario (Scenario 2). The main fuel to suffer is gas which loses 1145 million therms whilst the other fuels gain slightly. A clear implication of the model is the worsening competitive position of gas in the domestic market following the imposition of VAT.

In our final scenario we consider energy demand in a more competitive environment. We illustrate the effects of increased competitiveness within the electricity industry, all other industries remaining unchanged. Specifically we assume that the price of electricity declines by 2% per year relative to the price of other fuels. Interestingly the effects are quite modest - only an extra 66 million therms of electricity is demanded in 1995 increasing to 313 million therms in 2000 (10.5% over the base case). Most of this consists of new energy demand (305 million therms) and the remainder is bid away from coal and oil.

Note on Other Fuels

Coke and breeze and other solid fuels make up around 5% of total domestic sector energy demand. Demand for coke and breeze has declined quite rapidly in recent years; their combined sales shrank by 52% between 1982 and 1992. In the case of solid fuels the decline has been less rapid (22.4% over the same period). Since it has not yet been possible to include other fuels in the current modelling exercise we simply introduce the assumption that these trends will continue up to 2000. The demand for solar and geothermal heat, whilst currently very small, is expected to double in the forecast period.



UK ENERGY MARKET - IRON AND STEEL SECTOR

David Hawdon

Recent Developments

Although substantially reduced as a consumer of energy, the iron and steel sector remains the largest industrial energy user, slightly ahead of the chemicals industry. The industry has been characterised by a number of significant developments some of which are likely to remain important in forecasting demand.

1. The energy intensity of iron and steel production has fallen consistently so that unit energy requirements in the early 1990s are only around 50% of 1960 levels. Most of this reduction, however, was achieved in the 1970s and early 1980s and more recently there has been a reversal of this trend. Given the changes in energy prices which have occurred, we would have expected this type of movement.

2. As in other industrial sectors, coal consumption has declined to almost negligible levels. However, consumption of coke, although falling during the seventies and early eighties, has recovered its market share so that in 1992 it held almost the same share as in 1960. (45.2% compared with 46.2%). Thus a distinction has to be made between solid fuels: coal and coke are essentially in different markets - coal for heating and coke for process use.

3. Inter fuel substitution occurs largely with the introduction of new technology. Thus the adoption of electric arc processes in the seventies led to the rapid expansion of electricity consumption. This process was overtaken by the spread of natural gas techniques so that gas consumption overtook that of electricity in the 1980s. However, the use of electricity could easily be increased by the adoption of 'mini-mill' technology, increasingly popular in the USA and Japan. These are very much smaller than existing blast furnaces and rolling mills, use cheap scrap metal rather than iron ore and coke, and have much higher labour productivity. Their chances of widespread adoption within the UK are likely to be hampered in the short run by uncertainty over the future of steel making, although in the longer run could be quite sensitive to movements in the price of electricity.

4. Iron and steel output in the UK is likely to fall as the world steel market adjusts to overcapacity in steel making. A large proportion of excess capacity is in Europe, especially in national steel companies in Italy, Spain and Germany where heavy subsidies hinder any adjustment to changed market conditions. EC proposals that each country should share in capacity reductions are taken into account in our forecasts.

Future Trends

Analysis of energy demand in the iron and steel industry has proved troublesome for two main reasons. In the first place a substantial amount of energy is used as coke or electricity directly in the steel making process. This part is unlikely to respond to relative price movements in the same way as fuel used for energy purposes. Secondly there are problems in the interpretation of recorded energy consumption and in particular disagreement between the DTI and the Iron and Steel Statistical Bureau regarding the true level of natural gas consumed within the industry. We are unable to reconcile demand data for 1992 and 1993 from the two sources. Since our own projections are based on definitions adopted by the DTI, users should bear the above remarks in mind when interpreting our results.

Our short run results suggest that of all the fuels, coal, oil and electricity demand are the most responsive to output changes in the industry. Gas, due probably to the statistical problems previously mentioned, has a measured short run output elasticity of 0.22 suggesting relatively slow responsiveness. Demand for coal, gas and electricity are relatively inelastic with respect to own price changes in the short run, becoming increasingly elastic with time. Iron and steel output is projected to grow at around 4% in 1993 and at lower rates of between 2.4 and 1.1% per annum up to 2000.

On the basis of these estimates and output growth assumptions we forecast a significant shrinking of the demand for gas. To some extent this represents a correction from the overrecording of gas demand which we believe has occurred in the DTI data for 1992 and 1993. It also reflects the effects of substantial growth in real energy prices expected during the period. Conversely the demand for oil is expected to rise at around 5% per year to year 2000 reflecting gains due to previous periods of lower prices. Little change is expected in electricity demand and coal's historical downward trend will continue although at a less rapid rate than in the past.

In our competitive scenario, electricity prices are set to rise at around 2% less than under the business as usual scenario. The main effect of this is to raise the rate of growth of electricity consumption by 0.3% in

1994 and 1% and in 2000 or by between 1 and 17 million therms per year.

Note on Other Fuels

Consumption of coke oven gas per unit of output declined significantly during the sixties and seventies, stabilised in the eighties, and then resumed its decline in the early 1990s. We believe that this downward trend is likely to continue throughout the forecast period as a result both of the introduction of new technology and of continuing rationalisation within the industry. Since it has not yet been possible to include other fuels in the current modelling exercise we simply introduce the above as an assumption in order to complete the estimation of final demand.

ENERGY MARKET - IRON AND STEEL SECTOR (Million therms per year)						
	1960	1970	1980	1990	1992	
Coal	1016	210	44	3	2	
CokeBF	3298	2752	988	1421	1293	
CokeOP	638	733	223	283	272	
COG	515	439	186	270	237	
Gas	145	244	451	461	484	
Electricity	217	373	316	310	290	
Petroleum	1000	2328	653	294	281	
C/P	263	114	6	0	0	
Total	7092	7193	2867	3042	2859	
Market Shares						
Coal	14.3%	2.9%	1.5%	0.1%	0.1%	
CokeBF	46.5%	38.3%	34.5%	46.7%	45.2%	
CokeOP	9.0%	10.2%	7.8%	9.3%	9.5%	
COG	7.3%	6.1%	6.5%	8.9%	8.3%	
Gas	2.0%	3.4%	15.7%	15.2%	16.9%	
Electricity	3.1%	5.2%	11.0%	10.2%	10.1%	
Petroleum	14.1%	32.4%	22.8%	9.7%	9.8%	
C/P	3.7%	1.6%	0.2%	0.0%	0.0%	
Growth rates - annual averages						
		1970/60	1980/70	1990/80	1992/90	1992/60
Coal		-4.97%	-8.55%	-3.34%	6.31%	-17.69%
CokeBF		-8.80%	-11.38%	-5.51%	19.32%	-2.88%
CokeOP		-5.59%	-7.79%	8.84%	0.00%	-2.63%
COG		-4.38%	11.61%	-12.10%	-2.67%	-2.40%
Gas		5.04%	16.95%	-1.22%	-7.26%	5.84%
Electricity		4.99%	1.28%	2.65%	0.45%	0.91%
Petroleum		11.10%	-3.80%	-6.98%	1.43%	-3.89%
C/P		-11.48%	-14.65%	-	-	-
Total		2.07%	-0.73%	-2.56%	-1.50%	-2.80%

UK ENERGY MARKET - OTHER INDUSTRIES SECTOR

David Hawdon

Recent Developments

Industrial uses of energy include a very heterogeneous collection of processes specific to each industry's own principal and secondary activities, together with the more general processes of steam raising for power and relatively low temperature heating purposes. It would clearly be advantageous to separate out these uses and specify appropriate individual models for each process. Unfortunately, official statistics of energy use do not provide this detail. Instead data on fuel consumption is available only on a relatively small range of industrial categories. This data is complicated by the fact that in recent years the basis of industrial classification has been altered to conform with revisions in the definitions of industries for collection of production data. It is therefore very difficult to obtain any clear impression of the changing industrial composition of energy demands let alone of the specific uses to which energy is applied.

In order to make progress we have decided to regard the 'Other Industry' category, which excludes iron and steel, as a single category for estimation and forecasting purposes. This may be justified on grounds that there are many common factors affecting the industrial sectors of the UK economy - macro economic prospects for the economy as a whole, trade prospects and exchange rate conditions, inflation and wage costs, investment opportunities and costs and the general state of confidence - which would support a broadly similar treatment. Nevertheless it is important to bear in mind the following factors in assessing the prospects for energy demand in this sector.

1. The importance of four sectors to industrial energy demand. Chemicals, engineering, food and minerals account for around 63% of total Other Industry demand in 1992, with chemicals the leading sector (24%). Of these, chemicals and food have a larger share now than in 1960 whilst engineering has declined (from 21% to 16%) and minerals has recovered to its 1960 share (around 10%). These four sectors account for almost the same proportion overall as in 1960, but have tended to increase their shares of the total during years of economic expansion.

2. Relative decline has occurred in three sectors - textiles, paper and building materials - from 27% in 1960 to 15% in 1992. In these sectors, large efficiency gains have been coupled with relative economic decline to produce substantial reductions in absolute energy demand levels. It is unlikely that these trends will be reversed in the short term.

3. The sector exhibiting the greatest increases both absolute and percentage is, unfortunately, the Other or Unclassified sector. Whereas in 1960 it accounted for only 12% by 1992 its share had increased to 23% making it second only to chemicals in importance. It is clearly important that more information is collected on this category so that better analysis of demand can be made.

4. The demand for energy by industry has declined steadily since the seventies. The rate of decline accelerated in the eighties but has moderated in the early nineties. In contrast to the earlier years, the use of gas, both natural and coke oven gas by industry declined between 1990 and 1992, while demand for coal and especially coke witnessed some recovery in these years. Only the demand for electricity has exhibited positive growth throughout the entire period. These conflicting trends present an exacting task for demand modelling.

Future Trends

The econometric analysis of energy demand by the Other Industry sector produced estimated short run price elasticities of -0.22 , -0.46, -0.18 and 0.06 for oil, gas, electricity and coal respectively. Long run elasticities were all substantially higher except for oil where the positive elasticity result was difficult to interpret. Combining these with projected growth of industrial output of 2.4% in 1994, 1.4% in 1995 and 1.1% pa up to 2000, the following forecasts are made of fuel demands.

Coal is expected to resume its downward path from 1993 at a rate of decline varying between -7 and -1% per year. The rise in demand experienced in 1992 is viewed as a temporary hike which will not be sustained. Oil's decline is even more marked in percentage terms with rates of around -18% from 1994 onwards. To some extent this can be explained in terms of higher expected oil prices. Much of the losses to coal and oil are however picked up by gas

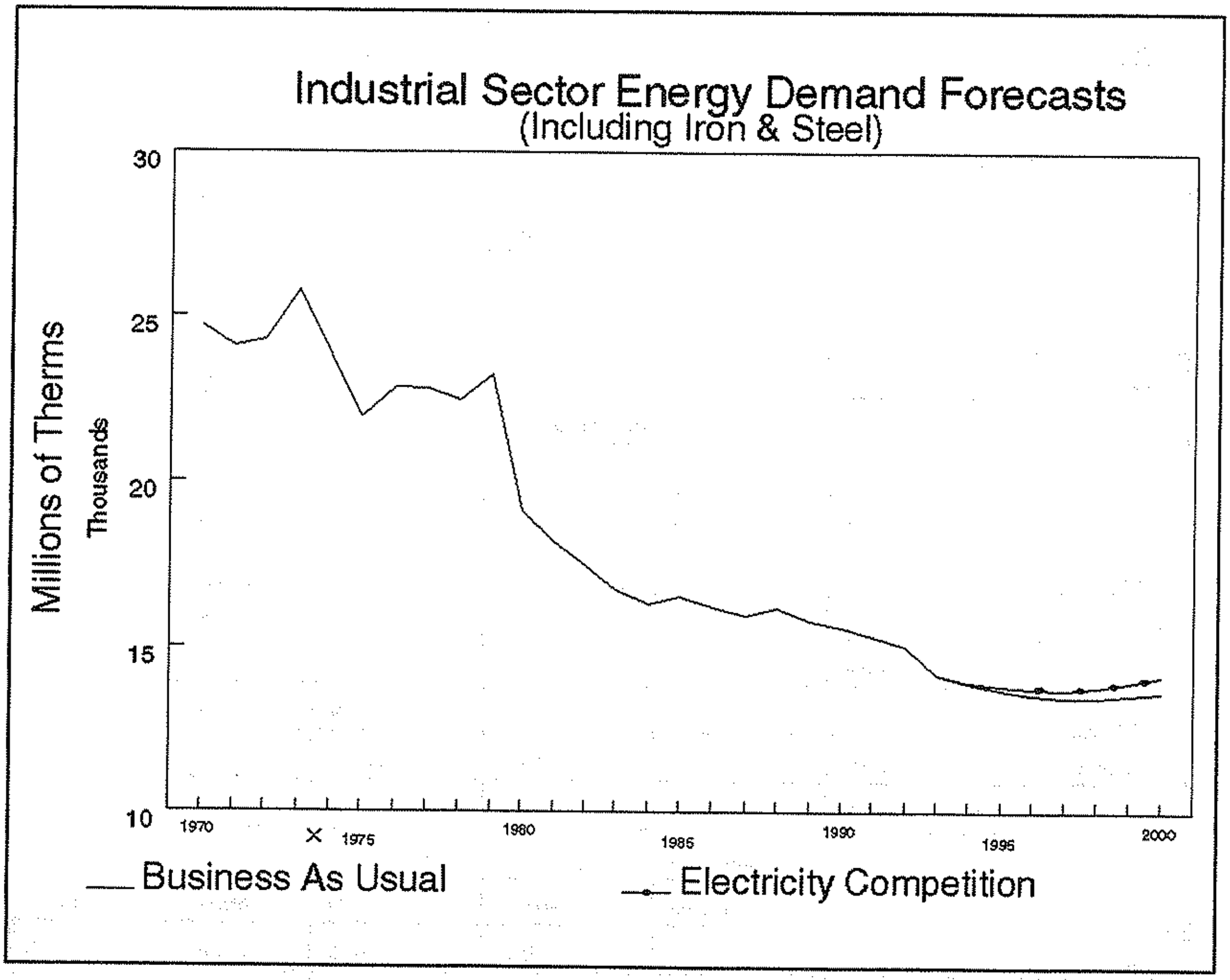
UK ENERGY MARKET - OTHER INDUSTRY SECTOR (Millions of therms per year)						
	1960	1970	1980	1990	1992	
Coal	8029	4824	1974	1406	1589	
Coke	874	348	104	59	84	
Other solid	48	27	12	28	28	
COG	36	23	69	19	18	
Gas	717	1172	5611	4962	4268	
Electricity	1302	2118	2405	3125	3153	
Petroleum	3121	8945	6071	2944	3029	
C/P	132	39	8	0	0	
Total	14259	17496	16254	12543	12169	
Market Share						
Coal	56.3%	27.6%	12.1%	11.2%	13.1%	
Coke	6.1%	2.0%	0.6%	0.5%	0.7%	
Other solid	0.3%	0.2%	0.1%	0.2%	0.2%	
COG	0.3%	0.1%	0.4%	0.2%	0.1%	
Gas	5.0%	6.7%	34.5%	39.6%	35.1%	
Electricity	9.1%	12.1%	14.8%	24.9%	25.9%	
Petroleum	21.9%	51.1%	37.4%	23.5%	24.9%	
C/P	0.9%	0.2%	0.0%	0.0%	0.0%	
Growth rates - average annual compound						
		1970/60	1980/70	1990/80	1990/90	1992/60
Coal		-4.97%	-8.55%	-3.34%	6.31%	-4.94%
Coke		-8.80%	-11.38%	-5.51%	19.32%	-7.06%
Other solid		-5.59%	-7.79%	8.84%	-	-1.67%
COG		-4.38%	11.61%	-12.10%	-2.67%	-2.14%
Gas		5.04%	16.95%	-1.22%	-7.26%	5.73%
Electricity		4.99%	1.28%	2.65%	0.45%2	2.80%
Petroleum		11.10%	-3.80%	-6.98%	1.43%	-0.09%
C/P		-11.48%	-14.65%	-	-	
Total		2.07%	-0.73%	-2.56%	-1.50%	-0.49%

which enjoys growth of between 6 and 7% per year. Electricity whose price is projected to rise at the highest rate over the period experiences demand growth of only around 2% per year in the business as usual scenario.

The effects of increased competition in the electricity sector are slight in this sector. Growth in electricity demand is only around 0.2% higher each year than under business as usual assumptions. The overall effect is to raise electricity demand by between 3 and 15 million therms per year only.

Note on Other Fuels

Other fuels account for less than 1% of total energy demand in this sector. Demand for two of the fuels in this category - coke oven gas and other solid fuels - has remained remarkably stable during the last three years. Substantial gains, however, were made by coke and breeze, the largest of the other fuels, in 1992 following many years of decline. This is attributable largely to increased activity in the non ferrous metals and in the chemicals sectors. We believe that the upsurge in demand is temporary. Since it has not yet been possible to include other fuels in the current modelling exercise we simply introduce the assumption that demand for all fuels in this category will remain relatively constant through the forecast period.



UK ENERGY MARKET - TRANSPORT SECTOR

Roger Fouquet

Recent Developments

Since the 1960s, the transport sector has become an increasingly important factor in the UK's energy demand, and its role will continue to grow. At present, it consumes approximately a third of UK's final user demand.

The transport sector depends on oil for 99 percent of its energy services. Such dependency results from the sector's inability to diversify its energy sources. After two oil shocks, most sectors managed to find alternatives to oil for generating power, heat and light. The transport markets felt no other fuel satisfactorily generated motion. Today, the sector consumes two-thirds of UK's oil demand.

In the 1960s, railway coal still provided a third of the sector's energy requirement. But in that decade, railway, the main coal users, lost a large share of the market to the road networks and switched its rolling stock to more efficient diesel engines. Rapidly - by 1970 - coal was virtually excluded from the market.

Through the 1970s, market shares for various types of oil solidified. The shares today remain mostly unchanged: road oil (leaded and unleaded gasoline and derv) drives 80 percent of the market, and aviation spirit 15 percent. The remainder of demand is split between diesel used in inland waterways and diesel and electricity running train engines.

Road and air travel, consuming 95 percent of the total, determine the transport sector's energy demand growth rates. Because both markets - as well as demand for oil in railways - boomed over the last thirty years, the sector's demand has grown at an annual rate of 2.5 percent. Even during the 1970s, the rate hardly faltered. In the 1990s, however, demand growths have been standing well below average. Economic recession can be blamed for the sector's low energy demand growth rates, which will no doubt reach new heights along with production, distribution and consumption.

Modelling of Transport Demand

Demand for fuel in the transport sector depends primarily on activity variables. Price and income variations tend to influence fuel demand indirectly by affecting activity variables. The discussions relating to modelling and future trends reflect this view.

Since fuel consumption from road travel - mainly cars, lorries and buses - depends on car ownership, car and freight use and consumption per kilometre, discussion of future energy demand revolves around their trends. These trends depend on factors such as individual wealth, car and petrol prices, car technology, and road infrastructure. Thus, we use a two step approach to forecasting road oil demand. An error correction model is set up, first, to estimate vehicles owned, and passenger and freight kilometres from income, GDP, and real price of motor spirit (which only has a short-run effect); energy efficiency has not been included due to lack of statistics though we include a direct short-run price effect to try and proxy efficiency improvements. Then, these forecasts are used to estimate total road oil demand.

Jet fuel demand is based on a similar two-step approach: the number of passengers and cargo travelling depend on personal disposable income and GDP, though more discretion is used in estimation. An error correction model produces estimates of the activity variables' elasticities, for the short and long run. In the short run, cargo is excluded - because of its lack of explanatory power - and personal disposable income is introduced directly. Based on the elasticity estimates and forecasts of activity variables, we calculate demand for air turbine fuel.

Rail travel energy demand can be split into main groups: electricity used for infrastructure and electricity and petroleum pulling trains. The energy demand for infrastructure depends on facilities used in the organisation of and responsibility relating to railway service, such as computers and station maintenance. As these are fixed costs and not based on activity variables, forecasts are made from assumptions about future changes in expenditure. For energy used directly to run trains, an error correction model estimates demand. Both electricity and petroleum depend on activity variables, passenger and freight kilometres, and a substitution variable, electrified route - as the network expands electricity demand will grow, while diesel demand will be negatively affected.

UK ENERGY MARKET - TRANSPORT SECTOR (Million therms per year)						
	1960	1970	1980	1990	1992	
Coal + OSF	2869	90	18	0	0	
Road Oil	4518	8498	11042	15409	15545	
Air Oil	798	1536	2081	2911	2952	
Rail Oil	105	498	365	265	283	
Water Oil	445	470	499	541	542	
Rail Elec.	77	94*	104*	124+56	125+58	
Total	8812	11186	14109	19306	19505	
Market Shares						
Coal + OSF	32.6%	0.8%	0.1%	0%	0%	
Road Oil	51.3%	76%	78.3%	79.8%	79.7%	
Air Oil	9.0%	13.7%	14.7%	15.1%	15.1%	
Rail Oil	1.2%	4.5%	2.6%	1.4%	1.5%	
Water Oil	5.0%	4.2%	3.5%	2.8%	2.8%	
Rail Elec.	0.9%	0.8%	0.9%	0.9%	0.9%	
Growth Rates - annual compound averages						
		1970/60	1980/70	1990/80	1992/90	1992/60
Coal + OSF		-41.4%	-17.5%	-	-	-
Road Oil		6.5%	2.6%	3.4%	0.4%	3.93%
Air Oil		6.8%	3.1%	3.4%	0.7%	4.17%
Rail Oil		16.8%	3.2%	3.2%	3.3%	2.69%
Water Oil		0.5%	0.6%	0.8%	0.1%	0.62%
Rail Elec.		2.0%	1.0%	5.6%	0.4%	1.53%
Total		2.4%	2.3%	3.2%	0.5%	2.51%

Inland waterway energy consumption should depend on the level of economic activity, measured by GDP. The econometric estimates, however, do not support this argument. Demand will be forecast using anticipated changes in the use of waterways.

There is a certain amount of substitution between transport markets (i.e. between cars and trains, and trains and planes), but is not explicitly incorporated into the equations to avoid overly complex modelling. The activity variables - car use, for example, in the case of road demand - will pick up any substitution between markets, and feed it into the level of fuel consumption.

Explanatory Variables and Future Trends

Road Oil Demand

Car ownership in the UK, one of the main determinants of road fuel demand, grew considerably in the 1950s and 1960s, slowed down after the two oil shocks, and took off again in the mid-1980s. The recent recession limited car ownership growth in 1992 to only 1.4 percent. Sales for the first half of 1993 suggest an important revival of the UK car industry. As consumers anticipate increases in real wages, low car prices, smaller risks of being made redundant and stable interest rates, they start buying durable goods such as cars again. For company cars, however, a change in the method of taxation next year - paying relative to their price rather than their engine size - should cut sales significantly in 1994 and 1995. Thus, the expansion of the car market expected as the recovery rekindles economic activity and confidence may, in part, be offset by the slow sales in company cars. Car ownership should rise by 5.9 percent this year, by 4.8 percent next year, by 4 percent in 1995, and average about 3.7 percent per annum up to the end of the decade.

The growth in individual car use tends to be much slower than ownership. Individual car use (total car use divided by car ownership) is only ... percent higher in 1992 than in 1960. Naturally, personal car use has a relatively low saturation point as a driver cannot spend all day in his/her car. None the less, life styles have changed considerably over the years and cars have become increasingly important, whether for travelling to work, going shopping or visiting relatives and friends. The expansion of suburbia results in greater distances being travelled to work or shopping centres and means that in less densely populated areas public transport becomes less viable - thus, the need to use the car. It has also been helped by the spillover effects from a declining rail service - higher fares, fewer lines.

In 1992, personal car use declined, mainly due to the recession. In the next couple of years, it should rise slightly as economic activity does. After that, several forces should start to limit its rise. First, the government has shown its commitment to raising petrol prices, for revenue and environmental reasons. Though driver price elasticity is low, a five percent annual rise in petrol prices should gradually alter behaviour. Second, with the increase in car ownership anticipated, serious congestion on roads will be unavoidable, discouraging many from using cars in urban areas. Third, in an attempt to curb congestion, authorities are likely to impose road tolls or improve urban planning - which may involve an integrated transport network, allocation of car licenses for inner-city driving or banning cars from certain parts of towns. Four, better information services, such as computers in cars, should enable drivers to minimise distances travelled. In the medium and long term, these factors should slow and maybe stop the rising trend in car use resulting from an increasingly mobile society. We anticipate small but positive growth rates in car use as long as economic activity prospers; beyond that, congestion, tolls, fuel prices, and other market forces, will lead to (small) negative growth rates in personal and company car use.

In other words, total car use (road passenger kilometres) will rise by 7.4 percent this year, 5.5 percent next year, and 4.4 percent in 1995, due to car ownership and individual car use growth. By 1996, slowing car sales and declining personal use will lead to lower total car use - averaging 1.8 percent up to 2000; fuel demand growth may fall somewhat as a result.

Ever since oil became an issue in the 1970s, technological developments have enabled car manufacturers to sell increasingly energy efficient models. As running costs take a growing proportion of the costs of owning a car, improvements in fuel consumption become an important aspect of car design. Anticipated rising real petrol prices should continue to send signals to car manufacturers that drivers do not want high consumption vehicles (i.e. guzzlers). New cars will benefit from highly efficient engines, designs reducing wind-resistance, and smaller and lighter models. There is also an expanding market for diesel engines, particularly for company cars, which are more efficient than petrol-run cars. On the other hand, increasing traffic congestion will lead to fuel wastage. Other factors that influence fuel consumed per kilometre are car maintenance, driving behaviour, and speed levels. Overall, energy efficiency should rise through the decade as price effects and environmental concerns mount.

Several factors should continue to drive freight energy demand. Freight depends primarily on economic activity. As producers require more inputs and consumers buy more products, lorries and vans distribute a larger volume of goods around the country. The volume can be amplified by a greater need for foreign products or the decline in use of other methods of distribution. For the first half of 1993, van sales have been low, displaying firms' cautious attitude towards the recovery but, in the next few years, as GDP expands, European borders open-up, and rail infrastructure dwindles further (with the exception of the channel tunnel), road freight distributors can expect a growing demand. For the next three years, the average annual rate of freight kilometres will be around five percent. After that, downward pressures will slow growth rates to an average of 4.5 percent per year until 2000.

Road oil demand should continue to grow, particularly in the next couple of years. Through 1995, we can expect growth rates of 3.5 percent - rising to 18942 million therms. After that oil demand will slow to about 2.1 percent per year until the end of the decade, reaching a level of 18942 million therms per year, by far the single greatest use of energy in the UK.

There appears, however, to be a rapid shift out of leaded petrol. In 1988, leaded petrol provided two-thirds of the road oil market; the rest being provided by derv fuel. In 1992, leaded, unleaded and derv shared the road oil market equally. By 1995, we expect half of the road oil demand will be for unleaded, as fuel taxation continues to disfavour leaded petrol. Tax and efficiency factors have also encouraged some car owners to buy derv fuel engines; now, about 10 percent of the car market. This trend will also continue.

Air Fuel Demand

Demand for aircraft fuel follows very closely the number of passengers and volume of freight transported. Over the past 40 years, air travel has risen mainly because of lower travel costs and economic prosperity. The development of jet engines - increasing efficiency and propulsive power - and the introduction of bigger aircraft - carrying more passengers - have improved energy efficiency and reduced flying costs; leading to cheaper fares and increased demand. Demand has also risen as a result of growth in economic activity and personal wealth; for example, the use of airplanes for holiday-destinations has led to the boom in chartered flights, which represents over half of UK's international flights.

The early successes enabled airlines to invest in new, higher performance carriers, cutting costs and fares further. In the past, even through recessions and rising oil prices, air travel demand kept growing. In 1991, the combination of a severe recession and terrorist threats during the Gulf War drove customers away. Demand sharply dropped and wiped out most airline companies' already small profits. Airlines, unable to meet the costs of new aircraft ordered in more prosperous times, have kept using older less efficient models.

Moreover, the wave of deregulation imposed by the single European market has forced many previously protected airline companies to compete with one another. Since 1 January 1993, air fares in Europe are no longer set through a bilateral agreement between nationalised companies but are open to the discretion of airlines flying each route. Fares on routes with more than two carriers have dropped significantly and demand, this year, should follow on from 1992's rise.

Economic recovery and greater spending power should help further revitalise an unstable airline industry. Air travel demand will grow with personal disposable income and gross domestic product in the 1990s. The rate of growth will also depend on the airline companies' ability to shift to a mass market, the effects of deregulation and competition on air fares, and the substitution effects from other means of travel and telecommunications.

In the past, companies imposed significant price discrimination on fares for the same journey, depending on whether the traveller was first-, business-, or economy-class. The expensive seats subsidised other consumers. But as holiday-travellers (with high price-elasticities) take an increasingly large share of the demand and companies depend on them more and more for their revenue, airlines will have to provide cheaper and faster services to a wider market. Airlines will need to seek ways to cut costs to meet the new demand.

So long as bankruptcy, mergers and landing slot monopolies do not leave a small number of powerful airlines to split the routes, deregulation and privatisation of airline companies will also push down costs. In 1997, competition should be even fiercer than today as flight routes will be open to all European airlines; the industry should eventually run more efficient services - lowering costs and increasing demand.

Demand for air travel will also depend on competition from other sources. The greatest threat to airlines on European destinations will be high-speed rail links, such as between London and the continent. The duration of such train journeys, delivering passengers in the centre of cities, will rival airplanes' for short and medium distances. Once the Channel tunnel opens, around mid-1994, it will take some, particularly business, passengers and freight away from the airlines. The shift in demand will in part be thwarted by delays over the high-speed rail link's construction - now, not to be completed before next decade - but will still be significant to airlines. The increased use of fax-machines and tele-conferencing equipment may further limit business-class demand. Such factors will increase UK airline dependence on the lower-end of the market and their urgent need to cut costs.

An increasingly price-sensitive clientele and competition - between airlines and from other forms of transport and communication - should force airlines to make important cost cuts. Airlines will try to run more efficient services. Their ability to reduce the number of empty seats on each flight (the load factor), to improve traffic control systems, and to avoid buying new and expensive aircraft will limit costs and, thus, reduce fares to passengers and cargo. Cheaper prices and economic recovery should significantly push up demand in the coming years. Passenger demand is expected to grow at about 6.5 percent per year up to 2000. Freight volume will rise at an annual rate of four percent.

Fuel demand should follow the trend. The factors that might create a wedge between energy and passenger demand growth are airplane fuel efficiency and load-factors (i.e. an airplane's ratio of seats used to total available seats). Since the oil shocks, airline companies have been aware of aircraft' high dependency on oil. They have tried to limit it by improving plane engines and designs. This trend should continue as computers help pilots minimise fuel-use.

Load factors, however, have dropped by five percent in the last three years to 59 percent. Competition may initially lead to an even smaller average load factor as more flights use the same route. The number of places filled on each flight, though, will determine whether airlines survive or perish in the newly competitive market. With a market preferring low-price to high-quality services, airlines have the opportunity to place more passengers on each flight. Load factors may initially drop, raising fuel consumption per flight, but as the European air travel market stabilises they should return to above 60 percent. Overall, aircraft fuel (95 percent turbine fuel) consumption should grow, but at a slightly slower pace than air travel demand. Aircraft fuel demand will reach 2994 million tonnes this year, a rise of 1.5 percent. The growth rate will rise to 3.5 percent in 1995, and 4.5 percent per year beyond then. Demand should be about 3900 million therms by 2000.

Railway Fuel Demand

The current economic recession caused much of the recent stagnation in British Rail's business. Economic activity was and will remain the single most important determinant of future energy consumption. Its anticipated recovery will boost BR's services. Public spending, privatisation and the Channel tunnel, however, should also shake-up the existing rail services.

In recent years, a substantial decline in rail investment has led to increases in fares, reductions in the frequency of services, and an ageing rolling stock. Customer responses to changes have varied. Commuters tend to be inelastic to fare increases, and have, thus, not reacted. Leisure travellers consumption patterns are more flexible and dwindling use reflects the decline in rail investment. Freight appears similarly sensitive to recent changes, freight demand in the last few years has favoured road transport. Thus, while other modes of transport have soared, the number of rail passengers, in the last ten years, has remained approximately unchanged while the volume of freight carried has declined by nearly twenty percent in four years.

In the next three years, rail investment is expected to halve. As a result, fares should rise faster than inflation, and track and rolling stock are unlikely to improve. Because of the pattern of demand elasticities, the decline in public spending should reduce the number of leisure passengers and the volume of freight, with only a small effect on commuters.

By 1995, certain parts of the rail network will be privatised. The profitable pieces, Inter-City and part of the freight distribution service, should be sold off. Private initiative and investment should improve efficiency and reduce costs. The government intends, at first, though, to minimise competition in order to encourage private investment. As a result, the new rail companies will benefit from considerable market power. Efficiency improvements may or may not get passed on to customers in the form of lower fares. If they do, passenger demand should rise considerably as, for the profitable lines, it tends to be fare-elastic.

Uncertainty, however, remains over how many franchises will actually be bought. The remaining services will stay under BR (or its future equivalent) management. They will suffer from important cutbacks. The government wants to reduce its spending on rail - expected to be approximately halved in the next three years. Inevitably, fare increases and declines in service efficiency will result. But, because commuter demand is inelastic, the effects may be minimal. At present it remains ambiguous what effects privatisation will have on the overall number of passengers but it is likely to depend on the level of competition introduced on private lines and the amount of public subsidy on non-profitable services.

Freight demand, on the other hand, should rise, as long as sufficient investment in infrastructure and rolling stock occurs. Judging from the American experience, rail can be the cheapest method of distributing bulk goods from two fixed points. After a recent decline in rail freight deliveries within the UK, privatisation should allow private initiative to bring back business.

The Channel tunnel, and its high-speed link, should provide the railways with a large injection of demand. The tunnel and the opening-up of European borders should increase travel - both passenger and freight - to the continent. A rapid service will also enable rail to compete with short airplane flights. The substitution effect is likely to be considerable as trains can deliver travellers to the centres of cities; the effect will depend greatly on the outcome of competition between airline industries on air fares and improvements in air traffic control to reduce delays. Unfortunately, the high-speed rail link on the British side of the Channel looks unlikely to be ready before 2000, limiting the overall boost to rail companies.

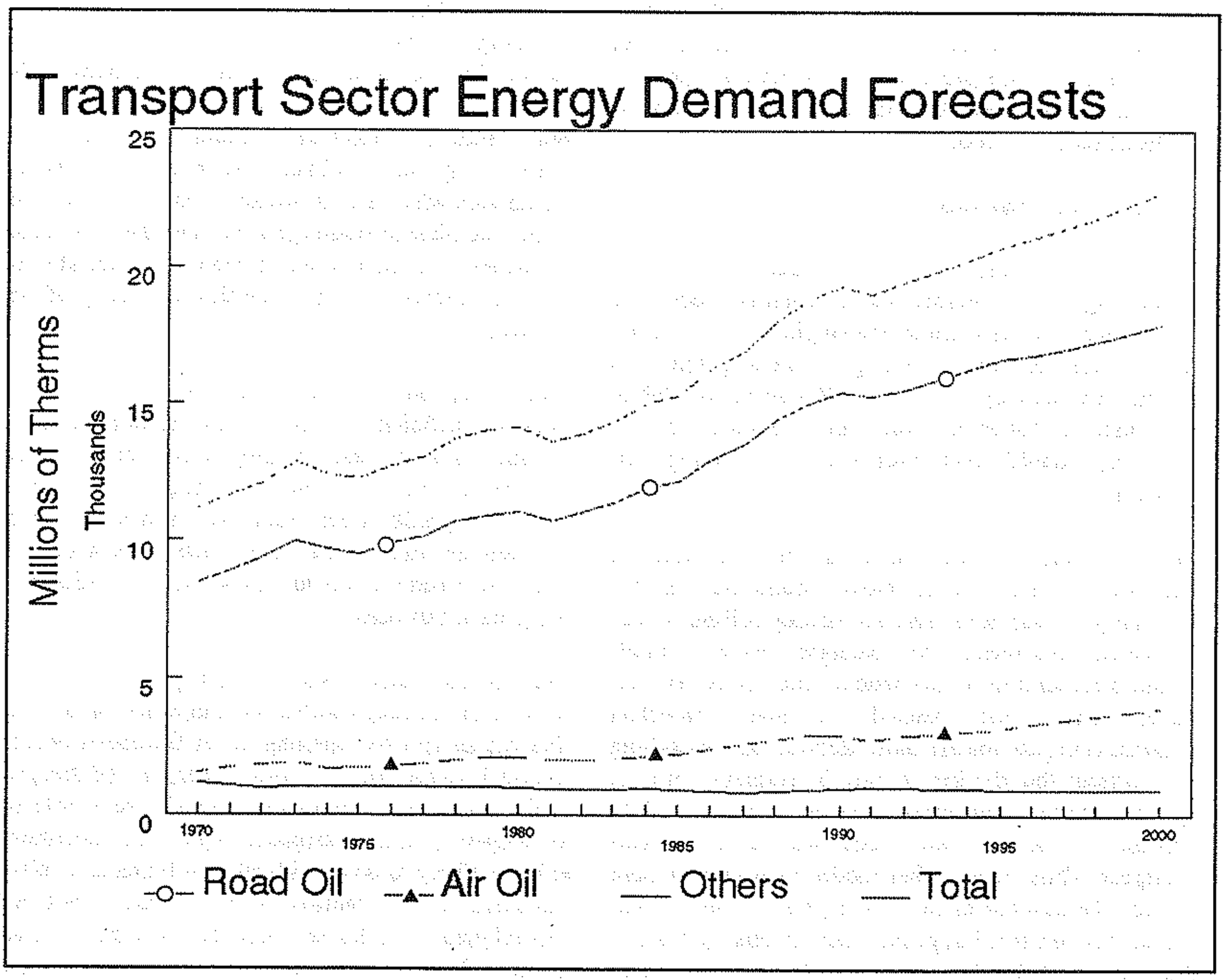
With investment drying up, continuing switch to electrified rail route appears likely to slow. Certain important lines in the privatisation scheme - such as Inter-City lines -, however, might receive special attention. Inter-City routes should be completely electrified by the end of the century. As such lines, particularly the Channel tunnel link, are expected to carry more passengers, electricity demand should continue to grow by just under one percent per year up to 1995; beyond that, rail electricity demand will rise by about 12 percent in five years. Diesel oil consumption carrying less successful routes will probably slightly decline. We expect demand will shrink by about a tenth this decade.

Inland Waterway Fuel Demand

Inland waterway use should vary with gross domestic product and personal disposable income. Some barges are used for carrying heavy goods and others for leisure activity. Though more and more bulk carrying has moved onto roads, we have allowed fuel demand to rise in line with gross domestic product. Thus, by 2000, we propose oil demand will be above 600 million therms.

Transport Premises

The energy demand from transport premises, such as airports and train stations, will probably grow slightly in the next few of years. Expanding computer use will increase electricity demand - especially for air traffic and railway network controls. The declining investment in rail services may lead to cut-backs on train station expenditure and conservation efforts.



UK ENERGY MARKET - PUBLIC ADMINISTRATION AND DEFENCE SECTOR

Peter Pearson

This is a market that experienced some decline over the decade of the 1980s, in terms of total energy use, having seen modest increases over the previous two decades. 1991 and 1992, however, saw increases at more than 5 per cent per year. Continuing long-term influences here are likely to be the anticipated declines in military personnel and associated activities and heating needs, and the switch over to gas for space hear in buildings.

Coal experienced the familiar spectacular decline from its pre-eminence of 1960 to its currently less than one tenth share of the market. Gas has seen a significant increase in share, to more than two fifths, with the major penetration occurring over the past twenty years. Electricity also increased its share, particularly over the past decade. Petroleum, which held a half share in 1970, now holds a little over one quarter of the market.

The high growth rate of electricity in the 1960s and of gas in the 1960s and 1970s, when the latter grew at annual averages of 12 and 17 per cent respectively, gave way to the much slower growth rates of the 1980s, at less than 3 per cent. Over 1990 and 1992, however, gas grew at more than 10 per cent while electricity grew at half that rate and petroleum only around one quarter. There seems little reason not to expect the share of gas to continue to rise. Future developments will depend, among other factors, on the pace of decline in defense activity (including employment of miliary personnel and housing provision), on whether there will be significant changes in civil service activity and on the extent of improvements in energy management in public buildings.

UK ENERGY MARKET - PUBLIC ADMINISTRATION (Million therms per year)						
	1960	1970	1980	1990	1992	
Coal + OSF	1455	1106	461	285	238	
Gas	67	201	948	1221	1491	
Electricity	192	405	538	659	736	
Petroleum	668	1742	1599	905	957	
Total	2382	3454	3546	3070	3422	
Market Shares (per cent)						
	1960	1970	1980	1990	1992	
Coal + OSF	61	32	13	9	7	
Gas	3	6	27	40	44	
Electricity	8	12	15	21	22	
Petroleum	28	50	45	29	28	
Growth Rates - Annual average compound						
		1970/60	1980/70	1990/80	1992/90	1992/60
Coal + OSF		-2.39%	-5.83%	-3.82%	-9.47%	-2.62%
Gas		11.61%	16.78%	2.56%	10.50%	10.29%
Electricity		7.75%	2.88%	2.05%	5.68%	4.34%
Petroleum		10.06%	-0.85%	-5.53%	2.83%	1.25%
Total		3.79%	0.26%	-1.43%	5.58%	1.25%

The forecasts are mainly derived from the model estimates, although for gas in particular we have departed significantly from the model, partly in the anticipation of structural change. Coal already insignificant, is expected to continue to decline further, as is petroleum but not as rapidly. Electricity grows little up to 1995 and shows a small decline thereafter. Gas, however, continues to grow relatively rapidly up to 1995 and then very slowly through to 2000. Overall consumption grows modestly up to 1995 and then shows a gradual decline, reflecting the influence of anticipated economising in this sector.

UK ENERGY MARKET - AGRICULTURAL SECTOR

Peter Pearson

For the past thirty years increasing farm size, intensified mechanism and processing, advances in agronomy, a variety of subsidies (including support via the Common Agricultural Policy) and a continuous decline in employment have been associated with a rising trend in agricultural output. However, although total energy consumption rose during the 1960s, a period of particularly rapid decline in employment, it fell significantly in the 1970s. By 1980 it was only 80 percent of its level of 750 million therms ten years earlier. In the 1980s, however, it fell much more slowly, with total energy use in 1992 almost the same as in 1990, at 538 million therms.

In terms of fuel shares, in the decade of the 1960 coal's already small share of one fifth of total energy use was more than halved and since then has never recovered. By contrast, gas entered the market in a small way in the 1980s and its has slowly risen. Electricity is the other fuel whose share has risen, doubling by 1980 to the roughly one quarter share that it holds today.

UK ENERGY MARKET - AGRICULTURE SECTOR (Million therms per year)						
	1960	1970	1980	1990	1992	
Coal + OSF	121	64	10	37	33	
Gas	0	0	0	34	40	
Electricity	72	123	136	132	131	
Petroleum	408	563	448	330	334	
Total	601	750	594	533	538	
Market Shares (per cent)						
	1960	1970	1980	1990	1992	
Coal + OSF	20%	9%	2%	7%	6%	
Gas	0%	0%	0%	6%	7%	
Electricity	12%	16%	23%	25%	24%	
Petroleum	68%	75%	75%	62%	62%	
Growth Rates - Annual average compound						
		1970	1980	1990	1992	1992/60
Coal + OSF		-6.17%	-16.94%	13.98%	-5.56%	-3.27%
Gas		-	-	-	8.47%	-
Electricity		5.50%	1.01%	-0.30%	-0.38%	1.94%
Petroleum		3.27%	-2.26%	-3.01%	0.60%	-0.59%
Total		2.24%	-2.30%	-1.08%	0.47%	-0.03%

Petroleum, on the other hand, has seen its 1980 three-quarter share decline to less that two-thirds at present, despite the significantly lower prices experienced from the mid-80s. The increasing shares for gas and electricity partially reflect the growing importance of activities like the drying and processing of grain and other food crops, and the animal husbandry carried out under cover with increasing mechanisation. The table of growth rates is consistent with the picture for the fairly static situation of overall energy use and the evolution of market shares.

Last year's 20 percent devaluation of the 'green pound' (used to convert prices set by the European Union into sterling) effectively raised cereal process and increased set-aside compensation payments for UK farmers.[1] This, allied to the wider effects of sterling devaluation, has led to substantial growth in average farm incomes (above 20 percent last year, and possibly more this year). However, the gains have not been evenly distributed, some of the principal gainers being large arable farms. The declining small family farm sector, not all of whose crops or livestock are covered by the CAP, has continued to struggle and faces pressures both to diversify into areas such as the provision of leisure and tourism services and to find other sources of employment.

Despite the encouragement resulting from devaluation, recent lower interest rates and this year's temporary 40 per cent tax allowance on farm equipment, commentators see these as essentially short-term gains, and envisage renewed pressures on farm incomes in the future. Last year's CAP reforms, intended to be neutral for the average-income European farmer by paying compensation for three years to counteract planned price reductions, will not necessarily offset the price falls in the case of the UK's larger-than-average, higher yielding arable farms. And once the effects of devaluation have worn off, payments for set-aside are thought unlikely fully to compensate for foregone earnings. A new GATT deal would give a further turn to the screw of competitive pressures. Moreover, following the three-year period of the present CAP reforms, it seems likely that there will be further cuts in support prices, Such pressures will squeeze out the inefficient and are likely to increase concentration in UK agriculture.

In the meantime, there is evidence that some farms are using their short-term income gains to help reduce debt levels significantly below their peak in August 1991. There is also the opportunity to invest in land or machinery. Nevertheless, a recent survey suggests that although investment in farm machinery has grown this year, this is against a pattern of long-term decline, with overall sales a third lower than in 1988. Moreover, while tractor sales rose significantly this year, following last year's record low, they are still around half of what they were 10 years earlier.

In the light of these influences, allied with the continued phasing-in of various set-aside programmes, it is not expected that total energy use in agriculture will show significant growth; indeed we expect a gradual decline from a plateau. Our forecasts, although informed by the model estimates, do not rely strongly upon them. We envisage a fairly static overall energy consumption through to 1995, with gas continuing to increase its overall level and share. Over the longer period, with growing competitive pressures leading to a continued increase in average farm size and the decline of smaller and less-efficient farms, total energy consumption seems likely to fall back to around its 1989 levels or less. We envisage continued but not spectacular growth in gas, with a consequent increase in its share, the possibility of some limited gains in 'other solid fuels', a fall in oil and a small decline in electricity consumption.

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1 See Hargreaves, D & A Maitland (1992), 'Furrowed brows to look at lean years', Financial Times, November 29, 16.

UK ENERGY MARKET - MISCELLANEOUS SECTOR

Peter Pearson

This sector has shown a fairly static picture of output over the past few years, accompanied by growth in total energy use of a little over 2 per cent per year during the 1980s and small declines at the beginning of the 1990s.

Coal use fell rapidly between 1960 and 1980 and is now insignificant. Its place has been taken by gas and electricity, each with current shares of more than 40 per cent, while petroleum's current share of about one tenth of the market is less than half of what it was in 1980 and a quarter of its 1970 level.

In terms of growth rates, gas grew particularly rapidly - at more than 7 per cent per year - in the decade of the 1970s. In the following decade gas continued to grow significantly faster than its nearest competitor, electricity, but at a slower rate of 4.5 per cent per year. Petroleum, on the other hand, declined by more than 5 per cent per year over the past decade. Neither coal not petroleum show signs of recovering their former pre-eminent positions. The major question, therefore, is whether gas and electricity will maintain their current relative positions and whether gas will increase its share and get close to a 50 per cent share of the whole market. Our forecasts do not rely closely on the model estimates, although these formed the basis for them. Total energy consumption rise slowly to 1995 and thereafter gradually increases up to 2000. By 1995 coal drops to a third of its 1992 level, oil is static, while electricity and particularly gas experience some gains. By 2000 gas has reached a 49 per cent share of total consumption, largely at the expense of coal and oil.

UK ENERGY MARKET - MISCELLANEOUS SECTOR (Million therms per year)						
	1960	1970	1980	1990	1992	
Coal + OSF	1535	562	122	152	80	
Gas	332	561	1133	1760	1894	
Electricity	363	825	1215	1761	1776	
Petroleum	568	1283	892	515	470	
Total	2798	3231	3362	4188	4220	
Market Shares (per cent)						
	1960	1970	1980	1990	1992	
Coal + OSF	55%	17%	4%	4%	2%	
Gas	12%	17%	34%	42%	45%	
Electricity	13%	26%	36%	42%	42%	
Petroleum	20%	40%	27%	12%	11%	
Growth Rates - Annual average compound						
		1970	1980	1990	1992	19992/60
Coal + OSF		-9.56%	-14.17%	2.22%	-27.45%	-8.28%
Gas		5.39%	7.28%	4.50%	3.74%	5.56%
Electricity		8.56%	3.95%	3.78%	0.42%	5.12%
Petroleum		8.49%	-3.57%	-5.34%	-4.47%	-0.41%
Total		1.45%	0.40%	2.22%	0.38%	1.27%

6. ELECTRICITY GENERATION ENERGY DEMAND

Colin Robinson

Fuel use in electricity supply will change fundamentally in the next few years as the major generators are released from most of the constraints on fuel use which existed under nationalisation (when, as Chapter 3 explains, governments protected indigenous fuels via controls of electricity supply fuel use) and in the first three years of privatisation. In this new market, the shares of different fuels are very uncertain. Moreover, uncertainty is compounded because of the number of important decisions pending in the energy field (see Chapter 3) and because the new market in electricity has some unusual features which may bias fuel choice decisions. An element of protection for coal in electricity supply still remains: the new coal contracts, from April 1993 onwards, are probably a little larger than the generators would freely have signed. Nevertheless, there may be some bias against coal in the privatised regime. It is not just that nuclear power is still protected whereas coal now has little state support. The generation duopoly and its effects on the rest of the industry may well tend to depress demand for coal. Although the duopoly will no doubt be undermined in the course of time, its adverse effects come at a crucial time for coal when output would in any case be falling because of the reduction in protection. Briefly, the source of the problems is as follows.

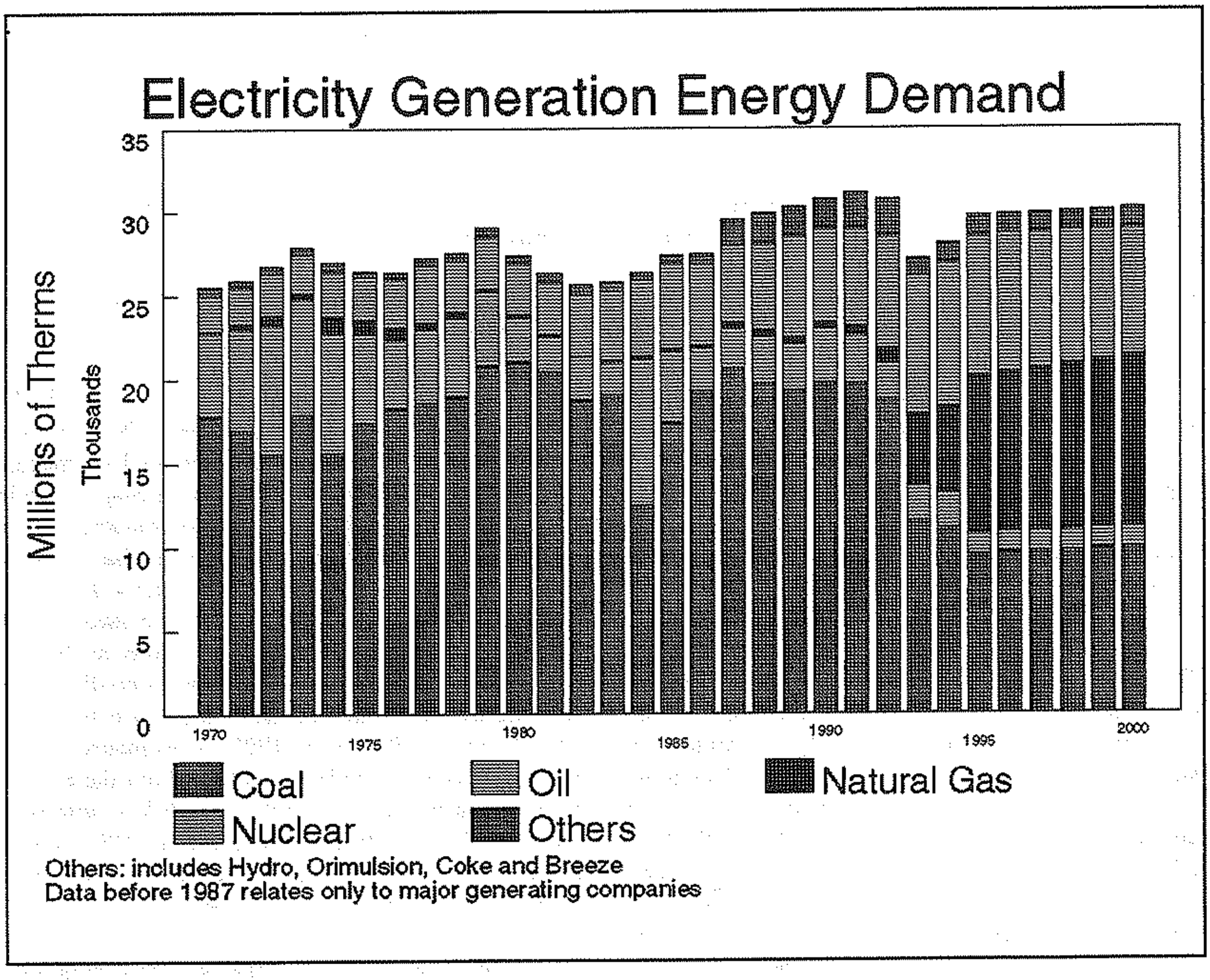
In a market with a number of rival generators, all with fossil fuel fired plant, in the absence of collusion each generator would invest in new plant only if it expected that the avoidable costs of the new plant (capital and operating) would be less than the avoidable costs (operating plus any incremental capital) of existing plant. Such expectations might be right or they might be wrong. But the competitive process would penalise those companies which made poor fuel choice decisions and reward those which made better decisions. It would therefore provide incentives to make better fuel choices than one's competitors.

However, in a market where all coal fired plant has been divided between two companies, each of which is a successor of the CEGB and each of which therefore is likely to have reasonable knowledge of the other's costs, the competitive process is unlikely to work so well. Fuel choices will probably not be the same as those which would have been made in a market with more rival producers. The duopolists have sufficient market power (given them by government) to indulge in strategic gaming so as to maintain their own positions at the expense of potential newcomers.

Exactly how that power will be exercised is necessarily somewhat uncertain. But some bias against existing coal-fired plant seems one likely result. The major generators may well, for example, have some incentive to announce plans to build new gas plant as a means of pre-empting entry to generation: they know that entry will only be with gas-fired stations which are perceived to be lower-cost than other new plant. Even if their own estimates suggest that it would have been cheaper to keep existing coal stations in operation, they may announce such plans as a means of entry deterrence: because of their market power, they are unlikely to be constrained from passing on to the RECs and large consumers the costs of the choices they make. Moreover, because the two major generators, between them, control the bulk of generating capacity in England and Wales, they can accelerate their plant closure programmes if capacity shows signs of becoming excessive.

Another bias in the system which arises from the duopoly which favours the construction of new gas stations is that the RECs have an incentive to avoid the market power of the generators. Thus they will tend to build more new plant themselves (or sign long term contracts with owners of new plant) than they would have done had the generators been competitive. Most of the RECs have little existing generation capacity and so the alternative of keeping open coal or oil-fired power stations does not arise.

Because of all the uncertainties, only the most general idea of future fuel use in electricity supply can given. The following broad trends seem possible. Consumption of coal (including imported coal and stock drawdown) may well halve by the mid-1990s compared with 1992 and then stabilise at about 25 mtoe (42 million tonnes of coal or 21,000 million therms). Use of natural gas will increase, most probably reaching about the same size as coal consumption by the mid-1990s and then remaining approximately constant. Generation of nuclear electricity is likely to increase slightly up to 1994, assuming Sizewell B is commissioned on time, but will then fall a little through the rest of the 1990s on the assumption that several Magnox plants will be decommissioned.


Electricity Generation Energy Demand
Millions of Therms
Thousands
35
30
25
20
15
10
5
0
1970
1975
1980
1985
1990
1995
2000
Coal
Oil
Natural Gas
Nuclear
Others
Others: includes Hydro, Orimulsion, Coke and Breeze
Data before 1987 relates only to major generating companies

7. PRIMARY ENERGY DEMAND AND ENVIRONMENTAL IMPLICATIONS

Roger Fouquet

Primary energy requirements represent the real resource burden of the final energy demands suggested by the SEECEM model. Although our work has focused on the demand side of the energy balance, supply side considerations are needed in the construction of primary energy requirements. We have avoided an explicit optimising approach to the selection of energy inputs because the UK energy sector is so far advanced down the road towards a regulated private market that the strategic behaviour of the large energy companies is now the key to future supply decisions. It is more fruitful rather to try and anticipate how they will react to the external conditions in which the market is likely to develop.

The key issues are the extent to which gas, coal oil and non fossil electricity sources including nuclear are employed by the electricity generators in supplying demands for electricity. Colin Robinson's discussion of the likely behaviour of the generators and the RECs in the new market situation is the basis of this calculation. We simply take the indicated input purchasing strategies, convert them into electricity outputs, test whether they match up with the forecast demand for electricity, and adjust backwards until supply is in line with demand. No market clearing mechanism is employed at this stage in the development of the model, although future work could well attempt to mimic the adjustments which occur in the real word electricity market.

Gas's displacement of Coal

The principal implications of the conversion procedure are that overall natural gas inputs are likely to rise ten-fold between 1990 and 1995 as the 'dash for gas' works itself out. Based on our forecasts of final user electricity demand, we estimate that natural gas used to generate that demand will be about 8,497 million therms by 1995. Total demand for natural gas will be 32,447 million therms, 23 percent higher than if gas use for power generation had stayed at the 1992 level. In sum, we anticipate primary demand for natural gas will grow at an annual rate of 15 percent between 1992 and 1995, and just one percent between 1995 and 2000.

Power generators' increased use of gas rather than coal and the privatisation of British Coal will accelerate the movement out of coal. Coal, which in 1992 generated nearly two thirds of the UK's electricity, may, by 1995, reduce its share to 32.3 percent. This should lead to a 42 percent decline in primary coal demand.

As coal's role in generating electricity declines, so does its role in the UK energy mix. Outside the electricity supply industry, coal use will remain limited - it should gradually decline from over 3,000 to about 2,000 million therms per year. Nine percent of coal enters coke ovens to be carbonized making coke, breeze and coke oven gas; six percent is used in other industries, four percent in the domestic sector, and two percent by the rest. Though their relative shares may rise as electricity generation's share - 79 percent in 1992 - drops, their absolute level should also fall. We anticipate that coke oven use, as the iron and steel industry declines, and the domestic sector demand will fall. The decline in primary demand for coal between 1992 and 1995 is estimated at 42 percent, falling to under 15,000 million therms (62 million tonnes) between 1995 and 2000 - with only minor variation between scenarios. By 1995, coal's share of total energy demand will drop from over a quarter to approximately 13 percent.

For British Coal (or its successors), the decline may be even sharper. For the three years following electricity privatisation, generators were required to buy indigenous coal (see chapter 6). The requirement has now been lifted and they have been able to seek contracts from the lowest bidders. Costs associated with deep-mines, providing three-quarters of UK coal, mean that British Coal competes with foreign suppliers, tending to use open-cast mines, at a comparative disadvantage. The increasing attraction of low-sulphur coal - not common in UK mines still open - will further reduce interest in British coal. The British mining industry will inevitably contract as demand falls though the extent will depend on effective bargaining between energy producers and power generators. For the mining industry, this bargaining power will be small as long as the main electricity generators remain so important and British Coal is privatised in five regional companies

The ensuing environmental effects of the switch are important. In 1990, coal emitted 40 percent of UK's carbon dioxide and 75 percent of UK's sulphur dioxide, mostly from power stations. The shift out of coal to gas should reduce both carbon dioxide and sulphur dioxide emissions from power stations by about 40 percent in the five years up to 1995.

Petroleum Fluctuations

We forecast that UK primary demand for petroleum should first fall to about 39,216 million therms (90 million tonnes) in 1995, down less than two percent from 1992 due to the decline in fuel oil use in electricity generation, and then up to 41,879 million therms (96 million tonnes) by 2000 as road oil demand recovers the difference. Flucutations in primary demand for petroleum will be virtually unaffected by the V.A.T. on domestic fuel and increased competition in energy supply industries. Rushing V.A.T. would push petroleum demand highest, but less than one percent above other scenarios. The fall and, then, rise in demand reflects the variation between petroleum products.

Motor spirit and aviation fuel will continue to take a rising share of the petroleum products' market - up from 40 (in 1992) to 50 percent (in 2000) of the total - at the expense of heavy fuel and gas oil. The most substantial increase will be the continued growth of unleaded motor spirit, replacing leaded petrol and, in terms of sales, surpassing it before 1995. Leaded petrol may become a small fraction of total oil used in the UK by 2000. Demand for aviation turbine fuel will be particularly buoyant in the second half of the decade, increasing by over twenty percent from 1995 to 2000. Diesel demand, though declining in industrial and most other sectors, should stay approximately constant due to the rising trend in the transport sector. Industrial sector's declining demand for petroleum means heavy fuel and gas oil demand will decline. But the main source of decline in petroleum products will be from heavy fuel oil used for generation as it is expected to fall by nearly forty percent of its 1992 level in 1995 to 1,619 million therms (about 3 million tonnes); the figure includes orimulsion imports, which after rising in 1993 should stay constant through the decade.

The decline in primary petroleum demand in 1995 should reduce carbon and sulphur dioxide emissions, particularly as the decline comes from more pollutant fuel and gas oil. Emissions, however, will start picking up again as the fuel and gas oil decline stabilises and growth in road and air products continues virtually unhindered. Transport sector emissions will be nine percent higher in 1995 than in 1992, and more than 25 percent higher by 2000. As other shares drop, overall carbon dioxide in the UK will drop but, with road and air traffic rising, the transport sector will be responsible for an expanding share - up from 17 to 22 percent of total emissions. While the effect of the car boom on carbon dioxide level is undermined by other changes in the energy markets, its emissions of nitrogen oxides is significant. Road transport, alone, emits over half of UK's nitrogen oxides and this share will continue to grow.

Nuclear Power

The almost uninterrupted growth in nuclear fuel to generate electricity since 1960 appears ready to stop. The government's nuclear review due out next year will determine the future of the fuel's use in the UK energy mix. A decision to build Sizewell C would ensure that nuclear power generates approximately one tenth of UK's primary energy demand in the medium term. The choice not to go ahead with plans - possible if the government and capital markets believe Nuclear Electric cannot compete commercially with other sources or electricity overcapacity suggests additional power would be unnecessary - means nuclear's share may dwindle as old Magnox reactors shut down. For the next couple of years, however, the level of nuclear power should remain approximately constant.

The fuels used in nuclear power should remain the same as before - a combination of uranium and mixed oxide fuels. Though past attempts to make plutonium-run power stations have been relatively unsuccessful, THORP's go-ahead, may create an additional incentive for nuclear power generators to use plutonium-enriched fuels.

Renewable Sources

Renewables provide approximately two percent of UK's electricity and one percent of its total primary energy demand, approximately 947 million therms. Most of this, 67 percent, originates from large-scale hydro generators. Just under a third of renewable energy utilisation comes from biofuels. Gasses from sewage sludge digestion and landfills, as well as waste combustion, generate most of the biofuel electricity, while wood and straw combustion provide most of the direct heat from Renewables. The last two percent comes from small-scale hydro, wind power and solar heating.

Through the 1980s, overall renewable energy remained - more or less - constant. Between 1988 and 1992 though, with the introduction of the Non Fossil Fuel Obligation, renewable-generated electricity (excluding large-scale hydro) grew by 83 percent, while renewable heating stayed level. Landfill gas use trebled and sewage gasses generated 30 percent more electricity. In the same period, wind power increased seven-fold.

Following the 1989 Electricity Act and the Non Fossil Fuel Obligation, the regional electricity companies are required to supply a set amount from renewable sources. The RECs, buying some of their electricity from renewable stations, cover the difference between the renewable and standard prices from a levy imposed on customers' electricity bills. The scheme has enabled the development of 116 renewable projects, and anticipates another 81 in the next couple of years. The growth in renewable electricity (excluding large-scale hydro) should continue at around 5 to 10 percent; an ambitious target for 2000 is that the NFFO in its first ten years ensures 1,500MW of new renewable capacity - equivalent to the present large-scale hydro capacity. The obligation, which acts as a protective blanket for the infant industry, is due to be removed in 1998. The development of renewable energy into the next century will depend principally on the NFFO's extension after 1998.

Though on the whole renewable energy supplies are a protected industry, several other factors in the energy markets may influence the development of renewable resources. First, as most of the levy on electricity for encouraging Non-fossil fuel sources is used by nuclear stations, a decision not to build Sizewell C may leave additional funds to help generators using renewables. Second, increased competition should, assuming demand grows accordingly and the RECs continue to have the NFFO imposed, favour the expansion of renewable electricity. Third, the overcapacity in the electricity sector means that only renewable power stations, such as landfill gas, waste-derived generation, and wind power, with low initial and unit costs provide an interest to the RECs. Four, because the UK appears likely to meet certain of its more publicised environmental requirements - carbon dioxide and sulphur dioxide -, the pressure to increase renewable energy use as a means of abatement will lessen. But, above all, the success or failure of renewable energy supply will depend on whether private investors feel alternatives to fossil fuels are commercially viable and have a future in the UK's energy mix.

Efficiency Improvements

Price rises highlight the benefits of conserving energy and improving the efficiency of appliances using energy. Since the early 1970s, partly from price pressures, technology has enabled appliances to become more efficient and users to be less wasteful. From 1970 to 1989, the energy ratio - primary energy demand relative to GDP - declined virtually every year. But in the last four years, UK's energy ratio started rising; that is, more energy was required to produce the same amount of goods. Thus, energy efficiency declined.

The inefficiencies are likely to have been caused in great part by falling real energy prices. If that is the case, with government introducing or raising taxes on energy, particularly in domestic and transport sector, we should expect the ratio to start declining again, and energy efficiency to improve.

There are several potential developments that could also influence the energy ratio. First, additional government support for energy conservation schemes, presently embodied by the Energy Efficiency Office, including subsidising suitable investment projects, further taxing of wasteful behaviour, and encouraging appliance manufacturers to promote efficient products, would send public the correct signals. At present, several schemes - targeting mainly low-income households - have been introduced; but, because of their limited scale and scope, overall energy efficiency will remain unaffected.

Second, the expansion of demand-side management programmes - such as audits, monitoring, the provision of computer-regulated appliances and dissemination of information on efficient equipment - by electricity companies would also help final users reduce energy demand. There appears, however, to be little enthusiasm from the supply side principally because of the present over capacity in the industry.

Third, the introduction of better combustion methods in electricity generation could significantly cut primary energy consumption. Combined cycle gas turbines that are now being installed transform fuel into energy at higher rates than coal power stations, which have efficiency rates of between 35 and 40 percent; a range of new advanced gas turbines have been claimed to reach efficiency levels of over 58 percent. With the increasing use of cheap installations and expensive fuels, the variable costs make-up a larger share of total costs; improving efficiency becomes the best way to cut average costs.

Four, the greater use of combined heat and power (CHP) should ensure fuel that is used provides more services - the Energy Efficiency Office aims to double 1990 CHP capacity by 2000.

All these factors could significantly reduce the level of energy required to produce a unit of production. We anticipate that between 1993 and 1995, the energy ratio will decline by an annual average of under one percent. It will then - between 1995 and 2000 - rise to just above one percent as GDP grows steadily. Such results display the poor rate of improvements in energy efficiency; scenario 2, where V.A.T. is abandonned, the improvements are even smaller.

As efficiency improvements fail to materlialise, there will consequences for the economy. Substantial improvements can put downward pressure on costs of production, limit the economy's vulnerability to supply shocks, reduce the depletion rates of exhaustible resources, and minimise environmental damage caused by energy use. As these imprvements do not appear additional burden is placed on the economy.

Environmental Consequences

The shifts in primary energy demand over the next few years will alter the level of noxious gas emissions. In particular, carbon dioxide and sulphur dioxide emissions will decline to 142 million tonnes and 2,103 thousand tonnes in 1995 (in scenario 1) - equivalent to reductions of 11 and 45 percent between 1990 and 1995. The electricity generators decision to 'dash for gas' has been the main cause for reductions in UK's of both emissions.

Other factors, such as the V.A.T. on domestic fuel, will mildly help carbon dioxide abatement. Scenario 2 shows that without the two-stage V.A.T. introduction carbon dioxide would be two percent higher in 2000; an all-at-once tax would push carbon down an additional percentage point.

The growth in car use, however, is likely to negate any domestic consumer improvements. If transport sector trends continue, cars and airplanes will be the main threats to meeting international requirements, promised at the Rio Summit in 1992, to keep carbon dioxide emissions in 2000 at 1990 level. We anticipate that the developments in the energy markets will ensure that UK meets its requirement. In 2000, between 148 and 152 million tonnes of carbon should be emitted from energy sources, about nine percent below the 1990 level.

The 1988 Brussels agreement to reduce sulphur dioxide emissions from large combustion plants by 40 percent and 60 percent of their 1980 level - 3,883 thousand tonnes - in 1998 and in 2003 are also likely to be met. Any new, tighter agreements, however, will require substantial government involvement. Our forecasts suggest the overall level of sulphur dioxide emissions will settle just above 2,000 thousand tonnes of sulphur, about 45 percent lower than in 1990.

The level of nitrogen oxide emissions, however, appears likely to rise. In the next few years, as road fuel use rises nitrogen oxide will become UK's fastest growing air pollutant.

8. CONCLUSION

Roger Fouquet

We have examined the future of energy markets, and modelled their impacts, in order to provide consumers, producers, analysts and policy-makers with forecasts of UK energy demand in the 1990s. Forecasting energy demand will help fuel and electricity suppliers estimate future capacity requirements and revenue. Demand estimates will also enable policy makers to assess the resource implications of energy policies and the revenue consequences of alternative taxation levels. Future energy consumption will have considerable impact on regional, national and international economies, as well as the environment.

We realise that SEECEM requires further development particularly in relation to the smaller demand sectors and in its use of elasticities based on long time period (1950 to 1992), but we intend to improve the models by examining the possibility of introducing additional explanatory variables and using quarterly data. For the present study, with the majority of price and activity variable elasticities being in line with other energy demand studies, we feel confident our forecasts of energy consumption will be a reasonable guide to the future.

We have identified and discussed the major features of energy demand through the decade - the likely jumps in natural gas consumption and the collapse of coal use in power generation as well as the steadily growing demand for oil in the transport sector and for natural gas in all final demand sectors. We observe from the results that final user demand appears to be taking a larger share of primary energy demand. In 1992, the ratio of final user demand to primary energy demand was 71 percent; by 2000, for the first scenario, we anticipate the ratio to rise to 73 percent. The rising share can be attributed to the growth in final user demand, mainly in the transport and miscellaneous sectors, and electricity generators' shift to more efficient technology, in part due to the continual stimulus to cost-cutting activities from privatisation and competition.

The economic significance of meeting a steadily growing final demand with a flow of inputs rising less than proportionately to output is clear in terms of resource costs and risks, as well as for the environment. Resource costs are lower for any given level of output. The economy's vulnerability to supply shocks is also reduced and, since a proportion of energy demand is met by imports, so is its trade deficit. Furthermore, the results also suggest that the economy can provide more services with less additional damage to the environment.

The efficiency improvements observed in the power generating process are the result of a once-and-for-all shift towards CCGT plants and an improved performance of nuclear stations. For those plants, further improvements will be minimal. While there may be a few more conventional power stations replaced and average efficiencies will increase through time, we are unlikely to see further large jumps in the final user to primary demand ratio without the introduction of even more efficient technology.

From a policy perspective, the electricity generation improvements which have been encouraged both by government and the invisible hand of the market, are likely to be less significant in the future. If the government intends to continue its campaign towards more efficient uses of energy, it must focus on final users. In this light, while it will probably not have a significant impact on the environment, the imposition of V.A.T. on domestic fuel, with the assistance of other measures, provides continuing incentives for energy efficiency impovements in the sector where the potential is greatest.

Summary of UK Final and Primary Energy Demand Forecasts
(Million therms per year)

	Energy Demand	1993	1994	1995	2000
Scenario 1	Final	61825	62267	63767	65419
	Primary	86582	87122	87145	90230
Scenario 2	Final	61825	62271	64565	68001
	Primary	86582	87123	88078	92994
Scenario 3	Final	61825	62246	62989	64273
	Primary	86582	87122	86499	89765
Scenario 4	Final	61825	62041	62971	67963
	Primary	86582	86794	87262	94915

APPENDIX I. ENERGY DEMAND MODELLING - THE ERROR CORRECTION MODEL

Roger Fouquet

The purpose of building a model stems from the need to explain consumer demand. Knowing and understanding the underlying determinants of demand allows future behaviour to be predicted. The modeller's main responsibility, therefore, is the development of a framework that can explain consumers' behaviour.

Energy demand modelling consists of understanding the special features of energy demand; identifying the market structure reflecting energy demand and the consumer groups with behaviour determined by similar factors; choosing which variables explain most fully demand; finding the relationships between them; gathering statistics as accurate and appropriate as possible, and, producing elasticity estimates. Using the results, and making assumptions about the future course of the explanatory variables, the modeller can generate forecasts of energy demand.

Features of Energy Demand

The demand for energy derives from consumers' desire to use the services certain appliances provide. These appliances, such as cookers, cars, or heaters, can only provide their services by consuming energy. The cook and the chauffeur buy natural gas and petrol because they want the services energy-using appliances supply. To understand the demand for energy, appliances must be analysed.

Since they consume energy, it becomes important to consider the rate at which appliances use energy. As a result of technical progress, appliance efficiency usually increases as time passes. But, because of the durable nature of energy-using equipment, lags develop between the sale of the latest, most efficient appliance and its acquisition.

Efficiency and lags alter consumption behaviour. Principally, they cause a significant difference between short run and long run adjustments to price, income or output changes. Modellers must observe how consumer's short run reactions turn into long run behaviour. Also, consumers may react differently to, say, price increases and price decreases, therefore, average elasticities from time-series regressions may not produce accurate estimates[1].

Choosing the Level of Aggregation

Two other other issues, relating to the modeller's choice of structure, need to be raised. First, the level of aggregation needs to be chosen. As each consumer behaves differently, disaggregation enables the modeller to examine more accurately specific demands for energy. Time and money restricitions (data gathering and number crunching) force a limit on the level of disaggregation. The modeller must decide on the appropriate level of aggregation, taking into account the purpose of the study, the need to make useful observations, and the available budget. Because of limited time and resources, yet needing to break demand into groups with similar explanatory variables, we chose to split consumers into seven sectors of the economy: domestic; transport - road and air; iron and steel industry; other industries; public administration and defence; agriculture; and miscellaneous, principally services.

Choosing the Market Structure

Second, our choice about whether to analyse the market for energy as a whole or each fuel separately depends inherently on consumers' ability to substitute between products. Some forecasters have estimated energy demand based on the market shares of each fuel; they assume that substitution between fuels determines to a large extent demand. Evidence suggests, however, that because of the durable nature of appliances little substitutability exists between fuels. Also, at present, most sectors in the UK are dominated by one fuel (natural gas in the domestic, oil in the transport). For SEECEM, we estimate elasticities of demand for each fuel separately but do include a price variable that is based on the ratio of the fuel's demand relative to a weighted

[1] For a more in-depth discussion of the special features of energy demand see Fouquet (1993) 'Recent Developments in Energy Demand Modelling' in D. Hawdon's Recent Studies of the Demand for Energy in the UK, Energy Surrey Energy Economics Discussion Paper no72.

average of energy price in the sector. The variable allows consumers to switch fuels if the price of a fuel changes relative to the overall energy price, thus, implicitly allowing some substitution between fuels. Choosing such a variable allows us to use the real price of fuel rather than its nominal form.

Choosing Variables

Again budget constraints, as well as the object of the study, suggest we choose a simple approach. Though each sector must be considered individually, we felt that every demand equation - for fuel in a particular sector - would be explained by the price of the fuel relative to the average price of energy in the sector (see above) and an activity variable. The activity variable was generally either personal disposable income (in the domestic and transport sectors) and the sector's index of output (for the other ones). Thus, price and an activity variable, as exogenous variables[2], explain consumer energy demand.

To choose price and activity variables suggests little consideration of the appliance's role in detemining demand. Because most sectors in the UK (the transport sector, for example, being an exception) are appliance-saturated and since we only intend to produce short-term forecasts, energy-using equipment variables will hardly vary for the period under observation. Similarly, we feel that energy efficiency will not improve enough to significantly alter forecasts only a few years ahead. Thus, for a short-run investigation of UK energy demand, appliance and efficiency variables should have minimal explanatory power.

For certain fuels in specific sectors, price and acitivity variables, on their own, provided insufficient explanation of consumer behaviour. In such cases, additional variables were sought. For example, we felt that the demand for electricity in the agricultural sector could be associated with the increased mechanisation and reduced labour force in the sector. An employment variable considerably improved the equations explanatory power (see Appendix III). For the transport sector, though price and income significantly explained demand for road and air oil demand, we chose to include additional variables. By adding the number of passenger and freight kilometres, as well as the number of vehicles, we were able to obtain more accurate elasticities (Dargay 1993). Temperature was included regularly as a variable where the fuel is used for space heating. Though a few equations still remain poor, the price and an activity variables - sometimes with the help of additional variables - explained the demand for most fuels. The basic energy demand equations look like this:

(1) $$D_{ist} = F\ (\ P_{ist}/P_{est}\ ,\ P_{est}/RPI,\ Y_{st}\ ,\ X_t\ )$$

where D_{ist} is the demand for fuel i in sector s, P_{ist} is the price of fuel i in sector s, P_{est} is the average price of fuels in sector s, Y_{st} is the activity variable chosen for sector s, and X_t are the posssible additional variables included.

Dynamic Specification

Though we argued that appliance stock may not be significant in the short-run, decisions made in past periods have considerable influence on present behaviour the model should incorporate some lags. We chose to model energy demand around the error correction model[3]. The error correction model (ECM) suggests that the consumer has a long-run optimal behaviour. After a shock, such as a price rise, the consumer will not be acting in an optimal way. The consumer will try to adjust his/her behaviour towards the equilibrium level, through time. Because of the costs of instantaneous full adjustment, however, our consumer will only gradually be able to change consumption behaviour - and correct the 'error' from the equilibrium. Thus, in the long run, consumption will be optimal; in the short run, it will be tending towards an optimal behaviour.

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[2] Price and activity variables are not entirely exogenous as, for example, a large increase in the demand for natural gas may cause price to rise as well; but we wanted to avoid the complexity that would be associated with such a system.

[3] Other attempts to do use the error correction for energy demand modelling include Bentzen, J and Engsted, T (1993) 'Short- and Long-Run Elasticities in Energy Demand: A Cointegration Approach.' Energy Economics, 15(2), p.9-16; and Hunt, L and Manning, D (1989) 'Energy Price- and Income-Elasticities of Demand: Some Estimates for the UK Using the Cointegration Procedure.' Scottish Journal of Political Economy, 36(2), p.183-93.

Thus, a change in the demand for a fuel will be determined by any changes in explanatory variables plus the adjustment in that period towards the optimal behaviour (or equilibirum). That is,

(2) $$D_{ist} = \beta_0 + \beta_1.\Delta D_{ist-1} + \beta_2.\Delta(P_{ist}/P_{est}) + \beta_3.\Delta Y_{st} + \beta_4.\Delta X_t + \beta_5.[D_{ist-1} - \alpha_0 - \alpha_1.(P_{ist-1}/P_{est-1}) - \alpha_2.Y_{st-1} - \alpha_3.X_{t-1}]^4.$$

The variables within β_5 are known together as the error correcting term. The ECM consists of short-run and long-run terms which permit the derivation of short- and long-run elasticity estimates.

As discussed above, energy consumers tend to have two types of reactions to changes in circumstances, such as a price rise - an immediate one and a gradual one. Initially, people will alter their consumption pattern, maximising utility, with a fixed stock of appliances; gradually, perhaps over a period of several years, they will be able to adjust it. Energy economists find short- and long-run elasticities valueable for interpreting the effects of policies and shocks. Furthermore, the coefficient on the error correcting term, β_5, indicates the rate of adjustment towards the long-run equilibirum; the closer it is to minus one the faster will be the alignment.

Trended Nature of Energy Data

The values of most variables in the first equation tend to rise through time; energy demand for oil in the transport sector, the index of production in the service sector, and so on. Because of the trended nature of the data, its expected value through time does not remain constant. As a result, statistical tests on variables and coefficients cannot be considered reliable; mean and variance must be constant or stationary for inferences to be accurate.

In the past, modellers ignored the problem and generally used a log linear model to provide long-run elasticities for energy demand. More recently, as new techniques have been introduced, modellers have chosen to tackle the problem of non-stationary data.

One technique proposed is to difference all trended variables. This turns rising, I(1) (i.e. integrated of order one) variables into constant ones, I(0). Modellers have managed to 'create' stationary data. Differenced models, however, are unable to provide information about long-run equilibrium behaviour.

Econometricians pointed out that though I(1) variables rise through time, the difference between related ones tend to remain constant. For example, energy demand and output grow through time, I(1), but the residuals of the regression of output on demand (i.e. the long run equation) move randomly around a fixed value - such as zero - and are, therefore, an I(0) time-series. These are called cointegrated equations.

The solution to the problem of having, in the long-run, non-stationary data but, in the short-run, coefficients telling us little about long-run behaviour is the error correction model. Modellers can, using the residuals from the long-run cointegrated equation and differenced non-stationary data, estimate both instantaneous and gradual consumer adjustments to shocks.

Because of the nature of data related to energy demand, using the ECM should improve energy demand modelling, particularly when used for forecasting. ECM forecasts may perform better than other models because cointegrated series tend to 'hang together' in a type of equilibirum[5]. The proof is in the pudding.

The next appendix discusses choices of data and related problems, provides statistical sources, and tests the variables for non-stationarity. Appendix III shows the regression results, and discusses them. Appendix IV describes the forecasting method, how potential policy alternatives are incorporated into the projections, and final user forecasts made. Appendix V presents primary energy demand forecasts and environmental effects.

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[4] All variables are in log form.

[5] See Granger, CWJ (1993) 'What Are We Learning About the Long-Run?', The Economic Journal, 103, p.307-17.

APPENDIX II. STATISTICAL INFORMATION

Roger Fouquet

Time Series Data

Along with most other energy economists, we feel several reasons justify modelling energy demand using a time-series approach. As discussed above, the ECM requires the use of time-series data. Also, the costs of cross-section data are large mainly because insufficient information exists about regional UK energy demand. And, forecasting favours such an approach. Time-series analysis, therefore, has been used, but we had to select the appropriate data.

Regarding the choice of data, supply greatly determines demand. The Digest of United Kingdom Energy Statistics (1993) - referred to as DUKES - provides the bulk of energy-related values. The period chosen depended on how far back its statistics went; they tended to go back to 1950. Thus, most of our estimates are based on demand between 1950-1992.

Over that period, a great deal of change has taken place: demand has gradually shifted out of coal, oil took its place; several oil shocks (two up, one down) later, natural gas heats many homes, oil still runs cars, and coal and nuclear power generate our electricity. Attitudes and appliances have changed in the last 40 years. Ambiguity remains, however, over how significant the changes have been. Most recently, Bentzen and Engsted (1993) found surprisingly no significant differences in elasticities between periods 1948-1973 and 1974-90 for Denmark. Because we used annual data, as opposed to quarterly ones, we needed sufficient points to get reliable inferences. Our elasticity estimates derive mainly from analysis of data over the whole period 1950-1992.

Sources

Most of the data for models and graphs in the main text originate from the Department of Trade and Industry's Digest of United Kingdom Energy Statistics 1993. Other sources used include the Monthly Digest of Statistics (MDS), the Department of Transport's GB Transport Statistics 1992 (GBTS), and the Department of the Environment's Digest of Water and Environment Statistics 1993.

To ensure continuity, at times, we have had to convert statistics that were originally, for example, in million of tonnes of oil equivalent into millions of therms - conversion tables can be found on in the Digest of United Kingdom Energy Statistics (1993) p.11 and p.123.

The precise sources can be found in the tables below:

Table A2.1.
Fuel Prices

VARIABLE	SOURCE	PERIOD*
PRICE OF COAL	DUKES 1993 Table 61	1950-1992
PRICE OF GAS	DUKES 1993 Table 61	1954-1992
PRICE OF ELECTRICITY	DUKES 1993 Table 61	1954-1992
PRICE OF OIL	DUKES 1993 Table 61	1950-1992

* After 1989, the basis for calculating the industrial fuel prices to average consumers changed in DUKES 1993 Table 61; new values must be divided by a coefficient (Coal: 1.045; Heavy Fuel Oil: 1.25; Gasoil: 1.015; Electricity: 1.16; Natural Gas: 1.08)

Table A2.
Domestic Sector

VARIABLE	SOURCE	PERIOD
COAL	DUKES 1993 Table 7	1950-1992
NATURAL GAS	DUKES 1993 Table 7	1950-1992
ELECTRICITY	DUKES 1993 Table 7	1950-1992
OIL	DUKES 1993 Table 7	1950-1992
PERSONAL DISPOSABLE INCOME	MDS July 1993	1950-1992
POPULATION (United Kingdom)	MDS July 1993 Table 2.1	1950-1992
MEAN TEMPERATURE (Great Britain)	DUKES 1993 Table A19	1950-1992
PRICES:* CONSUMER EXPENDITURE ON FUEL i FUEL i CONSUMPTION	 AAS 1993 Table 14.9 DUKES 1993 Table 7	 1950-1992 1950-1992

* Prices in the domestic sector have been calculated as Consumer Expenditure on Fuel i/Consumption of Fuel i.

Table A2.3.
Industrial Sector (Iron & Steel and Other Industries)

VARIABLE	SOURCE	PERIOD
COAL, COKE, BREEZE	DUKES 1993 Table 7	1950-1992
NATURAL GAS	DUKES 1993 Table 7	1950-1992
ELECTRICITY	DUKES 1993 Table 7	1950-1992
OIL	DUKES 1993 Table 7	1950-1992
IRON & STEEL INDEX OF PRODUCTION	MDS Sept. 1993 Table 7.1	1960-1992
MANUFACTURING INDEX OF PRODUCTION	MDS July 1993 Table 7.1	1960-1992
PRICES	See Prices Table	-

Table A2.4.
Transport Sector

VARIABLES	SOURCE	PERIOD2
ROAD OIL	DUKES 1993 Table 7	1960-1992
AIR OIL	DUKES 1993 Table 7	1960-1992
RAIL OIL	DUKES 1993 Table 7	1960-1992
WATER OIL	DUKES 1993 Table 7	1960-1992
RAIL ELECTRICITY	DUKES 1993 Table 7	1960-1992
ROAD PASSENGER KILOMETRES*	GBTS 1992 Table 4.7 [2]	1957-1992
ROAD FREIGHT KILOMETRES**	GBTS 1992 Table 4.7 [3]	1957-1992
ROAD VEHICLES	GBTS 1992 Table 5.3	1959-1992
AIR PASSENGERS	GBTS 1992 Table 9.14 MDS July 1993 Table 13.9	1950-1992
AIR CARGO	GBTS 1992 Table 9.14 MDS July 1993 Table 13.9	1950-1992
RAIL PASSENGER KILOMETRES	GBTS 1992 Table 5.13	1960-1992
RAIL FREIGHT KILOMETRES	GBTS 1992	1960-1992
ELECTRIFIED RAIL ROUTE	GBTS 1992	1960-1992
PERSONAL DISPOSABLE INCOME	ET Table 5 (or MDS) CHECK	
REAL PRICE OF MOTOR SPIRITS:*** PRICE OF MOTOR SPIRITS RETAIL PRICE INDEX	DUKES 1993 Table 59	1960-1992 1950-1992

* Road passenger kilometres is the sum of cars and taxis, motor cycles, and large buses and coaches.
** Road freight kilometres is based on adding light and heavy vans together.
*** The Real Price of Motor Spirits is calculated by dividing the price of Motor Spirits by the Retail Price Index.

Table A2.5.
Public Administration and Defence Sector

VARIABLE	SOURCE	PERIOD
COAL	DUKES 1993 Table 7	1950-1992
NATURAL GAS	DUKES 1993 Table 7	1950-1992
ELECTRICITY	DUKES 1993 Table 7	1950-1992
OIL	DUKES 1993 Table 7	1950-1992
GDP PUBLIC ADMINISTRATION	UKNA Table 2.4 AAS Table 14.6	1950-1992
MEAN TEMPERATURE (Great Britain)	DUKES 1993 Table A19	1950-1992
PRICES	See Prices Table	-

Table A2.6.
Agriculture Sector

VARIABLE	SOURCE	PERIOD
COAL	DUKES 1993 Table 7	1960-1992
NATURAL GAS	DUKES 1993 Table 7	1984-1992
ELECTRICITY	DUKES 1993 Table 7	1960-1992
OIL	DUKES 1993 Table 7	1960-1992
AGRICULTURAL PRODUCTION	MDS July 1993 Table 1.4	1960-1992
AGRICULTURAL EMPLOYMENT	AAS 1993 Table 6.2 MDS July 1993 Table 3.2	1960-1992
PRICES	See Prices Table	-

Table A2.7.
Miscellaneous Sector

VARIABLE	SOURCE	PERIOD
COAL	DUKES 1993 Table 7	1950-1992
NATURAL GAS	DUKES 1993 Table 7	1950-1992
ELECTRICITY	DUKES 1993 Table 7	1950-1992
OIL	DUKES 1993 Table 7	1950-1992
GDP TOTAL SERVICES	AAS 1993 Table 14.6	1950-1992
MEAN TEMPERATURE (Great Britain)	DUKES 1993 Table A19	1950-1992
PRICES	See Prices Table	-

Testing Non-Stationarity

Times-series variables cointegrate only if they are of the same order (i.e. they all need to be differentiated the same number of times before becoming stationary). We need to test whether our chosen variables are all of order one, I(1). Any I(0) time-series will not cointegrate and should, therefore, not be included in the error correction (or long-run) equation.

The Dickey-Fuller test scrutinises the assumption that all time-series are I(1)[6]. The test starts with the hypothesis that

(3) $$\Delta w_t = \tau_0 + \tau_1.T + \tau_2.w_{t-1} + e_t;$$

where w_t is the series, T is a time trend, and e_t are the reisduals. The coefficient τ_2 is the test statistic which if negative and significant rejects the hypothesis of w_t being I(1); otherwise non-stationarity cannot be rejected. We also use the Augmented Dickey-Fuller test (with trend), which includes lags of Δw_t to ensure the residuals produce white noise.

Virtually all variables appear to be non-stationary. The temperature time-series does, as expected, reject it, as does the real price of motor spirit. The only two borderline cases (either rejecting the DF test, but not the

[6] The cointegrating regression Durbin-Watson test also examines the hypothesis of an I(1) series. And, an inspection of the variables' correlogram tells us much about the integrating order of the series.

ADF(1) test or vice versa) recorded is for gas in the agricultural sector and electricity demand in the transport sector. The use of natural gas in agriculture only began in 1984; though we only have a small series we choose to assume non-stationarity because demand will probably grow in the future. Rail consumes nearly all the electricity in the transport sector but, in millions of therms, the demand is dwarfed in comparison to other forms of transport. We assume that the small demand leads to the possible rejection of non-stationarity; we, however, take it as an I(1) variable.

For I(0) variables, such as temperature and real price of motor spirit, they, in principle, do not influence long-term behaviour and, therefore, we introduce them in the dynamic, short-run equation in levels, but not in the long-run equation. Other than these minor cases, we can regress all I(1) variables in the long-run cointegrating regression as levels and as differenced terms in the dynamic equation[7].

We run the OLS regression

(4) $$LnD_{ist} = \alpha_0 + \alpha_1.Ln(P_{ist}/P_{est}) + \alpha_2.Ln(P_{est}/RPI) + \alpha_4 LnY_{st} + \alpha_5.LnX_t + e_t.$$

The α_i provide estimates of long-run adjustments in energy demand from changes in explanatory variables. The equation's residual, e_t, acting as the adjustment - error correcting - mechanism towards the long-run equilibrium, is introduced into the dynamic equation (2).

The residuals must, however, be stationary - for them to be introduced into the error corrrection model. We need to test to see whether equation (4) cointegrates. We use the Dickey-Fuller and Augmented Dickey-Fuller test to examine the residuals order of integration.

[7] The results of Dickey-Fuller and Augmented Dickey-Fuller tests do not appear here for space reasons but they can be received from the author on request.

APPENDIX III. HISTORICAL PARAMETERS

Roger Fouquet

Being satisfied that the time-series are non-stationary and the long-run equations are cointegrated and having fed the residuals into the dynamic equation and OLS regressed it, we produce short- and long-run energy demand elasticities. The coefficients determine our expectations about the effects of price and activity variable changes on demand. We, generally, expect, say, negative price elasticities and positive income and output elasticities and that long-run elasticities to be greater than short-ones. When the estimates do not meet our expectations the difference must be justified; for example, a negative income elasticity for domestic coal demand can be explained as the sign of an inferior good, as households become wealthier they tend to install gas central heating systems[1].

The estimates of energy demand elasticities reflect consumer ability or willingness to adjust to changes. In the short run, adjustments must be limited to reductions in fuel use, as appliance stock remains fixed. Consumers gradually replace appliance stock to best suit the new environment. The flexibility is far greater in the long run than in the short run; this fact should be reflected in higher long-run elasticities.

Elasticity Estimates

The elasticities, for the short- and long-run, tend to agree with other studies. In the domestic sector, we find relative price elasticities ranging from -0.29 for natural gas to -1.04 for coal in the short-run and from -0.90 for oil to -2.02 for coal in the long-run. Short-run values in the industrial sectors tended to be lower, while the long-run ones were similar. The effects of variations in the real price of motor spirit (only given in the short-run) for the transport sector tended to be below -0.1. Other sector elasticities were less reliable and further modelling is necessary.

Regarding activity variables, such as income, GDP or index of production, elasticities tended to fluctuate more between fuels and sectors. For example, electricity values were often large and positive; elasticities for coal were usually negative - suggesting an inferior good. Overall, short-run values - just like for price elasticities - tend to be half of corresponding long-run values.

The error correction model also provides some indication of the rate of adjustment from the short-run to the long-run. As values reach negative unity, the faster the adjustments take place. In the domestic sector, we can see that whereas natural gas adjustments (from, say, reducing central-heating use to buyng a more efficient system) may take around six or seven years (with a value of -0.18), the process will only take about two to three years (with a value of -0.41) for electricity demand (where appliances tend to be smaller and cheaper, and, thus, more readily replaceable). Values in the industrial sector are small (mostly, below -0.2). They reflect the assumption that large, expensive and durable appliances can only be replaced after depreciation, which may be up to twenty years in the industrial sector.

On the whole, we feel the model provides a simple yet appropriate way of modelling energy demand. While some elasticities cannot be understood, and further analysis is required, the majority of variation in UK's energy demand appears to be explained by SEECEM.

1 Unfortunately, for some of the smaller sectors, such as agriculture and public administration, we have little explanation for certain unexpected estimates.

Table A3.1.
UK Energy Market - Domestic Sector Elasticities (Long-Run and Short-Run)

LONG RUN:					
	Relative Price	Relative Energy Price	Disposable Income		
COAL	-2.02	-	-2.02		
OIL	-0.90	-	-0.19		
GAS	-1.37	-1.36	1.15		
ELECTRICITY	-1.26	-	0.72		
SHORT RUN:					
	Change in Relative Price	Change in Relative Energy Price	Change in Disposable Income	Temperature	Error Correcting
CHANGE IN:					
COAL	-1.04	-	-0.17	-0.76	-0.25
OIL	-0.49	-	0.02	-0.10	-0.19
GAS	-0.29	-0.59	-0.14	-0.29	-0.18
ELECTRICITY	-0.95	-	0.07	-0.27	-0.41

Table A3.2.
UK Energy Market - Iron & Steel Industries Elasticities (Long-Run and Short-Run)

LONG RUN			
	Relative Price	Production	
COAL	-0.38	1.96	
OIL	1.08	4.69	
GAS	-1.02	-0.6	
ELECTRICITY	-1.88	1.94	
SHORT RUN			
	Change in Relative Price	Change in Production	Error Correcting Term
COAL	-0.46	1.43	-0.09
OIL	0.02	1.25	-0.06
GAS	-0.44	0.22	-0.24
ELECTRICITY	-0.29	0.99	-0.09

Table A3.3.
UK Energy Market - Other Industries Sector Elasticities (Long-Run and Short-Run)

SHORT RUN			
	Relative Price	Production	
COAL	-2.00	-3.57	
OIL	0.08	0.12	
GAS	-1.66	0.41	
ELECTRICITY	-0.50	1.38	
SHORT RUN			
	Change in Relative Price	Change in Production	Error Correcting Term
COAL	0.06	0.66	-0.13
OIL	-0.22	0.57	0.03
GAS	-0.46	0.23	-0.19
ELECTRICITY	-0.18	0.89	-0.38

Table A3.4.
UK Energy Market - Transport Sector Elasticities (Long-Run and Short-Run)

LONG RUN							
	Passenger Kilometres	Freight Kilometres	Vehciles Owned	Electrified Rail Route	Real Price of Motor Spirit	Disposable Income/GDP	
PASS.KMS	-	-	-	-	-	2.05	
FREIGHT KMS	-	-	-	-	-	1.08	
VEH. OWNED	-	-	-	-	-	1.11	
ROAD OIL	0.26	0.19	0.7	-	-	-	
AIR OIL	0.4	0.25	-	-	-	-	
RAIL OIL	-1.48	0.44	-	-0.21	-	-	
RAIL ELEC.	0.06	0.02	-	0.73	-	-	
SHORT RUN							
	Change in Passenger Kilometres	Change in Freight Kilometres	Change in Vehicles Owned	Change in Electrified Rail Route	Real Price of Motor Spirit	Change in Disposable Income/GDP	Error Correction Term
CHANGE IN:							
PASS. KMS	-	-	-	-	-0.09	0.45	-0.10
FREIGHT KMS	-	-	-	-	-0.12	0.72	-0.08
VEH. OWNED	-	-	-	-	-0.01	0.41	-0.19
ROAD OIL	0.09	0.33	0.66	-	-0.04	-	-0.39
AIR OIL	0.37	-	-	-	-	0.79	-0.57
RAIL OIL	-0.37	0.22	-	-0.36	-	-	-0.52
RAIL ELEC.	0.62	0	-	0.16	-	-	-0.59

Table A3.5.
UK Energy Market - Agriculture Sector Elasticities (Long-Run and Short-Run)

LONG RUN				
	Relative Price	Production	Employment	
OIL	0.33	-0.55	-	
GAS	1.78	3.73	-	
ELECTRICITY	-0.02	-0.43	-1.20	
SHORT RUN				
	Change in Relative Price	Change in Production	Change in Employment	Error Correcting Term
CHANGE IN:				
OIL	-0.02	-0.14	-	-0.14
GAS	0.18	-0.08	-	-0.34
ELECTRICITY	-0.04	-0.01	-0.51	-0.34

Table A3.6.
UK Energy Market - Public Administration and Defence Sectors Elasticities (Long-Run and Short-Run)

LONG RUN				
	Relative Price	Production		
COAL	0.18	-9.00		
OIL	-1.57	-0.60		
GAS	-0.67	12.96		
ELECTRICITY	-1.64	3.00		
SHORT RUN				
	Change in Relative Price	Change in Production	Temperature	Error Correcting Term
CHANGE IN:				
COAL	-0.03	-1.74	-0.06	-0.03
OIL	-0.56	-1.18	-0.09	-0.05
GAS	0.02	3.09	-0.02	-0.21
ELECTRICITY	-0.04	-0.19	-0.05	-0.04

Table A3.7.
UK Energy Market - Miscellaneous Sector Elasticities (Long-Run and Short-Run)

LONG RUN			
	Relative Price	Production	
COAL	0.25	-4.49	
OIL	-0.7	-0.85	
GAS	0	2.56	
ELECTRICITY	-0.92	2.1	
SHORT RUN			
	Change in Relative Price	Change in Production	Error Correcting Term
CHANGE IN:			
COAL	0.8	-0.2	-0.19
OIL	-0.25	-1.3	-0.23
GAS	-0.06	-0.8	-0.18
ELECTRICITY	-0.22	0.26	-0.23

Testing[2]

Goodness-of-Fit, such as R-squared, and t-statistics on the coefficients suggest most of the variables have explanatory power. In the long-run equations virtually all of them are significant (the exceptions being oil demand in other industries and gas demand in agriculture). The short-run equations are less satisfying, though only the smaller sectors - public administration and defense, agriculture and miscellaneous - do not provide acceptable results. The domestic, industrial, and transport sectors goodness-of-fits and t-statistics are in-line with other studies using error correction models, such as Hunt and Manning (1987) and Bentzen and Engsted (1993).

The reliability of the coefficients also depends on the validity of assumptions made about the estimators. In the long-run equations, we anticipate serial correlation as variables presented non-stationary properties. The Durbin-Watson statistics tend to recognise the problem. The short-run equations, which were meant to solve the problem, display near-two Durbin-Watson values and suggest that the differenced variables and cointegrated equations do not suffer from serial correlation.

[2] We intend to present the estimates and tests in more detail, as well as as the results, in an article format.

APPENDIX IV. ENERGY DEMAND FORECASTS

Roger Fouquet

Description

Based on elasticity estimates produced using the Error Correction Model, we generate forecasts for energy demand between 1993-2000. As well as coefficients, we also need future values for the explanatory variables. Projected variables and coefficients enter the error correction model and generate forecasts for each fuel in the seven sectors.

How accurate are the forecasts? There exist several sources of possible error in our forecasts. First, the explanatory variables are likely to be inaccurate as they are based on our or other forecasters projections. Individual forecasts may be, in turn, inaccrate. But, since all variables have an equal likelihood of being wrong, there should be no particular bias in our forecasts.

Second, the structure of our model may not be perfect. Naturally, we chose the structure we felt most suited energy demand forecasting. Also, our estimates of coefficients may be inaccurate, as pointed out in Appendix III, section 3. Third, the inaccuracy may be increased by our models' inability to pick up any strucutural adjustments. We feel, however, that for a short-term forecast (certainly to 1995) structural adjustments will be minimal and trended growth will be the predominant determinant of energy demand. Structural adjustments cause non-zero residuals. There exist certainly other fluctuations in the energy markets that our models do not pick up, such as changes in the appliance stock and efficiency improvements, also leading to non-zero residuals. Again, though, they do not appear to bias forecasts in one particular direction, and, therefore must be assumed to be zero.

We produced forecasts for the 1992 energy demand, using equations from 1950-1991. The results were satisfying and encouraging. In 20 out of 28 cases (not all fuels were being forecast then), we correctly predicted the direction of change in demand. We were particularly satisfied with the domestic, iron and steel, transport, public administration and defense, and agriculture sectors. None of the sectors were completely wrong. Because of the abundance of errors though, we are under no illusion about the consistency of our forecasts.

Policy Alternatives

Forecasts can only be as good as our assumptions about explanatory variables and government intervention. We, therefore, propose various policy alternatives for the outlook of energy demand. Our choices stem from possible government initiatives highlighted in the discussion on energy policy: principally, possible changes to the structure of the proposed V.A.T. on domestic fuels - abandonning it or introducing the full 17.5% tax in April 1994 - and increasing the competition in the electricity and gas supply industries - reducing prices of the two energies by two percent per year from 1994 onwards.

Apart from these three variations, explanatory variables are as suggested in the discussions on prices and sectors. Thus, the domestic sector forecasts are based on four policy variants, and the other sectors are based on two, business as usual and increased competition.

Table A4.1.

UK Energy Demand - Domestic Sector

V.A.T. on Domestic Fuels Introduced:

- all Fuel Prices Increase by an Additional 8% in 1994; and
- all Fuel Prices Increase by an Additional 9.5% in 1995.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. RPI	7.5%	9.4%	5.9%	4.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	4.6%	11.3%	-13.0%	-1.0%	2.0%	8.0%	9.5%	7.0%
OIL	20.5%	19.5%	-2.8%	-12.0%	9.5%	10.0%	11.5%	9.3%
GAS	0.6%	6.9%	6.2%	0.0%	1.0%	10.0%	11.5%	6.0%
ELECTRICITY	4.5%	6.8%	10.5%	5.0%	6.0%	12.4%	14.3%	10.3%
3. PDI	5.2%	8.9%	-0.5%	2.3%	0.1%	0.5%	1.0%	2.0%
4. TEMPERATURE	2.0%	4.0%	-4.8%	0.4%	0.0%	0.0%	0.0%	0.0%
5. POPULATION	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
FORECASTS								
COAL	-12.8%	-18.0%	22.2%	-26.4%	10.9%	-4.7%	1.0%	-0.9%
OIL	-1.9%	4.0%	10.4%	4.9%	1.2%	1.6%	1.3%	0.2%
GAS	-3.3%	3.4%	11.2%	-1.2%	6.2%	2.1%	-0.3%	-1.1%
ELECTRICITY	-0.1%	1.7%	4.6%	1.4%	-0.2%	-2.9%	-3.1%	-1.2%
OTHER*	-11.1%	-2.6%	-1.7%	-9.4%	-3.3%	-2.7%	-7.6%	-3.0%
TOTAL ENERGY	-3.7%	0.7%	10.4%	-2.8%	2.4%	0.6%	-0.6%	-1.0%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	1642.0	1347.0	1646.0	1212.0	1344.6	1280.8	1293.4	1234.0
OIL	951.0	989.0	1092.0	1146.0	1159.9	1178.4	1193.8	1206.3
GAS	9914.0	10250.0	11395.0	11263.0	11960.4	12216.0	12178.9	11537.5
ELECTRICITY	3148.0	3200.0	3347.0	3394.0	3387.7	3288.8	3187.6	2994.3
OTHER*	491.0	478.0	470.0	426.0	412.0	401.0	387.0	373.0
TOTAL ENERGY	16146.0	16264.0	17950.0	17441.0	18264.6	18365.0	18240.7	17345.1

* OTHER includes coke and breeze, other solid fuels, and solar and geothermal heating - forecast without SEECEM.

Table A4.2.
UK Energy Demand - Domestic Sector
V.A.T. on Domestic Fuels Abandonned:

- no Additional Fuel Price Changes.

	1989	1990	1991	1992	1993	1994	1995	2000
CHANGE Percent Per Year								
MAIN ASSUMPTIONS								
1. RPI	7.5%	9.4%	5.9%	4.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	4.6%	11.3%	-13.0%	-1.0%	2.0%	0.0%	0.0%	7.0%
OIL	20.5%	19.5%	-2.8%	-12.0%	9.5%	2.0%	2.0%	9.3%
GAS	0.6%	6.9%	6.2%	0.0%	1.0%	2.0%	2.0%	6.0%
ELECTRICITY	4.5%	6.8%	10.5%	5.0%	6.0%	4.4%	4.8%	10.3%
3. PDI	5.2%	8.9%	-0.5%	2.3%	0.1%	0.5%	1.0%	2.0%
4. TEMPERATURE	2.0%	4.0%	-4.8%	0.4%	0.0%	0.0%	0.0%	0.0%
5. POPULATION	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
FORECASTS								
COAL	-12.8%	-18.0%	22.2%	-26.4%	10.9%	-4.5%	1.8%	-3.2%
OIL	-1.9%	4.0%	10.4%	4.9%	1.2%	1.6%	1.6%	-1.1%
GAS	-3.3%	3.4%	11.2%	-1.2%	6.2%	2.2%	6.0%	2.7%
ELECTRICITY	-0.1%	1.7%	4.6%	1.4%	-0.2%	-3.0%	-2.7%	-3.3%
OTHER*	-11.1%	-2.6%	-1.7%	-9.4%	-3.3%	-2.7%	-7.6%	-3.0%
TOTAL ENERGY	-3.7%	0.7%	10.4%	-2.8%	2.4%	0.6%	3.8%	1.0%
FORECASTS								
LEVELS (in Millions of Therms)								
COAL	1642.0	1347.0	1646.0	1212.0	1344.6	1283.9	1306.9	1100.7
OIL	951.0	989.0	1092.0	1146.0	1159.9	1178.9	1198.0	1134.9
GAS	9914.0	10250.0	11395.0	11263.0	11960.4	12219.0	12950.9	14668.1
ELECTRICITY	3148.0	3200.0	3347.0	3394.0	3387.7	3286.2	3196.3	2669.8
OTHER*	491.0	478.0	470.0	426.0	412.0	401.0	387.0	373.0
TOTAL ENERGY	16146.0	16264.0	17950.0	17441.0	18264.6	18369.0	19039.0	19946.4

* OTHER includes coke and breeze, other solid fuels, and solar and geothermal heating - forecast without SEECEM.

Table A4.3.

UK Energy Demand - Domestic Sector

V.A.T. on Domestic Fuels Rushed Forward:

- all Fuel Prices Increase by an Additional 17.5% in 1994.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. RPI	7.5%	9.4%	5.9%	4.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	4.6%	11.3%	-13.0%	-1.0%	2.0%	17.5%	0.0%	7.0%
OIL	20.5%	19.5%	-2.8%	-12.0%	9.5%	19.5%	2.0%	9.3%
GAS	0.6%	6.9%	6.2%	0.0%	1.0%	19.5%	2.0%	6.0%
ELECTRICITY	4.5%	6.8%	10.5%	5.0%	6.0%	21.9%	4.8%	10.3%
3. PDI	5.2%	8.9%	-0.5%	2.3%	0.1%	0.5%	1.0%	2.0%
4. TEMPERATURE	2.0%	4.0%	-4.8%	0.4%	0.0%	0.0%	0.0%	0.0%
5. POPULATION	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
FORECASTS								
COAL	-12.8%	-18.0%	22.2%	-26.4%	10.9%	-5.0%	9.1%	3.1%
OIL	-1.9%	4.0%	10.4%	4.9%	1.2%	1.6%	5.0%	2.2%
GAS	-3.3%	3.4%	11.2%	-1.2%	6.2%	2.1%	-9.7%	-3.6%
ELECTRICITY	-0.1%	1.7%	4.6%	1.4%	-0.2%	-2.8%	3.7%	1.9%
OTHER*	-11.1%	-2.6%	-1.7%	-9.4%	-3.3%	-2.7%	-3.6%	-3.0%
TOTAL ENERGY	-3.7%	0.7%	10.4%	-2.8%	2.4%	0.6%	-4.9%	-1.5%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	1642.0	1347.0	1646.0	1212.0	1344.6	1277.7	1394.6	1611.0
OIL	951.0	989.0	1092.0	1146.0	1159.9	1177.9	1237.3	1375.6
GAS	9914.0	10250.0	11395.0	11263.0	11960.4	12212.9	11033.5	9058.5
ELECTRICITY	3148.0	3200.0	3347.0	3394.0	3387.7	3291.4	3412.8	3742.5
OTHER*	491.0	478.0	470.0	426.0	412.0	401.0	387.0	373.0
TOTAL ENERGY	16146.0	16264.0	17950.0	17441.0	18264.6	18370.0	17474.1	16160.6

* OTHER includes coke and breeze, other solid fuels, and solar and geothermal heating - forecast without SEECEM.

Table A4.4.
UK Energy Demand - Domestic Sector
V.A.T. on Domestic Fuels Introduced and Competition in the Electricity Supply Industry Increased:

- All Prices Increase by an Additional 8% in 1994;
- All Fuel Prices Increase by an Additional 9.5% in 1995;
- Reducing Underlying Electricity Prices Every Year after 1993.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. RPI	7.5%	9.4%	5.9%	4.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	4.6%	11.3%	-13.0%	-1.0%	2.0%	8.0%	9.5%	7.0%
OIL	20.5%	19.5%	-2.8%	-12.0%	9.5%	10.0%	11.5%	9.3%
GAS	0.6%	6.9%	6.2%	0.0%	1.0%	10.0%	11.5%	6.0%
ELECTRICITY	4.5%	6.8%	10.5%	5.0%	6.0%	8.0%	9.0%	4.3%
3. PDI	5.2%	8.9%	-0.5%	2.3%	0.1%	0.5%	1.0%	2.0%
4. TEMPERATURE	2.0%	4.0%	-4.8%	0.4%	0.0%	0.0%	0.0%	0.0%
5. POPULATION	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
FORECASTS								
COAL	-12.8%	-18.0%	22.2%	-26.4%	10.9%	-6.8%	-0.6%	-3.2%
OIL	-1.9%	4.0%	10.4%	4.9%	1.2%	0.5%	0.3%	-1.0%
GAS	-3.3%	3.4%	11.2%	-1.2%	6.2%	1.5%	0.4%	-0.6%
ELECTRICITY	-0.1%	1.7%	4.6%	1.4%	-0.2%	-1.2%	0.1%	3.7%
OTHER*	-11.1%	-2.6%	-1.7%	-9.4%	-3.3%	-2.7%	-3.6%	-3.0%
TOTAL ENERGY	-3.7%	0.7%	10.4%	-2.8%	2.4%	0.5%	-0.2%	-3.5%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	1642.0	1347.0	1646.0	1212.0	1344.6	1253.0	1245.9	1047.8
OIL	951.0	989.0	1092.0	1146.0	1159.9	1166.1	1170.1	1112.5
GAS	9914.0	10250.0	11395.0	11263.0	11960.4	12140.2	12189.3	11814.2
ELECTRICITY	3148.0	3200.0	3347.0	3394.0	3387.7	3347.8	3351.3	3969.3
OTHER*	491.0	478.0	470.0	426.0	412.0	401.0	387.0	373.0
TOTAL ENERGY	16146.0	16264.0	17950.0	17441.0	18264.6	18308.1	18343.6	18316.8

* OTHER includes coke and breeze, other solid fuels, and solar and geothermal heating - forecast without SEECEM.

Table A4.5.
UK Energy Demand - Iron & Steel Sector
Business-as-Usual:

- No Additional Fuel Price Changes.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	9.2%	-12.6%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.0%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	10.4%	10.8%	10.3%
3. I&S PRODUCTION	2.0%	-2.8%	-9.1%	-4.6%	4.1%	2.4%	1.4%	1.1%
FORECASTS								
COAL	0.0%	40.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OIL	6.9%	-9.3%	0.7%	-5.1%	7.0%	5.8%	17.2%	7.3%
GAS	4.7%	-1.3%	-12.1%	19.5%	1.8%	0.0%	0.9%	0.2%
ELECTRICITY	1.5%	-8.8%	-1.3%	-3.3%	1.7%	0.6%	9.0%	0.2%
OTHER*	-1.5%	-5.5%	-4.5%	-4.4%	1.8%	-1.1%	-1.8%	-1.3%
TOTAL ENERGY	-1.3%	-5.5%	-4.8%	-1.3%	1.9%	0.0%	1.8%	0.2%
FORECASTS								
COAL	5	3	2	2	2.0	2.0	2.0	2.0
OIL	324	294	296	281	300.7	318.3	373.0	510.1
GAS	467	461	405	484	492.7	492.9	497.4	502.8
ELECTRICITY	340	310	306	296	301.0	302.8	330.2	333.8
OTHER*	2089	1974	1886	1802	1818.0	1799.0	1766.0	1645.0
TOTAL ENERGY	3220	3042	2896	2859	2914.4	2915.0	2968.6	2993.7

* OTHER includes coke and breeze and coke oven gas - coal and coke oven gas are forecast without SEECEM.

Table A4.6.
UK Energy Demand - Iron & Steel Sector
Competition in the Electricity Supply Industry Increased:

- Reducing Underlying Electricity Prices Every Year after 1993.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	9.2%	-12.6%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.0%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	3.4%	3.8%	4.3%
3. I&S PRODUCTION	2.0%	-2.8%	-9.1%	-4.6%	4.1%	2.4%	1.4%	1.1%
FORECASTS								
COAL	0.0%	40.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%
OIL	6.9%	-9.3%	0.7%	-5.1%	7.0%	5.9%	17.4%	6.9%
GAS	4.7%	-1.3%	-12.1%	19.5%	1.8%	-1.0%	0.0%	0.0%
ELECTRICITY	1.5%	-8.8%	-1.3%	-3.3%	1.7%	1.7%	10.7%	3.0%
OTHER*	-1.5%	-5.5%	-4.5%	-4.4%	1.8%	-1.0%	-1.8%	-1.4%
TOTAL ENERGY	-1.3%	-5.5%	-4.8%	-1.3%	1.3%	0.5%	1.9%	0.5%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	5	3	2	2	2.0	2.0	2.0	2.0
OIL	324	294	296	281	300.7	318.3	373.7	522.0
GAS	467	461	405	484	492.7	488.0	488.9	481.5
ELECTRICITY	340	310	306	296	301.0	306.0	338.7	392.2
OTHER*	2089	1974	1886	1802	1818.0	1799.0	1766.0	1645.0
TOTAL ENERGY	3220	3042	2896	2859	2896.4	2911.3	2966.6	3042.7

* OTHER includes coke and breeze and coke oven gas - coal and coke oven gas are forecast without SEECEM.

Table A4.7.

UK Energy Demand - Other Industries Sector

Business-as-Usual:

- No Additional Fuel Price Changes.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	9.2%	-12.6%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	10.4%	10.8%	10.3%
3. INDEX OF PRODUCTION	4.3%	-0.5%	-5.2%	-0.7%	4.1%	2.4%	1.4%	1.1%
FORECASTS								
COAL	-11.7%	-3.4%	-6.8%	21.2%	-7.1%	-6.6%	-5.9%	-1.2%
OIL	-8.8%	-6.3%	9.2%	-5.8%	-17.8%	-18.0%	-18.6%	-13.4%
GAS*	2.1%	3.9%	-5.2%	-9.3%	7.2%	7.7%	7.5%	3.6%
ELECTRICITY	2.4%	2.4%	-1.1%	2.0%	2.4%	2.6%	2.4%	1.8%
OTHER**	-9.0%	-30.2%	-10.4%	22.6%	0.0%	-0.8%	-0.8%	0.0%
TOTAL ENERGY	-2.6%	-0.3%	-1.0%	-2.0%	-3.3%	-0.9%	-0.1%	0.1%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	1456	1406	1311	1589	1476.9	1379.1	1298.4	1222.5
OIL	3141	2944	3215	3029	2489.2	2040.6	1661.7	547.1
GAS*	4777	4962	4705	4268	4574.2	4927.1	5295.1	6251.3
ELECTRICITY	3052	3125	3091	3153	3229.7	3314.4	3392.5	3694.4
OTHER**	152	106	95	130	130.0	129.0	128.0	128.0
TOTAL ENERGY	12578	12543	12417	12169	11900.0	11790.2	11775.7	11843.3

* GAS includes non-energy use of natural gas in the chemical industry, and landfill and sewage gas for heat.

** OTHER includes coke and breeze, other solid fuels, and coke oven gas - forecast without SEECEM.

Table A4.8.
UK Energy Demand - Other Industries Sector
Competition in the Electricity Supply Industry Increased:

- Reducing Underlying Electricity Prices Every Year after 1993.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	9.2%	-12.6%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	8.4%	8.8%	8.3%
3. INDEX OF PRODUCTION	4.3%	-0.5%	-5.2%	-0.7%	4.1%	2.4%	1.4%	1.1%
FORECASTS								
COAL	-11.7%	-3.4%	-6.8%	21.2%	-7.1%	-6.3%	-6.8%	-3.9%
OIL	-8.8%	-6.3%	9.2%	-5.8%	-17.8%	-18.8%	-19.1%	-13.1%
GAS*	2.1%	3.9%	-5.2%	-9.3%	7.2%	6.1%	5.5%	5.1%
ELECTRICITY	2.4%	2.4%	-1.1%	2.0%	2.4%	2.9%	2.9%	2.7%
OTHER**	-9.0%	-30.2%	-10.4%	22.6%	0.0%	-0.8%	-0.8%	0.0%
TOTAL ENERGY	-2.6%	-0.3%	-1.0%	-2.0%	-2.2%	-1.6%	-1.0%	0.7%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	1456	1406	1311	1589	1476.9	1383.1	1289.6	1032.5
OIL	3141	2944	3215	3029	2489.2	2019.7	1634.7	559.5
GAS*	4777	4962	4705	4268	4574.2	4852.4	5118.8	6421.0
ELECTRICITY	3052	3125	3091	3153	3229.7	3325.2	3423.7	3887.3
OTHER**	152	106	95	130	130.0	129.0	128.0	128.0
TOTAL ENERGY	12578	12543	12417	12169	11900.0	11708.7	11594.8	12028.3

* GAS includes non-energy use of natural gas in the chemical industry, and landfill and sewage gas for heat.
** OTHER includes coke and breeze, other solid fuels, and coke oven gas - forecast without SEECEM.

Table A4.9.
UK Energy Demand - Transport Sector
Business-as-Usual:

- Causing no Additional Fuel Price Changes.

CHANGE Percent Per Year	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. RET PRICE INDEX	7.5%	9.4%	5.9%	4.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
MOTOR SPIRIT	10.1%	10.3%	4.0%	9.2%	6.7%	9.4%	9.8%	9.3%
ELECTRICITY	12.4%	18.9%	3.3%	5.0%	7.0%	10.4%	10.8%	10.3%
3. ROAD PASS KMS	6.9%	2.4%	-0.1%	0.0%	4.4%	4.2%	3.0%	1.7%
FREIGHT PASS KMS	8.5%	-0.5%	2.2%	-2.3%	2.4%	2.5%	2.7%	2.6%
VEHICLES OWNED	3.8%	2.0%	-0.7%	1.4%	5.9%	5.0%	4.2%	4.1%
4. AIR PASSENGERS	6.2%	3.5%	-6.5%	16.1%	4.8%	6.0%	6.6%	7.2%
AIR FRT/CARGO	5.8%	3.6%	-6.1%	11.1%	2.0%	3.9%	4.3%	3.7%
5. RAIL PASS KMS	0.7%	1.2%	3.0%	-1.9%	2.0%	2.0%	1.0%	1.0%
RAIL FREIGHT KMS	-6.6%	-8.9%	-2.4%	-1.4%	2.0%	3.0%	2.0%	3.5%
ELEC. ROUTE	3.9%	8.1%	-0.5%	0.3%	0.3%	1.0%	2.0%	3.0%
6. PERS. DISP. INC.	5.3%	2.8%	-0.5%	4.0%	0.1%	0.5%	1.0%	2.0%
FORECASTS								
OIL ROAD	4.3%	2.7%	-0.7%	1.6%	3.0%	3.5%	3.6%	3.2%
OIL AIR	5.8%	0.3%	-6.3%	8.2%	2.2%	2.7%	3.3%	4.4%
RAIL ELECTRICITY	-3.6%	14.8%	-0.8%	1.6%	0.4%	0.5%	0.3%	2.0%
RAIL/WATER OIL	6.9%	-1.3%	3.8%	-1.4%	-0.1%	0.9%	1.2%	1.5%
OTHER*	0.0%	0.0%	0.0%	1.8%	1.7%	1.7%	0.0%	0.0%
TOTAL ENERGY	4.6%	2.5%	-1.4%	2.4%	2.7%	3.3%	3.4%	3.2%
FORECASTS								
LEVELS (in Millions of Therms)								
OIL ROAD	15007	15409	15298	15545.0	16011.4	16573.0	17164.6	19890.0
OIL AIR	2901	2911	2728	2952.0	3016.1	3098.1	3199.6	3903.0
RAIL ELECTRICITY	108	124	123	125.0	125.5	126.2	126.5	139.3
RAIL/WATER OIL	818	806	838	824.0	824.4	832.7	841.9	854.0
OTHER*	57	57	57	58.0	59.0	60.0	60.0	63.0
TOTAL ENERGY	18834	19306	19044	19505.0	20036.4	20690.0	21392.6	24849.3

* OTHER includes transport premises, such as airports and train stations - forecast without SEECEM.

Table A4.10.
UK Energy Demand - Public Administration and Defence Sector
Business-as-Usual:

- Causing no Additional Fuel Price Changes.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-1.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	12.4%	19.3%	3.3%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	10.4%	10.8%	10.3%
3. GDP PUB. ADMIN	0.0%	0.0%	1.0%	4.1%	2.9%	0.5%	0.5%	0.4%
FORECASTS								
COAL	-15.2%	-0.4%	-4.0%	-11.0%	-13.2%	-10.3%	-10.0%	-7.7%
OIL	-12.4%	-3.8%	3.4%	2.2%	-8.3%	-8.3%	-7.2%	-5.8%
GAS	-43.0%	1.5%	13.2%	7.9%	9.9%	5.9%	6.1%	7.1%
ELECTRICITY	0.2%	2.0%	4.1%	7.3%	0.5%	0.9%	0.6%	-0.2%
OTHER*	-13.8%	3.6%	-12.1%	-13.7%	-2.3%	-4.7%	-4.9%	-5.1%
TOTAL ENERGY	-7.2%	-0.1%	6.6%	4.6%	1.3%	0.4%	1.0%	2.1%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	228	227	218	194.0	168.3	151.0	135.9	83.4
OIL	941	905	936	957.0	877.5	805.1	746.9	529.2
GAS	1203	1221	1382	1491.0	1638.0	1735.1	1840.4	1907.0
ELECTRICITY	646	659	686	736.0	739.4	746.5	750.7	742.3
OTHER*	56	58	51	44	43	41	39	29
TOTAL ENERGY	3072	3070	3273	3422.0	3466.2	3479.7	3512.9	3290.9

* OTHER includes coke and breeze and other solid fuels - forecast without SEECEM.

Table A4.11.
UK Energy Demand - Public Administration and Defence Sector
Competition in the Electricity Supply Industry Increased:

- Reducing Underlying Electricity Prices Every Year after 1993.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-1.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	12.4%	19.3%	3.3%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	3.4%	3.8%	4.3%
3. GDP PUB. ADMIN	0.0%	0.0%	1.0%	4.1%	2.9%	0.5%	0.5%	0.4%
FORECASTS								
COAL	-15.2%	-0.4%	-4.0%	-11.0%	-13.2%	-10.3%	-10.1%	-7.7%
OIL	-12.4%	-3.8%	3.4%	2.2%	-8.3%	-10.2%	-9.3%	-7.5%
GAS	-43.0%	1.5%	13.2%	7.9%	9.9%	6.1%	6.3%	0.9%
ELECTRICITY	0.2%	2.0%	4.1%	7.3%	0.5%	1.1%	0.8%	0.4%
OTHER*	-13.8%	3.6%	-12.1%	-13.7%	-2.3%	-4.7%	-4.9%	-5.1%
TOTAL ENERGY	-7.2%	-0.1%	6.6%	4.6%	1.3%	0.0%	0.7%	1.3%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	228	227	218	194.0	168.3	151.2	136.7	83.4
OIL	941	905	936	957.0	877.5	788.4	715.2	447.8
GAS	1203	1221	1382	1491.0	1638.0	1737.8	1847.0	1930.1
ELECTRICITY	646	659	686	736.0	739.4	746.6	754.0	770.1
OTHER*	56	58	51	44	43	41	39	29
TOTAL ENERGY	3072	3070	3273	3422.0	3466.2	3466.0	3491.9	3261.4

* OTHER includes coke and breeze and other solid fuels - forecast without SEECEM.

Table A4.12.
UK Energy Demand - Agriculture Sector
Business-as-Usual:

- No Additional Fuel Price Changes.

	1989	1990	1991	1992	1993	1994	1995	2000
	CHANGE Percent Per Year							
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	18.9%	3.0%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	10.4%	10.8%	10.3%
3. AGRIC. PROD.	1.0%	5.2%	2.6%	2.3%	2.9%	2.6%	1.4%	1.5%
4. EMPLOYMENT	-4.4%	-1.1%	-2.5%	-5.2%	-3.8%	-4.2%	-4.6%	-3.6%
FORECASTS								
OIL	-8.4%	0.3%	2.4%	-1.2%	1.8%	-0.6%	-1.2%	-2.0%
GAS	6.7%	6.3%	2.9%	14.3%	-10.0%	6.8%	8.5%	7.8%
ELECTRICITY	-3.6%	-2.2%	1.5%	-2.2%	3.1%	-2.2%	-0.8%	-0.5%
OTHER*	-2.8%	5.7%	-2.7%	-12.5%	-3.2%	3.3%	0.0%	3.2%
TOTAL ENERGY	-5.6%	0.0%	2.2%	-0.4%	2.4%	-0.2%	-0.4%	-0.5%
FORECASTS								
	LEVELS (in Millions of Therms)							
OIL	329.0	330.0	338.0	334.0	340.9	338.3	334.4	300.6
GAS	32.0	34.0	35.0	40.0	44.9	47.0	50.9	71.3
ELECTRICITY	135.0	132.0	134.0	131.0	135.1	131.9	131.1	127.9
OTHER*	35.0	37.0	36.0	33.0	32.0	33.0	33.0	37.0
TOTAL ENERGY	531.0	533.0	543.0	539.0	551.9	550.2	549.4	536.8

* OTHER includes coal, coke and breeze, and other solid fuels - forecast without SEECEM.

Table A4.13.
UK Energy Demand - Agriculture Sector
Competition in the Electricity Supply Industry Increased:

- Reducing Underlying Electricity Prices Every Year after 1993.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	18.9%	3.0%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.1%	-0.3%	2.9%	6.0%	7.0%	3.4%	3.8%	4.3%
3. AGRIC. PROD.	1.0%	5.2%	2.6%	2.3%	2.9%	2.6%	1.4%	1.5%
4. EMPLOYMENT	-4.4%	-1.1%	-2.5%	-5.2%	-3.8%	-4.2%	-4.6%	-3.6%
FORECASTS								
OIL	-8.4%	0.3%	2.4%	-1.2%	1.8%	-1.2%	-1.5%	-2.2%
GAS	6.7%	6.3%	2.9%	14.3%	10.0%	9.1%	10.4%	10.2%
ELECTRICITY	-3.6%	-2.2%	1.5%	-2.2%	3.1%	-0.7%	-0.7%	-0.2%
OTHER*	-2.8%	5.7%	-2.7%	-12.5%	-3.2%	3.3%	0.0%	3.2%
TOTAL ENERGY	-5.6%	0.0%	2.2%	-0.4%	2.4%	0.0%	-0.4%	-0.2%
FORECASTS								
	LEVELS (in Millions of Therms)							
OIL	329.0	330.0	338.0	334.0	340.9	336.3	331.4	295.6
GAS	32.0	34.0	35.0	40.0	44.9	47.9	52.9	80.3
ELECTRICITY	135.0	132.0	134.0	131.0	135.1	133.9	133.1	132.9
OTHER*	35.0	37.0	36.0	33.0	32.0	33.0	33.0	37.0
TOTAL ENERGY	531.0	533.0	543.0	539.0	551.9	551.1	550.4	545.8

* OTHER includes coal, coke and breeze, and other solid fuels - forecast without SEECEM.

Table A4.14.
UK Energy Demand - Miscellaneous Sector
Business-as-Usual:

- No Additional Fuel Price Changes.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	8.4%	-12.6%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.0%	-0.3%	2.9%	6.0%	7.0%	10.4%	10.8%	10.3%
3. GDP SERVICES	2.6%	1.1%	-1.7%	-0.1%	1.1%	1.9%	1.1%	1.2%
FORECASTS								
COAL	-19.3%	80.4%	-8.4%	-35.5%	-10.2%	-20.5%	-8.6%	-10.6%
OIL	-7.4%	0.2%	-3.9%	-5.1%	1.1%	0.0%	-1.1%	-1.9%
GAS	-1.4%	3.6%	16.5%	-7.6%	5.6%	5.2%	3.8%	3.7%
ELECTRICITY	6.1%	-2.1%	4.8%	-3.7%	3.0%	3.8%	3.1%	3.2%
OTHER*	-6.6%	-1.4%	-26.1%	-39.2%	-3.2%	0.0%	0.0%	-9.3%
TOTAL ENERGY	20.5%	1.5%	7.8%	-6.6%	3.8%	4.2%	2.7%	2.7%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	46	83	76	49	44.0	35.0	32.0	15.0
OIL	514	515	495	470	475.0	475.0	470.0	426.0
GAS	1699	1760	2050	1894	2000.0	2100.0	2180.0	2577.0
ELECTRICITY	1798	1761	1845	1776	1830.0	1900.0	1958.0	2150.0
OTHER*	70	69	51	31	30	30	30	16
TOTAL ENERGY	4127	4189	4517	4220	4379.0	4540.0	4670.0	5254.0

* OTHER includes coke and breeze, and other solid fuels - forecast without SEECEM.

Table A4.15.
UK Energy Demand - Miscellaneous Sector
Competition in the Electricity Supply Industry Increased:

- Reducing Underlying Electricity Prices Every Year after 1993.

	CHANGE Percent Per Year							
	1989	1990	1991	1992	1993	1994	1995	2000
MAIN ASSUMPTIONS								
1. GDP DEFLATOR	7.1%	6.2%	6.7%	5.0%	1.7%	4.4%	4.8%	4.3%
2. PRICES OF								
COAL	-4.9%	3.8%	-1.9%	1.0%	-1.0%	6.0%	6.5%	7.0%
OIL	13.2%	8.4%	-12.6%	-4.0%	9.5%	9.4%	9.8%	9.3%
GAS	-9.2%	5.1%	-1.9%	4.0%	3.5%	7.0%	8.0%	7.0%
ELECTRICITY	7.0%	-0.3%	2.9%	6.0%	7.0%	3.4%	3.8%	4.3%
3. GDP SERVICES	2.6%	1.1%	-1.7%	-0.1%	1.1%	1.9%	1.1%	1.2%
FORECASTS								
COAL	-19.3%	80.4%	-8.4%	-35.5%	-10.2%	-20.5%	-8.6%	-10.6%
OIL	-7.4%	0.2%	-3.9%	-5.1%	1.1%	0.0%	-1.1%	-1.9%
GAS	-1.4%	3.6%	16.5%	-7.6%	5.6%	5.2%	3.8%	3.7%
ELECTRICITY	6.1%	-2.1%	4.8%	-3.7%	3.0%	3.8%	3.1%	3.2%
OTHER*	-6.6%	-1.4%	-26.1%	-39.2%	-3.2%	0.0%	0.0%	-9.3%
TOTAL ENERGY	20.5%	1.5%	7.8%	-6.6%	3.8%	4.2%	2.7%	2.7%
FORECASTS								
	LEVELS (in Millions of Therms)							
COAL	46	83	76	49	44.0	34.0	30.0	12.0
OIL	514	515	495	470	475.0	474.0	468.0	421.0
GAS	1699	1760	2050	1894	2000.0	2105.0	2184.0	2587.0
ELECTRICITY	1798	1761	1845	1776	1830.0	1920.0	1975.0	2270.0
OTHER*	70	69	51	31	30	30	30	16
TOTAL ENERGY	4127	4189	4517	4220	4379.0	4563.0	4687.0	5306.0

* OTHER includes coke and breeze, and other solid fuels - forecast without SEECEM.

4. Total Final Energy Demand

This chapter sums the individual sectors to provide an overview of final-user demand. Up to 1994, the four scenarios remain the same; 1994 onwards, the first three scenarios will vary in accordance with differences resulting from the possible V.A.T. taxations. The fourth one varies more as all sectors - except for the transport sector - differ from the base scenario.

Table A4.16.
Final Demand - All Classes of Consumers
V.A.T. on Domestic Fuels Introduced

ALL CLASSES OF CONSUMERS (in Millions of Therms)								
	1989	1990	1991	1992	1993	1994	1995	2000
COAL	3381	3071	3258	3049	3037	2847	2761	2557
OIL	24925	25103	25235	25539	25697	25658	26701	27632
GAS	18092	18688	19972	19440	20897	21519	22045	22856
ELECTRICITY	9225	9367	9589	9663	9748	9812	9879	10147
OTHER*	2885	2717	2584	2461	2464	2431	2381	2227
TOTAL	58508	58946	60638	60153	61843	62265	62973	66710

* OTHER includes coke and breeze, other solid fuels, coke oven gas, and solar and geothermal heating.

Table A4.17.
Final Demand - All Classes of Consumers
V.A.T. on Domestic Fuels Cancelled

ALL CLASSES OF CONSUMERS (in Millions of Therms)								
	1989	1990	1991	1992	1993	1994	1995	2000
COAL	3381	3071	3258	3049	3037	2851	2775	2424
OIL	24925	25103	25235	25539	25697	25658	26705	27501
GAS	18092	18688	19972	19440	20897	21522	22817	25986
ELECTRICITY	9225	9367	9589	9663	9748	9809	9887	9863
OTHER*	2885	2717	2584	2461	2464	2431	2381	2227
TOTAL	58508	58946	60638	60153	61843	62271	64565	68001

* OTHER includes coke and breeze, other solid fuels, coke oven gas, and solar and geothermal heating.

Table A4.18.
Final Demand - All Classes of Consumers
V.A.T. on Domestic Fuels Rushed Forward

ALL CLASSES OF CONSUMERS (in Millions of Therms)								
	1989	1990	1991	1992	1993	1994	1995	2000
COAL	3381	3071	3258	3049	3037	2845	2862	2934
OIL	24925	25103	25235	25539	25697	25640	26744	27801
GAS	18092	18688	19972	19440	20897	21516	20899	20376
ELECTRICITY	9225	9367	9589	9663	9748	9814	10103	10935
OTHER*	2885	2717	2584	2461	2464	2431	2381	2227
TOTAL	58508	58946	60638	60153	61843	62246	62989	64273

* OTHER includes coke and breeze, other solid fuels, coke oven gas, and solar and geothermal heating.

Table A4.19.
Final Demand - All Classes of Consumers
V.A.T. on Domestic Fuels Introduced and Competition in Electricity and Gas Supply Industries Increased

ALL CLASSES OF CONSUMERS (in Millions of Therms)								
	1989	1990	1991	1992	1993	1994	1995	2000
COAL	3381	3071	3258	3049	3037	2823	2703	2177
OIL	24925	25103	25235	25539	25697	25607	25902	28010
GAS	18092	18688	19972	19440	20897	21395	21885	23314
ELECTRICITY	9225	9367	9589	9663	9748	9772	10100	12185
OTHER*	2885	2717	2584	2461	2464	2464	2381	2227
TOTAL	58508	58946	60638	60153	61825	62041	62971	67963

* OTHER includes coke and breeze, other solid fuels, coke oven gas, and solar and geothermal heating.

APPENDIX V. FORECASTS OF ELECTRICITY GENERATION ENERGY DEMAND, PRIMARY ENERGY DEMAND AND EMISSIONS

Roger Fouquet

1. Electricity Generation

Forecasts of energy demand in the electricity generating market are based on Colin Robinson's estimates. The high degree of strategic interaction between generators and regional electricity companies means that projections based on time-series analysis would be futile. Instead, projections are based on existing contracts between generators (including the RECs) and fuel suppliers, as well as anticipated changes in fuel and electricity supply industries.

The percentages of each fuels assumed to be used are then applied to the total electricity demanded in order to ensure supply meets demand. This method generates the required primary inputs to electricity generation. We only display the chart for electricity generation in scenario 1 as the values differ only marginally. They are, however, taken into account to provide the primary energy demand.

Table A5.1.
Forecasts of Fuels Used in Electricity Generation

FUELS USED FOR ELECTRICITY GENERATION (in Millions of Therms)*								
	1989	1990	1991	1992	1993	1994	1995	2000
COAL	19293.0	19771.0	19744.0	18725.0	11776.0	11018	8676.0	9015.0
OIL	2761.0	3231.0	2882.0	2518.0	2487.0	2412.0	1619.0	1615.0
GAS	382.5	382.5	467.0	1019.0	4338.0	5045.0	8497.0	9247.0
NUCLEAR	6006.0	5538.0	5932.0	6665.0	8360.0	8487.0	7620.0	6894.0
HYDRO**	534.8	611.2	535.0	677.0	585.0	567.0	521.0	519.0
TOTAL***	29217.3	29773.7	31379.0	31232	29238	29200	28504	29016.0

* The values have been converted from Millions of Tonnes of Oil Equivalent (DUKES 1993 Table A13), using conversion tables from the Digest (p.11, p.123 and, for nuclear and hyrdro, dividing 1992 values in Table 3 by Table 1): coal x 1.7 x 234; oil x 406; gas x 425; nuclear x 390; hydro x 382; others x 300.
** HYDRO includes other primary renewable electricity sources.
***TOTAL includes electricity imports and autogeneration.

2. Primary Energy Demand

Adding each fuel's final demand (Tables A4.16-19) to the fuels used to generate electricity (Table A5.1) provides us with primary energy demand forecasts. Naturally, non-energy uses of oil, losses in distribution and fuels used by suppliers themselves must also be included; in 1992, these came to 5%, 2%, and 6% of the gross inland fuel consumption (DUKES 1993 p.9). The figures underneath, however, are for primary fuels - not primary energy demand - which do not incorporate surplus capacity of secondary fuels. Primary energy demand figures are quoted in conlcusion.

Table A5.2.
Primary Fuel
V.A.T. on Domestic Fuels Introduced

TOTAL PRIMARY ENERGY DEMAND BY FUEL (in Millions of Therms)						
	1991	1992	1993	1994	1995	2000
COAL	26447.0	24871.0	17957.0	16977.0	14499.0	14484.0
OIL	39873.0	40072.0	39549.0	39630.0	39216.0	41879.0
GAS	22441.0	22296.0	27283.0	28629.0	32625.0	34271.0
NUCLEAR	5932.0	6665.0	8360.0	8487.0	7620.0	6894.0
HYDRO	535.0	677.0	585.0	567.0	521.0	519.0
TOTAL***	96904.0	96152.0	95366.0	95904.0	95993.0	99713.0

* TOTAL includes other solid fuels, coke oven gas, orimulsion, electricity imports, and solar and geothermal heating.
** TOTAL includes non-energy use of oil, losses in distribution, fuels used by suppliers and statistical differences, their forecasts are assumed constant at the 1992 level.

Table A5.3.
Primary Fuel
V.A.T. on Domestic Fuels Cancelled

TOTAL PRIMARY ENERGY DEMAND BY FUEL (in Millions of Therms)						
	1991	1992	1993	1994	1995	2000
COAL	26447.0	24871.0	17957.0	16978.0	14543.0	14228.0
OIL	39873.0	40072.0	39549.0	39630.0	39256.0	41972.0
GAS	22441.0	22296.0	27283.0	28631.0	33447.0	37340.0
NUCLEAR	5932.0	6665.0	8360.0	8485.0	7642.0	6787.0
HYDRO	535.0	677.0	585.0	567.0	522.0	511.0
TOTAL***	96904.0	96152.0	95366.0	95904.0	96926.0	102478.0

* TOTAL includes other solid fuels, coke oven gas, orimulsion, electricity imports, and solar and geothermal heating.
** TOTAL includes non-energy use of oil, losses in distribution, fuels used by suppliers and statistical differences, their forecasts are assumed constant at the 1992 level.

Table A5.4.
Primary Fuel
V.A.T. on Domestic Fuels Rushed Forward

TOTAL PRIMARY ENERGY DEMAND BY FUEL (in Millions of Therms)						
	1991	1992	1993	1994	1995	2000
COAL	26447.0	24871.0	17957.0	16977.0	14736.0	15394.0
OIL	39873.0	40072.0	39549.0	39630.0	39207.0	41918.0
GAS	22441.0	22296.0	27283.0	28627.0	31594.0	32311.0
NUCLEAR	5932.0	6665.0	8360.0	8489.0	7744.0	7308.0
HYDRO	535.0	677.0	585.0	567.0	529.0	551.0
TOTAL***	96904.0	96152.0	95366.0	95903.0	95347.0	99248.0

* TOTAL includes other solid fuels, coke oven gas, orimulsion, electricity imports, and solar and geothermal heating.
** TOTAL includes non-energy use of oil, losses in distribution, fuels used by suppliers and statistical differences, their forecasts are assumed constant at the 1992 level.

Table A5.5.
Primary Fuel
V.A.T. on Domestic Fuels Introduced and Competition in Electricity and Gas Supply Industries Increased

TOTAL PRIMARY ENERGY DEMAND BY FUEL (in Millions of Therms)						
	1991	1992	1993	1994	1995	2000
COAL	26447.0	24871.0	17957.0	16898.0	14510.0	15404.0
OIL	39873.0	40072.0	39549.0	39607.0	39234.0	42210.0
GAS	22441.0	22296.0	27283.0	28465.0	32593.0	36315.0
NUCLEAR	5932.0	6665.0	8360.0	8437.0	7719.0	7959.0
HYDRO	535.0	677.0	585.0	563.0	527.0	600.0
TOTAL***	96904.0	96152.0	95366.0	95575.0	96115.0	104411.0

* TOTAL includes other solid fuels, coke oven gas, orimulsion, electricity imports, and solar and geothermal heating.
** TOTAL includes non-energy use of oil, losses in distribution, fuels used by suppliers and statistical differences, their forecasts are assumed constant at the 1992 level.

3. Emissions

Fossil fuel combustion causing most of man-made carbon and sulphur dioxide, we felt that our forecasts of primary energy consumption could provide relatively accurate estimates of future emissions. Estimates are based on the (1991) ratio of individual fuels' emissions to their primary demand; multiplying ratios by forecasts of fuels' primary demand provides an approximate measure of future emissions. Naturally, the method assumes ratios stay unchanged over time. Estimates, therefore, do not incorporate adjustments such as flue gas desulphurisation retrofitting on existing coal power stations. The general trends in emissions, however, ought to be correct.

Table A5.6.
Carbon Dioxide Emissions
V.A.T. on Domestic Fuel Introduced

CARBON DIOXIDE EMISSIONS BY FUEL (in Millions Tonnes)						
	1991	1992	1993	1994	1995	2000
COAL	64.0	54.0	43.5	41.1	35.1	35.0
MOTOR SPIRIT	21	21.2	21.5	22.2	23.0	26.7
DIESEl/GAS OIL	16	16.2	16.3	16.2	16.2	16.7
FUEL OIL	12	11.0	10.2	9.6	7.8	6.5
OTHER PETROL	7	7.1	7.3	7.3	7.3	8.0
GAS	32	30.5	38.9	40.8	46.5	48.9
TOTAL	159.0	155.0	143.3	143.3	142.0	147.8

Table A5.7.
Carbon Dioxide Emissions
V.A.T. on Domestic Fuel Cancelled

CARBON DIOXIDE EMISSIONS BY FUEL (in Millions Tonnes)						
	1991	1992	1993	1994	1995	2000
COAL	64.0	54.0	43.5	41.1	35.2	34.4
MOTOR SPIRIT	21	21.2	21.5	22.2	23.0	26.7
DIESEl/GAS OIL	16	16.2	16.3	16.2	16.2	16.7
FUEL OIL	12	11.0	10.2	9.6	7.8	6.5
OTHER PETROL	7	7.1	7.3	7.3	7.4	8.1
GAS	32	30.5	38.9	40.8	47.7	53.2
TOTAL	159.0	155.0	143.3	143.3	143.4	151.7

Table A5.8.
Sulphur Dioxide Emissions
Business as Usual

SULPHUR DIOXIDE EMISSIONS BY FUEL (in Thousands Tonnes)						
	1991	1992	1993	1994	1995	2000
COAL	2785.0	2338.4	1890.9	1787.7	1526.8	1525.2
MOTOR SPIRIT	17	17.2	17.4	18.0	18.6	21.6
DIESEL/GAS OIL	99	100.0	100.6	100.2	100.4	103.5
FUEL OIL	573	530.2	487.5	459.1	372.5	309.8
OTHER PETROL	26	26.5	27.1	27.2	27.2	29.8
GAS	0	0	0	0	0	0
TOTAL	3565.0	3012.3	2531.6	2450.4	2059.1	2047.8

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