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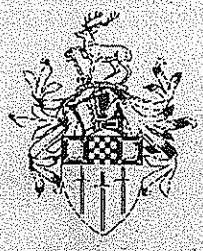
THE S.E.E.C. UNITED KINGDOM ENERGY DEMAND FORECAST (1994-2000)

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

July 1995



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THE SEEC UNITED KINGDOM ENERGY DEMAND FORECAST (1995-2000) UPDATE

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EXECUTIVE SUMMARY

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Energy Demand Forecasting Service

The Surrey Energy Economics Centre began producing annual short term forecasts in 1993. Based on a sectoral econometric model of the UK energy market, the Centre produces annual forecasts of final user energy demand. Combined with projections of electricity generators' fuel input, these figures provide indications of primary energy demand and environmental impact. Last year's results were considered accurate and anticipated the major swings in energy use in 1993, principally the explosion of natural gas use by electricity generators. The forecasting exercise also provided insight on the impact of the introduction of VAT on domestic fuel.

This year's model, in addition to being updated with the most recent available statistics, includes an additional variable, the average price of energy, in order to better represent consumer decision-making. As well as minor alterations to the model and the data, new scenarios examine the impact of the increased competition in supply of energy to the domestic sector and of potential petrol taxes levied on road users in order to abate environmental pollution.

Summary Forecast

With energy prices staying close to inflation and economic activity continuing to expand, all sectors - except iron and steel - are expected to have a growing demand for energy, particularly electricity and natural gas, and to a lesser extent petroleum products; final user coal demand will continue to fall. Transport and miscellaneous sectors are likely to exhibit the highest growth rates in demand for energy.

The electricity generated to meet requirements will come increasingly from natural gas power stations, crowding-out coal use. The main increase, after 1993, is expected in 1995; afterwards both fuels' use will rise again. Inputs of heavy fuel oil, replaced to some extent by orimulsion, and nuclear power, as the Magnox reactors are wound down, are expected to fall slightly over the decade especially after the government's review of the nuclear industry.

Overall natural gas use will continue to rise, as will petroleum products, particularly light fuel - due to the continued growth in the transport sector. Primary coal demand will drop in 1995, and grow modestly thereafter. Nuclear power is anticipated to shrink slightly. Renewables will continue to grow modestly - no break through is expected.

The shift out of coal towards natural gas will ensure that the UK meets its target of stabilising carbon dioxide emissions at the 1990 level by 2000. Beyond 2000, electricity generators and the transport sector may push emissions back up. Sulphur dioxide emissions are expected to fall, meeting the 1998 target agreed upon in the Large Combustion Plant Directive of reducing emissions 40% below the 1980 level; whether the UK will achieve the 2003 target of reducing emissions by 60% is less certain, even as more power stations install FGD systems. Achieving the same targets for nitrogen dioxide appears to be unlikely, even as catalytic converters on cars become more widespread. Such projections of emission reductions are vital in determining the government's position on environmental legislation - domestically, within the European Union and around the world.

SUMMARY TABLE: United Kingdom Energy Demand Forecasts [1]

	1993	2000 Scenario 1	2000 Scenario 2	2000 Scenario 3
Domestic Sector	17593	19562	20172	19662
Industrial Sectors	14023	14783	14783	14783
Transport Sector	19853	22899	22899	22824
Other Sectors	8123	10297	10297	10297
Final User	59592	67641	68151	67566
Electricty Generators	30023	32506	32506	32506
Primary Energy	94437	106221	106777	106115
Carbon Dioxide Emissions [2]	155	153	154	153
Sulphur Dioxide Emissions [3]	3500	2570	2554	2569
Nitrogen Dioxide Emissions [4]	2750	2772	2774	2765

1. Million therms
2. Million tonnes of carbon
3. Thousand tonnes of sulphur
4. Thousand tonnes of nitrogen

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INTRODUCTION

Roger Fouquet

The United Kingdom Fuel Mix

In the last twenty years, concerns about energy use have shifted from security of supply to its environmental impact. As a result, analysts of energy markets have moved their focus from the supply-side to the demand-side.

And in those years, partly as a result of fears about security of supply and environmental damage, as well as reforms to the structure of energy supply industries, price fluctuations and rising personal disposable income, there have been considerable changes in industrialised nations' energy use. In the United Kingdom, after the oil shocks, petroleum products lost some of their attractiveness, particularly for electricity generators and users requiring heating services. The demand for petroleum products has, however, continued to grow as the main fuel for transport services. Coal, important in heating services and the largest source of energy for electricity generators, is also being replaced. In its place, natural gas is now the main fuel for heating services. And, in 1993, natural gas has made major in-roads into the electricity generation market. Nuclear power has been slowly increasing its share of the generators market. The conclusions of the nuclear review are likely to affect this growth. The role of renewables, such as hydroelectricity, wind power and biofuel combustion, in the UK energy mix remains small.

As final users and electricity generators have gradually changed the fuels and technology used to provide the desired services, the impact on the economy and the environment has changed too. Energy inputs form a smaller proportion of total expenditure in the UK than they did ten years ago, despite cries of soaring prices. Substitutability between energy inputs is greater and sources of energy supply are more diverse than ever before. Energy use and related supply shocks, therefore, places less of a threat to the economy than previously anticipated.

Impact of economic activity on the environment has also changed, although more ambiguously. On the one hand, carbon and sulphur dioxide emissions have been declining over the last twenty years as result of natural gas and nuclear power's expanding share of primary energy demand and technological improvements. On the other hand, the level of nitrogen dioxide and particulate emissions and radioactive waste have continued to grow. Technological diffusion may ensure that these problems do not escalate. In the meantime, they are concerns for analysts of energy markets.

Forecasting Energy Demand

Energy use, and its impact on the economy and the environment, are of great concern to companies supplying energy and related-technology, observers of energy and environmental markets and policy-makers. In order to make plans and choose the appropriate course of action, these groups must anticipate future trends in energy use and its consequences. The role of forecasting these trends is an important informational service, and one that is in growing demand in the UK since the reforms to the energy supply industries.

To reliably forecast energy demand, an understanding of its determinants is

necessary. The principle determinants of aggregate energy demand are the price of energy, the level of economic activity and wealth, and air temperature. These must be modeled in a manner that reflects how they influence demand. In addition, it is necessary to have some reliable understanding of how the determinants will vary through time.

Within the UK, there have been various attempts to forecasts energy demand most recently, for example, the Department of Trade and Industry has produced long-term forecasts of energy demand and environmental impact.

The Surrey Energy Economics Centre has, since 1993, produced annual short-term forecasts. Based on a sectoral econometric model of the UK energy market, the Centre produces annual forecasts of final user energy demand. Combined with projections of electricity generators' fuel input, these figures provide indications of primary energy demand and environmental impact. Last year's results correctly anticipated the major swings in energy use in 1993, principally the explosion of natural gas use in by electricity generators. The forecast also provided insight to the impact of the introduction of VAT on domestic fuel.

The Aims

With hindsight, there are always improvements to be made. This year's model, in addition to being updated with the most recent available statistics, includes an additional variable, the average price of energy, to better represent consumer decision-making. As well as minor alterations to the model and the data, new scenarios examine the impact of the increased competition in supply of energy to the domestic sector and of potential petrol taxes levied on road users to abate environmental pollution.

Outline

This occasional paper begins with a discussion of the world oil market and prices. This analysis is followed by a discussion of energy policies in the UK. These two pieces form the basis for making projections of UK fuel prices presented in section four. The next section explains changes made to the forecasting exercise. Section six analyses the energy demand and environmental forecasts. The conclusion discusses what these forecasts might imply to policy-makers in particular, and suggests potential improvements. The appendix presents the forecasts made.

PROSPECTS FOR OIL PRICES TO END 1996

Paul Stevens, Centre for Petroleum and Mineral Law and Policy, University of Dundee

International prices

The view taken in the last forecast about international oil prices (formulated at the start of August 1993) has proved remarkably accurate. Furthermore, the underlying analysis behind that forecast remains largely valid today. The following views were expressed:-

1. "while Saddam Hussein remains in power, Iraqi oil will remain absent from the market in any substantial quantities".

This has been the case. UN sanctions remained despite growing pressure, especially from Russia and France. This is simply because the US, for purposes of domestic political imperatives, could not allow Iraqi oil back while Saddam Hussein remained in power. With the Congressional elections looming in November 1994, no American politician could afford a triumphant Saddam on network television. The only change since mid 1993 has been increased leakage of oil exports via Iran adding to the existing leakages through Turkey and Jordan. This remains insignificant for the international market although total leakages are providing sufficient foreign exchange to maintain Saddam's grip on power.

The underlying view contained in the last forecast remains valid. Iraq is likely to remain out unless there is a change of regime in Baghdad. This view runs counter to the current conventional wisdom which believes that pressure for an Iraqi return will grow to such a level as to become irresistible. However, despite strong reservations by many about the legality of its position, the US insists on an interpretation of the UN Resolutions which allows it to continually shift the goal posts. Currently, the main thrust of the US position is the lack of human rights, an area where Baghdad realistically can offer little. Privately, US administration officials admit that if backed into a corner by the rest of the Security Council, the US will simply use its veto to prevent an Iraqi return. This view of continued Iraqi absence is reinforced when it is remembered that the next US Presidential campaign will probably swing into action as winter approaches.

If Iraq were to return, it would have a significant impact. Iraq could export 2 million b/d rising quickly to over 3 million b/d within 3 months assuming no constraint on export capacity. Subsequently, with foreign company help it could rise quickly to much higher numbers. In addition, Iraq's return would force the negotiation which OPEC has continually avoided simply because it is so controversial. Failure of OPEC to reach a plausible agreement to allow re-entry would cause a price collapse. For how long prices would stay low remains uncertain. Potential Iraqi capacity will remain as a dampener on the market for the period under review. Despite the views outlined above, many elements in the market will see an Iraqi return behind every discussion of UN Sanctions in New York.

2. "the oil market will be comfortably supplied. ... upward pressure on price is an extremely unlikely option provided there is no substantive change to Saudi Arabia's policy. ... oversupply is likely to continue ... a price collapse along the lines of 1986 cannot be ruled out."

At the time of the last forecast, the oil price had averaged $17.20 (Brent) during June-July and $18.34 during January-May. Subsequent oversupply remained the norm and, as can be seen from the figure, in the fourth quarter of 1993 the oil price fell to around $13 largely in response to a surge in North Sea production which appeared to take the market by surprise. Prices recovered during the second quarter 1994. Dated Brent rose from $13-14 per barrel in February and March to $17-18 per barrel by summer. However, this was driven largely by fund managers moving into all commodities (including oil) in response to a poor performance by equity markets. In April 1994, NYMEX's "speculators category" for oil showed an increase in transactions from 10,000 to 100,000. During summer, price again weakened as fund managers withdrew their interest. In August, speculative transactions fell to 25,000. This was despite a serious strike which affected Nigerian production.

The consensus prevalent since the OPEC meeting in November 1994 is that, absent Iraq, the market is likely to become tighter as the year progresses. This is based upon the assumption that oil demand will grow while OPEC maintains its quota fixed at 24.52 million b/d for 1995.

This view may be wrong. The 1994-5 winter has proved so far (end of February) to be relatively mild which threatens a potentially dangerous stock build for the second quarter of 1995. This could generate significant price weakness.

The general view is that 1995 will see marginally higher economic growth than 1994 but that oil demand is likely to repeat the pattern of 1994. It is likely that non-OPEC production may rise. In 1995, North Sea production will continue to expand adding some 500,000 b/d to the 800,000 b/d added in 1994. As always, Russian exports remain an enigma. In 1994, they were up 8 percent and the official target is for a similar rise in 1995. However, there are constraints upon the capacity of export facilities and there remains great uncertainty over export taxes and licenses. On balance, absent any major upheaval in Russia, their exports are most likely to maintain current levels with a possibility of steady growth over the next two years.

During the last 18 months, OPEC, apart from Saudi Arabia and Kuwait, has probably been producing close to capacity. Many capacity plans have been shelved reflecting financial constraints. Indeed, for many countries the problem lies in finding resources to maintain existing capacity. Iran provides an example. The official line from Teheran is that capacity is 4.2 million b/d shortly to rise to 4.5 million b/d. However, it is clear that many projects have been delayed. In particular the crucial gas reinjection programmes are being hampered by a lack of finance and an inability to secure effective foreign company involvement. Given Iran's acute financial crisis, it seems inconceivable that they would not have produce more than their 3.6 million b/d quota in 1994 had they been able.

Most of the OPEC governments require revenues immediately. In particular, a number such as Algeria, Iran and Nigeria need higher revenues to contain political discontent which is driven largely by failed economies. If the market does show signs of tightening and prices rise, these financial pressures are likely to encourage some squeezing of additional barrels. Thus it is quite likely that the benefit of improved prices may be taken in volume weakening many gains.

As always, a key issue will remain Saudi Arabia's oil policy. At the end of the November 1994 OPEC conference, Hisham Nazer stated that the objective was "higher prices". However, it remains to be seen whether Saudi Arabia is willing to take explicit action to achieve this aim. It is also uncertain how far any action can actually control prices. In the current market, all that Saudi Arabia (with or without OPEC) can do is to try and ensure that global supply approximates to global demand. If that is achieved, it only creates a very wide range within which the traders and speculators then set the market price for crude. It is not clear whether Saudi Arabia (with or without OPEC) is capable of fine tuning the market. They are just as likely to overshoot (or undershoot) and force prices too low (or too high) given their objectives.

Taken together, all this is a recipe for price volatility which is likely to characterize the period. Evidence increasingly suggests that oil prices are becoming more volatile than most other commodities (A. Plourde & G.C. Watkins, How volatile are crude oil prices? OPEC Review Vol XVIII No 4 Winter 1994.). However, absent a politically induced supply disruption which can never be ruled out, on average, prices are likely to stay weak in the stlg15-17 range for the next 2 years.

UK Prices

As explained in the previous forecast, absent dramatic price changes, international oil price movements are unlikely to feed into significant changes in consumer prices. Close to the top of the UK Government's policy agenda is the need to raise tax revenue. 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. Oil products will continue to attract high levels of tax. In the last Budget (November 1994) road fuels attracted a 5 percent increase in duties with inflation for the following 12 months forecast at below 3 percent. 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 under the banner of protecting the environment, especially given that road building is currently an increasingly sensitive issue. Even higher international prices are likely to have limited impact. For petrol in the UK, currently only 14 percent of the pump price (premium unleaded) is the actual international price of gasoline. This 14 percent also includes refining and transportation costs. The remainder is sales tax and marketing margins. Thus the cost push element of international prices is relatively minor.

Conclusion

Oil product prices to the UK consumer will not fall in real terms. The most likely outcome is a gradual rise in real terms of around 5 percent per year.

THE UNITED KINGDOM POLICY ENVIRONMENT

David Hawdon

Although the UK government has sought to reduce its direct involvement in the running of the UK energy sector, its influence on the British energy markets remains significant. This section examines some of the main developments in policy-making that could determine the course of UK energy markets.

The Profits of Privatisation

Public concern over the high profit levels achieved by the privatised electricity and gas uti9lities have created an expectation of government intervention in the industries. At one level this is rather surprising. In a competitive market, varying levels of profit are to expected as competition weeds out the inefficient and rewards the efficient producers. The industries were expected to make efficiency gains as they moved from public to private ownership. To some extent the criticisms can be explained in terms of political payoff - the privatisation programme was the creation of one party, and any problems in the outworking of this programme obviously provides a source of political advantage to the opposition. The closer we move towards an election the more each party will use available information to its advantage. Such criticisms are only to be expected. What does not seem to have been anticipated is the extent of the distributional effects of privatisation and the ability of the management of the utilities to use private information to their own advantage. This is the nub of criticisms of high executive share holding gains accompanied by real reductions in labour force levels and remuneration together with perceived falls in the quality of consumer service.

Actions of senior management can be explained as a rational response to expectations of increased competition and tightening regulatory regimes. Share options bring about a transfer of monopoly profits from shareholders to managers. Managers have a first mover advantage in a game with poorly informed shareholders. Future uncertainty regarding profits increases the costs of waiting for rewards and the value of non performance related transfers.

After the event it is likely that remuneration rules will be further reinforced to remove profits from managerial discretion. We would expect a more rigorous regulation regime over the next five years.

The Environment of the Environment

The weakening of environmental policy has manifested itself in various ways during 1994 and 1995. The UK has accompanied most of the EU countries and the US in abandoning moves to impose specific carbon taxes. The expected second round of VAT increases has not materialised for 1995. In addition the work of the Energy Saving Trust has been minimised by failure of the regulators of both electricity and gas industries to authorise significant activity by the Trust. The government appears not to feel that further activity is needed to achieve CO_2 emission reduction targets by 2000, the year agreed at the Rio earth summit in 1992.

Expected Changes in the Gas Industry

The new gas bill, announced on 3 March, makes provision for the extension of competition to domestic consumers of

gas by 1998. Competitors will not be allowed to 'cherry pick', and will have to compensate British Gas for any disproportionate bearing of social costs. Statutory responsibilities are to be converted into specific one or five year contracts with customers, which will be policed by the Regulator. The bill increases the influence of the Regulator by requiring scrutiny of competitors licenses. The bill takes account of British Gas's reservations about competition, although it creates a potential minefield of disputes about behaviour which will deter potential entrants from an over aggressive approach to competition. Nevertheless we expect some downward pressure on prices to result during the five year period of the forecast.

Disatisfaction with the operation of the electricity pool is another factor which may lead to stronger regulation of energy markets.

The Nuclear Review

In May 1995, the government published its conclusions about the nuclear review. It proposed that in the present state of the electricity supply industry there was no need for further publicly-funded nuclear power stations. It would allow, however, private capital to support any future projects, and, therefore, intends to privatise the AGR & PWR stations run by Nuclear Electric, as well as BNFL. The ageing Magnox reactors would remain in public hands.

These conclusions will keep nuclear's share of the electricity fuel-mix stable for a few years. Privatisation may give the industry an efficiency boost, increasing its competitiveness and share of the electricity market. Once, however, the Magnox reactors are decommissioned this share is likely to fall slightly. Any nuclear reactors that might be built with private money will not be completed until well into the next decade and so do not fit within this forecasting exercise.

Since the AGR and PWR stations are expected to be privately-owned by the end of 1996, the State will no longer have to concern itself with how to cover their decommissioning costs. This will be a worry for the private sector. Thus, once this part of Nuclear Electric is privatised, the levy on electricity users for their liabilities will stop. In addition, the conclusions of the Nuclear Review suggest that as a result of future earnings from the sale of electricity from the public-owned power stations and the sale of AGR and PWR power stations, the decommissioning costs associated with the Magnox reactors will be covered. Therefore, the levy placed on electricity use to accommodate the decommissioning of Magnox reactors will also be dropped when the other stations are privatised. This decision could lead to a fall in electricity prices after 1996.

ENERGY PRICES IN THE UNITED KINGDOM

David Hawdon

Past Projections and Actual Prices

• Domestic Energy Prices

Projections of energy prices formed an important part of the basis for our forecasts of energy demand in the first Occasional Paper. In view of the substantial change in energy policy which resulted in the imposition of VAT on domestic fuels it is hardly surprising that the eventual outcome for prices differed from the assumptions we made in December 1993. We will look at these deviations shortly. First, however, we must refer to an equally important source of error - revisions to prices for the year immediately preceding the forecast.

Our forecast was made before full data was available on prices in 1993. We believed at that time coal prices would rise by 2% - in fact they barely changed in the year. In real terms we forecast a rise of 0.3% whereas, in fact, coal prices fell by 3%. To some extent this revision to our coal prices helps to explain the slightly higher than expected coal demand in 1993. Our estimated oil prices were also lower than actually occurred. The impact of the regulatory framework on gas and electricity prices was in similar fashion underestimated. Since all fuel prices were lower than expected our model should have predicted higher energy demand. In the outcome, however, apart from coal, demand was lower than would have been forecast. Thus, although the outcome in 1993 was very close to the estimated demand, this was due to compensating movements in other exogenous variables rather than to the estimated effects of prices.

Turning now to the performance of our price projections for 1994, we find some significant differences between forecast and out-turn. Oil prices had been expected to rise by 10% under the influence of higher environmental taxation as well as the VAT imposition. In fact, they rose negligibly. This is difficult to explain in the light of rising world oil markets throughout 1994, but may reflect the relatively weak position of oil in the domestic sector market. Gas and electricity prices were lower than expected because of the low rate of inflation in the economy working through the price capping mechanisms. Electricity prices were particularly severely restrained to a growth of 3.3% compared with our previous prediction of 12.4%. These lower than expected prices are likely to account for some of the extra fuel demand recorded for this section in 1994.9

• Transport Sector Prices

We had forecast a growth of 9.4% in motor spirit prices in 1994. In fact, this forecast is not far off the mark at the beginning of the year, before the extra tax was added. By August 1994, prices were only 7.1% higher than in the previous year and this fell to only 4.6% by December. Substantial competition from supermarket forecourt petrol outlets may be responsible for this lowering of the tax impact.

• Industrial Prices

Here again our price projections turned out to be too high. In fact, prices of coal, gas and electricity fell slightly in 1994 while we had predicted increases of between 6% (coal) and 10% (electricity).

Our best projection was for oil prices where growth of 8.1% was far off the projected growth of 9.4%. Differences in market conditions and structures no doubt account for the lack of correlation in prices in industrial markets. The same phenomenon was observed for 1993 when again we overestimated prices.

Industrial Fuel Prices Projections

• Heavy Fuel Oil

One of the principal difficulties in forecasting the price of heavy fuel oil is the wide difference between international and UK oil prices. Thus, IEA data indicate that between the 4th Quarter of 1993 and 3rd Quarter of 1994, in the North Western European market spot crude oil prices rose 14.7%, spot high sulphur heavy fuel oil prices by 70.1%, low sulphur heavy fuel oil by 41.8% while the internal UK market heavy fuel oil prices increased only by 26.9%. Of course, exchange rates and taxation explain some of the difference between the UK and other markets, but probably not more than 10% of the difference. Even in the current market oriented climate, long term contracts and oligopolistic relationships between UK oil companies, mean that the price of oil in the UK responds only imperfectly and slowly to world oil prices.

Much of the rise in heavy fuel oil prices in relation to crude oil is due to a9 relative shortage of residual fuels. Oil companies have steadily improved the recovery capacity of refineries so that less heavy fuel oil is now available. This means that prices are now much more responsive to temporary surges in demand than in the past. For example, prices fell by 10% during the fortnight after Christmas due to unusually mild weather. Prices have since then more than recovered, whilst crude oil prices continue to decline. A further contributory factor is the ongoing recovery of industrial activity. We would expect heavy fuel oil prices to remain relatively high throughout 1995.

In the medium term however, oil prices will show a tendency to fall. Output of crude oil outside the OPEC area is growing. The UK is developing the region west of the Shetlands using new technology which allows economic operation of fields in up to 3000 feet of water. Norway's production is likely to surge over the next three year making it the second largest exporter after Saudi Arabia. South America and Asia are also displaying significant output growth. Within OPEC the acute revenue needs of Saudi Arabia and Kuwait will impose persistent pressures to expand exports. The return of Iraq to the world oil market is likely within the next two years, and will again make for more abundant oil supplies.

Further ahead, supplies are again likely to be concentrated in the hands of the OPEC producers. At the same time both demand growth and environmental concerns will lead to raised domestic prices.

• Coal

The emergence of the newly privatised UK coal industry at the end of 1994 removes certain aspects of uncertainty surrounding future coal prices while leaving others still to be resolved. Claims arising from subsidence due to previous mining operations, for example, will be handled by the State in the form of the new Coal Authority, and do not have to be met by the private coal operators. Uncertainty about the long term future of the industry was reduced when the Labour Party indicated that it had no intention of renationalising the industry.

Nevertheless it is too soon to evaluate the likely course of competition in the coal market. If, as indicated prior to privatisation, RJB, the new owner of English and Scottish coal regions, carries out its intention to displace imports, an aggressive price strategy is indicated. It is difficult to see targets of 34 million tonnes of coal by 1999. If sales to electricity generators fail to grow as anticipated and it becomes necessary to raise revenue by extra sales in the industrial sector it is possible that coal will fall. The risk for RJB is that there will be a smaller potential market in electricity than it assumed at the time of the bid.

The role of the smaller independent producers is likely to be crucial in the industrial market. The future of these pits depends crucially on success in this and the domestic market since they do not have access to electricity market contracts. They are likely to compete keenly for customers and to keep coal prices low.

Coal prices charged by the major exporters drifted lower both in 1993 and 1994. This process is likely to continue throughout 1995. In the long9er term, economic growth in Asia is likely to lead rising coal prices which may be reinforced by higher levels of environmental taxation.

• Gas

British Gas' intention to raise gas prices in line with UK inflation together with the increase in standing charges announced in November will enable it to raise profits in the period immediately before deregulation of the market in 1998. The opening-up of the domestic market is likely to stimulate competition in all markets and will provide the opportunity for lower gas prices. The removal of cross subsidies between markets is likely to benefit larger consumers including industrial consumers.

The development of UK's biggest remaining untapped gas reserves (2,600bn cubic metres), the Britannia field off Aberdeen, will provide large supplies for the first time to independent gas companies. Although this will provide opportunities for effective competition in the sector, any impact on prices will be moderated by the opening of an interconnector pipeline with Europe. The interconnector will enable producers to sell in the European market if prices in the UK fall below European levels. In any event we are likely to witness the development of a spot market as uncommitted gas becomes more widely available in the late 1990s. It will be important for the government to ensure that British Gas is not able to control gas transmission prices, so that cost reductions at this time are passed on to consumers.

We anticipate higher gas prices as the industry moves towards deregulation followed by some lowering of gas prices in the late 1990s as new capacity comes on stream.

• Electricity

Growth in demand for electricity lies behind many of the improved financial results reported in the sector. In combination with emergency closures of some nuclear plant, it also produced significant increases in Pool prices in early January. Nuclear Electric's closure of Heysham 1 due to the appearance of hairline fractures following its earlier closure of Dungeness B, had an impact on prices which was heightened by cold weather and by the closure some coal fired plant. Although this effect is likely to pass once the winter period is over, it illustrates the sensitivity of the system to

unexpected loss of capacity, particularly in peak periods.

Changes in ownership of the electricity sector will probably have beneficial effect on prices in 1995. The regional electricity companies are to dispose of the National Grid in the early part of the year. One consequence is that domestic customers are to be offered one-time payments. It would be strange if industrial customers were not also to benefit from a sale which is anticipated to raise £4 billion. The government's sale of its 40% share in the generators should also benefit consumers as well as shareholders.

Continued active take-over bidding for regional electricity companies indicates that substantial changes in ownership may be expected. Since the Regulator's approval has to be sought for any change of ownership, it may be expected that some of the profits from such bids will be passed on in the form of lower prices to consumers.

Future prices are likely to reflect increased competitive activity in the industry.

CHANGES TO SEECEM FORECASTS

Roger Fouquet

This section explains the changes made to the model, the data, the resulting elasticity estimates and the scenarios used to produce forecasts, after the 1993 forecast exercise.

Model

The SEEC energy demand model disaggregates UK fuel users into seven sectors: domestic, iron and steel, other industry, transport, public administration and defence, agriculture and miscellaneous which includes services. Apart from the miscellaneous sector and to some extent the other industry sector, these groups incorporate similar decision-makers. Therefore, in this model, UK fuel users are separated into groups for which the determinants of demand are - more or less - the same. For example, domestic demand depends on households' disposable income, iron and steel fuel demand is a function of production in that sector.

Nevertheless, there was also an attempt to homogenise the major factors that influence demand across sectors. Therefore, in each sector there is one activity variable, two price variables and, for certain sectors, a temperature variable.

The sectoral activity variables have remained the same as in the previous forecasting exercise. In the domestic, road fuel and air fuel sectors, demand depends on personal disposable income. In the other sectors, it is determined by the sector's index of production; for miscellaneous users, the index is based on total services. This activity variable drives demand.

Two price variables are also used, as opposed to one previously, to highlight the two-stage decision-making process. Decision-makers seek first to allocate an energy budget as a proportion of total expenditure. Allocation will be a function of the average price of energy in that sector relative to the overall costs in the sector. Average price of energy is calculated by summing all fuel prices in a particular sector each weighted by the amount of the particular fuel consumed in that sector and divided by the total consumption in that sector. Overall costs is measured by the retail price index for domestic and transport fuel users, and the GDP deflator for other sectors. Average price is divided by the overall costs to estimate the relative price of energy. This variable was only included in the domestic sector before.

The main price variable in the previous forecasts reflected the second part of the decision-making process. Once an energy budget has been allocated, the user decides which fuel amongst the available ones (usually, coal, petroleum, natural gas or electricity) to use. This second choice depends on the price of each individual fuel in the sector relative to the average price of energy in that sector. The two price variables are now both used.

In addition to these three variables, a temperature variable is included for sectors where heating forms an important part of the energy-derived services. The temperature variable used is the annual average for Great Britain.

These four main variables form the basis upon which energy users choose their level of consumption. As in the previous exercise, a cointegration approach is used

to model how these variables influence demand. There is both an economic and statistical reason for choosing this approach.

From an economic perspective, it is assumed that a decision-maker has an ideal or preferred choice of energy consumption from a particular combination of production, relative energy and fuel prices, as well as temperature. The decision-maker wants to use that ideal amount. Because the combination of production, prices and temperature is constantly changing and the decision-maker's consumption level depends considerably on the energy-using equipment available which cannot be instantly traded for a more appropriate appliance, there is a lag between the decision-maker's ideal and actual level of energy consumption. Through time, the lag or error will adjusted, and the decision-maker will move towards his/her ideal or long-run consumption level. The cointegration approach or error-correction model (which have proven to be equivalent) takes account of the long-run adjustment process through the error correction term (ECt) in equation (1), as well as the short-run effects of or immediate reactions to the production, price and temperature variables.

$$\begin{aligned} D_{ist} = {} & \beta_0 + \beta_1 \,.\, \Delta(P_{est}/RPI_t) \\ & + \beta_2 .\, \Delta(P_{ist}/P_{est}) \\ & + \beta_3 \,.\, \Delta\, Y_{st} + \beta_4 .\Delta X_t \\ & + \beta_5 .\, [Dis_{t-1} - \alpha_0 - \alpha_1 .(P_{ist-1}/P_{est-1}) \\ & \quad - \alpha_2 .\, Y_{st-1} - \alpha_3 .X_{t-1}]. \quad (1) \end{aligned}$$

From a statistical perspective, the cointegration approach is important for estimating reliable elasticities. A simple linear estimation of price and activity elasticities would be based on data that rises through time, because most of the energy-related time-series data appears to moving along a trend (see charts). As a result, the estimates are unreliable. To resolve this problem, the data must be transformed so that it does not trend up or down but, through time, remains around a constant. By differentiating the data, and basing estimates on the change in fuel demand, the elasticity estimates should be more reliable. This procedure can, however, only be done if the demand (not the change in demand) is cointegrated with the price and activity variables. Cointegration means that although each variable individually is integrated of order one (I(1)), (i.e. they trend up or down), they all trend together and, therefore, the difference between demand and the other variables remains around a constant value. That is equivalent to saying, the error or lag between the ideal and actual consumption oscillates around zero, and does not continue to get larger as would be the case for variables that trended at different rates.

This approach that takes account of the nature of the data once again forms the basis of activity and price elasticities of demand estimates.

Data

With respect to the 1993 forecasts, certain changes were made to the data used to create estimates. First, the data includes more recent years. Because the data for 1994 has not yet been published in the Digest of Energy Statistics (Department of Trade and Industry), the data incorporates only 1993 values. Second, as in many statistical series, some of the data series have been revised as statisticians receive additional information about the relevant economic behaviour. These revisions have been incorporated in the SEEC model. Third, indices, such as the index of production for the iron and steel sector, have in many cases been changed from 1985 to 1990, thus, shifting the whole series downwards. The most

recent indexed series are used here. Fourth, for each sector, there is now an additional variable, the relative price of energy which did not previously exist. All these changes to the data, as well as the actual model, mean that the elasticity estimates will be different.

Elasticity Estimates

In the larger, more homogeneous sectors, such as domestic, iron and steel and transport, also the miscellaneous sector, elasticities hardly changed - even with the introduction of relative energy price variables.

Domestic income elasticities are once again very low in the short run. In the long run, values are closer to unity for gas and electricity. For coal and oil, they are negative, showing a preference for the cleaner, more efficient fuels. Also as expected, relative fuel price elasticities are all negative. This indicates that if a fuel price rises relative to the average energy price in that sector (because of the weights attached, the price of natural gas is the main determinant of average domestic energy price), decision-makers will have a tendency to shift away from that fuel towards a cheaper one.

Although the introduction of a relative energy price variable did not have a great impact on other elasticities, they still provided interesting estimates. In the short-run, all estimates in the domestic sector of the impact of the average energy price relative to retail price index on specific fuel demands are negative. In the long run, however, only the elasticity for natural gas is negative. The others tend to be small and positive. Two possible forces are at work. First, as suggested earlier, the average energy price in the domestic sector has a two-thirds weighting on natural gas. Therefore, relative energy price variable will be negatively related with gas demand, and positively with other fuels, through the fuel-substitution effect. Second, an important feature between 1960 and 1993 was a high growth in retail price index. If overall costs have risen, the budget allocated to energy may have shrunk. This forces consumers to gradually reduce consumption of the particular fuel or shift towards efficient natural gas. Since the retail price index is the denominator of the relative energy price variable, when it increases, demand for inefficient fuels may fall.

Generally, it appears that both budgetary constraints (such as retail price index rises) and budgetary improvements (such as increases in disposable income) can lead eventually to shifts out of the less efficient fuels (principally, coal and oil) towards highly efficient ones, mainly natural gas. This naturally can cause non-standard elasticity signs, although they seem appropriate.

As stated earlier, estimates in the larger sectors tend to be unaffected by model and data changes (see tables). In other sectors, mainly the agriculture and public administration sectors, there does appear to be some variation. For those sectors, estimates were expected to be unstable. Fortunately, because these sectors are relatively small, estimates may only mildly alter the overall energy picture.

The fact that elasticity estimates remain mostly unaffected in spite of all the changes in made to the model and data indicate a high degree of stability, and suggests that they are reliable estimates. And, since the domestic and transport sector, which have particularly stable estimates, between them make up two-thirds of the UK's energy requirements, overall forecasts made should be relatively accurate - provided projections of explanatory variables are correct.

Scenarios

To produce forecasts using the elasticity estimates, projections of the related explanatory variables need to be formulated. Price projections were derived from the previous discussion about world oil prices, UK energy and environmental policies. Projections of activity variables are, unless otherwise specified, kept the same as for the previous forecasting exercise; for a complete explanation of projections see the previous paper (R. Fouquet, D. Hadon, P. Pearson, C. Robinson & P. Stevens, The Future of UK Energy Demand - The S.E.E.C. United Kingdom Energy Demand Forecast (1993-2000). S.E.E.C. Occasional Paper no.1, 1993)

Initially, a base scenario is presented, which gives the general expected trend of explanatory variables. In addition, to allow for different possible policy developments, two other scenarios are presented: one to take account of natural gas and electricity price falls in the domestic sector resulting from increased competition in those fuel supply industries, the other to examine the impact of the UK Government complying with Royal Commission on Air Pollution's recommendation to increase road fuel prices. Unless specified, the variables in the two alternative scenarios will change at the same rate as the base scenario.

The trend in personal disposable income taken from a combination of projections, including the National Institute Economic Review forecasts, is expected to average 2.8% up to the end of the decade. For the same period, industrial production will grow at 4% per year. The rates for iron and steel, agriculture and public administration and defence will be between 1% and 1.5%.
The retail price index and GDP deflator have been assumed to rise at the same rate: 2.6% in 1994, 3.9% in 1995 and 4.5% in 1996 onwards. Domestic average energy prices will rise at an average of 1% per annum above the RPI rate; electricity prices are expected to be two percent below the average rate. Non-domestic average fuel prices will grow below the GDP deflator until 1999. In general, the price of petroleum products will grow fastest; coal and electricity prices will increase at a relatively slower rate, particularly before in 1996. In the transport sector, as a result of tax levies, real fuel prices will rise by 5% per annum.

An alternative scenario proposed is that competition in the supply industries initially introduced to large consumers will be extended to all. This would put downward pressure on domestic prices. In this scenaio, nominal gas prices are anticipated to be 1.5% lower than in the base scenario and nominal electricity prices about 1% lower. This means that, because of the weighting placed on gas prices, average energy prices in the domestic sector will fall by more than 1% compared to the base scenario. So, although real gas prices fall slightly, real electricity prices actually will be marginally higher than in the base scenario. Of course, real coal and petroleum product prices will be considerably higher.

The third scenario proposes that the UK Government seeks to follow recommendations made by the Royal Commission on Air Pollution about further increases in road fuel prices. This is in an attempt to reduce energy use and air pollution from the transport sector. Recommendation 29 of the Royal Commission states that the real price of road fuel should double in the ten years up to 2005. This is equivalent to an annual growth rate of 11.4% in nominal prices. The base scenario suggests it will be approximately 9.5%.

ENERGY DEMAND AND ENVIRONMENTAL FORECASTS

Roger Fouquet

Final Users Demand

This section gives a brief outline of final user energy demand forecasts between 1994 and 2000, indicating how they change according to scenarios (Table 1). Projections of energy use by electricity generators, primary energy demand is forecast, enable estimates of carbon, sulphur and nitrogen dioxide emissions to be made over the same period. These forecasts are presented in that order.

- Domestic

Overall energy consumption in the domestic sector is expected to rise at an annual rate of 1.4% between 1995 and 2000 to 19,562 million therms. A combination of modest, 1.5% per annum, growth in natural gas and a rapid, 4%, rise in electricity demand will outweigh the decline in coal and the stabilisation of oil demand.

If natural gas and electricity prices and, therefore, average energy prices are lower than assumed in the base scenario as a result of competition in the energy supply industries, overall energy demand will rise at an annual rate closer to 2%, reaching 20,000 million therms by 2000. Natural gas and electricity prices in the competition scenario are projected to decline by 1.5% and 1%, respectively. Because of the large weighting of natural gas in the average energy price in the domestic sector, only the real price of natural gas is lower in the competition scenario rather than the base scenario, while other fuel prices have risen in real terms. As a result, competition in the energy supply industry leading to the price cuts in the proposed scenario only increases demand for natural gas from an annual growth rate of 1.5% to nearly 2.5%. For other fuels, the competition reduces demand. If, however, the scenario projected that the decline in electricity prices was greater than the decline in average energy prices, competition in the energy supply industries would be expected to push up demand for electricity.

- Industrial

In the industrial sector, energy demand will rise slightly from 14,174 million therms in 1995 to 14,784 million therms in 2000. The continued decline of fuel demand in the iron and steel sector minimises the mild growth in demand in other industries. The greatest victim of this trend are coal suppliers. Industrial use of coal, coke and breeze is anticipated to fall by over 20% from 2,919 million therms to 2,206 million therms between 1995 and 2000. After an intitial decline, industrial demand for petroleum products is expected to rise at annual rate of 3% over the same period. Natural gas consumption will finish at the same level, although some fluctuation is expected within the period. Most significant, however, is the rise in industrial electricity demand, anticipated to be above 4% per year for the whole period.

- Transport

Most fuel in the transport sector is consumed by road users. Road users' share of 80% in 1993 is expected to remain more or less constant up to 2000. Forecasts indicate that road fuel use will grow steadily at approximately 1.8% per year over the next seven years. This is

despite the fact that road passenger kilometres are anticipated to fall initially before growing at 1.7% per year. Although, in the base scenario, fuel prices are assumed to rise at 5% per annum in accordance with Government's budget proposals, their effect on demand is minimal. It should be noted that - because road fuel prices are stationary and, therefore, in theory, have no long term effect on demand - the role of fuel prices is indirect via road passenger and freight kilometres and the number of vehicles owned. In consequence, the model may under-estimate the effect of prices on road fuel demand.

The alternative scenario proposed was that the Government follows in part the Royal Commission's recommendations on air pollution. In an attempt to discourage driving and ensuing air pollution, recommendation 29 suggests doubling the real price of oil between 1995 and 2005. This, using the predicted retail price index, is equivalent to a nominal rise of 11.4% per year. As the model assumes non-stationarity and, therefore, no long term price-effect on demand, the impact of the real price rise on road passenger kilometres, freight kilometres and vehicles owned is negligible. The forecast decline in demand resulting from following recommendation 29 is less than 1% by 2000. It should be noted, however, that a continually rising real oil price contradicts the assumption of non-stationarity. It might be reasonable to expect some long term effects of prices on demand that the model does not incorporate.

The remaining 20% share of the transport energy market is also expected to grow steadily up to the end of the century. This is especially true of the air oil demand, which is forecast to rise at a rate of nearly 4% per year after 1995. Petroleum products used for waterways and railways are expected to rise at around 1% per year.

- Other sectors

The most significant rise in energy demand is anticipated in the other sectors. The twenty percent rise between 1995 and 2000 is evenly shared by the public administration and defence sector and by the miscellaneous sector. Natural gas use is forecast to rise by over 5% per annum in these sectors. Growth in electricity demand in the miscellaneous sector is expected to be as rapid, and around 2% in the public administration and defence sector. Coal consumption is expected to decline especially in the public administration and defence sector. Petroleum products in this sector are expected to rise at around 5% after 1995, and decline in the miscellaneous sector.

- Overall Demand

With all sectors forecast to increase their demand for energy through the 1990s, overall final user energy demand is naturally expected to rise - from 59,592 million therms in 1993 to 67,641 million therms in 2000. The growth in demand will be most pronounced in the latter part of the decade as the UK economy continues to grow. In addition, competition in the energy supply industries should keep real fuel prices low, putting little downward pressure on demand. Increased competition in the domestic sector is expected to bring prices down which will further increase overall final user energy demand; the forecasted increase over the base scenario by 2000 is, however, only about 0.5%. For the third scenario, which assumes increased prices in the transport sector, the reduction of overall final user energy demand is even smaller.

Electricity Generation Energy Use

Final user demand for electricity is forecast to rise by 5%, from 9,750 million therms in 1993 to 10,282 million therms in 1995, and up 22% to 12,298 million therms in 2000. To this demand, electricity must be provided by the generators through the use of primary energy.

The generators' fuel mix has in the past been biased towards coal and nuclear use, as these two energy sources have been protected by Government. Recent changes to electricity supply industries, privatisation and increased competition, have reduced the coal industries protected status in the fuel mix. As a consequence, in the 1990s, there has been a major shift out of coal towards natural gas. This dash for gas, however, has been extenuated by the two main electricity generators' strategic decisions to limit the attractiveness of market entry by regional electricity companies and potential independent generators. In addition to this new strategic bias, nuclear power will continue to be ensured a share in the fuel mix certainly until 1996, when most of Nuclear Electric will be sold off. Beyond that date, nuclear will continue to provide base-load electricity even if no longer protected by the government.

The major drop in coal use by generators has already occurred; in 1993, coal use fell by 38% to 11,536 million therms. Another, smaller fall is expected in 1995 - down to 9,547 million therms. Afterwards, coal use will increase slightly to meet rising final user electricity demand. Its share of the total electricity generators' fuel mix is likely to fall from 39.5% in 1993 to just under 30% in 1995, remaining relatively constant thereafter.

The decline in coal has been mirrored by a rise natural gas use. In 1993, its use by generators rose four-fold to 4,250 million therms. By 1995, the expansion of relatively cheap and efficient combined-cycle gas turbine (CCGT) power stations will push natural gas use above 9,000 million therms. Up to 2000, the growth will be more gradual, perhaps rising about 10% over that period. The natural gas share has risen from 14.5% in 1993 to nearly 30% in 1995.

Petroleum products use, which is virtually exclusively fuel oil, is expected to fall in 1995 by 30% to 1,782 million. Most of this decline can be accounted for by a shift towards orimulsion. Beyond 1995, fuel oil and orimulsion shares are expected to remain relatively constant.

After peaking in 1994, at an anticipated 8,580 million therms, nuclear's share of the generators' fuel mix is expected to fall gradually, as no new power stations are likely to be completed by the end of the decade and as old Magnox reactors come to the end of their lives. Its share is expected to be around 26% in 1995, down to 23% in 2000.

The share of other energy sources for electricity generators, be they hydro, biofuel renewables such as landfill gas, sewage gas, wood combustion, straw combustion and refuse combustion, or electricity imports from France, are expected to stay relatively constant.

Final user demand for electricity is expected to rise at an annual rate of 2.7% from 1993 to 2000. Because of the use of more efficient power stations, such as CCGTs, electricity generators are expected to meet this demand by increasing total fuel input at an annual rate of 1.7%. Consistent improvements in efficiency will, in the long-run, have an impact on UK's total energy requirements.

Primary Energy Demand

To forecast primary energy demand in the UK, energy balance tables (following the format in table 3 of the Digest of United Kingdom Energy Statistics, 1994) have been created for each year up to 2000. These tables include all uses of energy sources, starting with primary energy demand, feeding through into secondary energy demand and onto final user demand. Having forecast final user demand and by assessing inputs required to convert fuels, in power stations, refineries and coking installations, to meet final user demand, it is possible to work backwards and calculate primary energy requirements for the UK.

As expected from the changes in electricity generators' fuel mix, as well as the continued decline in the iron and steel industry and the scrapping of coal heaters, primary coal demand has fallen dramatically in the 1990s. Demand fell 33% from 1990 to 1993. While the decline is not expected to continue at the same rate, forecasts suggest it will fall from 17,772 million therms in 1993 to 14,570 million therms in 1995 and then up slightly, due to growth in electricity demand, to 15,344 by 2000.

The share of the demand for petroleum products is continuing to shift towards lighter fuels. While the demand for heavy petroleum products by heavy industry, households and electricity generators declines, use of lighter oils for transportation grows. In 1993, fuel oil, gasoil and diesel made up 43% of total petroleum products; in 2000, the figure is forecast at 41%. Motor spirit's share will continue to rise from 30% to 32% over the same period. This growth in lighter fuels will over-ride any decline in heavy fuel oils, ensuring that the demand for crude petroleum grows - from 40,712 million therms in 1993 to 44,920 million therms in 2000; an annual growth rate of approximately 1.5%.

Natural gas demand will continue to rise. In all final user sectors, natural gas has become the principal method of space heating, and many new gas heaters are being installed. The introduction of CCGT power stations has further boosted gas demand. Because of this latter force, natural gas total demand is expected to leap in 1995, from 25,409 million therms in 1993 to 31,056 million therms in 1995. Afterwards growth will be more gradual, at an expected annual rate of 2.5%, reaching 35,243 million therms by 2000.

In 1993, coal made up 18.8% of UK's total primary energy used, crude petroleum 43.1%, natural gas 26.9% and nuclear 8.8%. The shift out of coal towards natural gas and the continued growth of petroleum will alter this picture. By 2000, coal is forecast to provide 14.4% of UK's primary energy requirements, crude petroleum 42.3%, natural gas 33.1% and nuclear 7.6%.

Efficiency

The 1990s have seen a significant improvement in the primary energy to GDP ratio. In 1993, the use of more efficient power stations ensured that primary energy demand stood still while the economy continued to grow. A similar improvement in the economy's use of energy can be expected. These are, however, once-and-for-all improvements. From 1995 to 2000, total primary energy demand will grow at an annual rate of 2% per annum. As GDP is expected to grow at a rate slightly above 2%, the economy can be expected to get gradually more efficient. The rate, however, cannot be considered satisfactory either for concerns about security of supply or the environment.

Environmental Consequences

Clearly, up to 2000, in all scenaioes primary energy demand will continue to rise. Had the fuel mix remained the same over the last ten or twenty years, the UK would be unlikely to meet any of its international agreements, such as the United Nations Commission on Development and Environment (UNCED) in Rio to stabilise carbon dioxide emissions at the 1990 level by 2000 or the Large Combustion Plant Directive to reduce sulphur and nitrogen dioxide emissions at the 1980 level by 40% in 1998 and 60% in 2003.

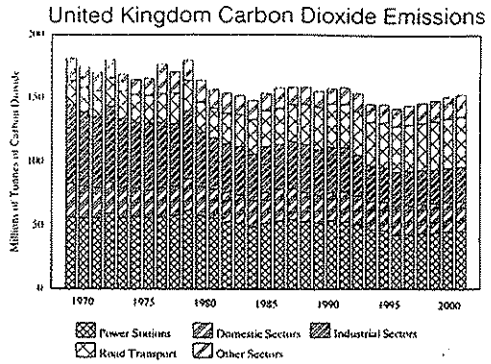
The major change in UK energy markets through the 1990s has been and will conitnue to be the shift out of coal towards gas for heating and especially electricity generation. In 1990, generators were responsible for 34% of carbon dioxide emissions, 72% of sulphur dioxide emissions and 27% of nitrogen dioxide emissions in the UK. Because coal's carbon and sulphur content is greater than most petroleum products' content and is considerably greater than natural gas', any shifts out of coal will put downward pressure on carbon and sulphur dioxide emissions.

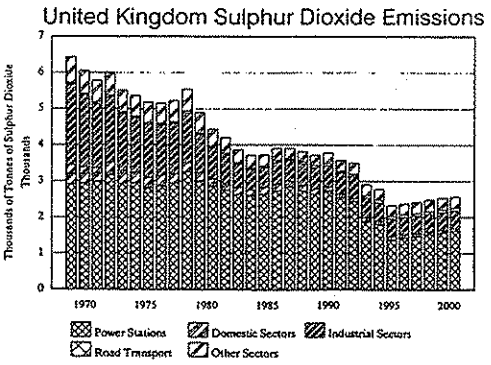
Therefore, even with rising total primary energy demand, the UNCED target of 158 million tonnes of carbon is likely to be met. Based on the forecasts of energy demand, projections of carbon dioxide emissions - the main greenhouse gas - are anticipated to be around 153 million tonnes in 2000. Since the dash for gas was a once-and-for-all shift out of coal and petroleum combustion from cars will continue to grow, however, increasing primary energy demand is likely to mean that the level of carbon dioxide emissions will start rising beyond 2000. Any longer term agreements made in relation to carbon dioxide emissions will require Government to introduce additional measures to encourage pollution abatement.

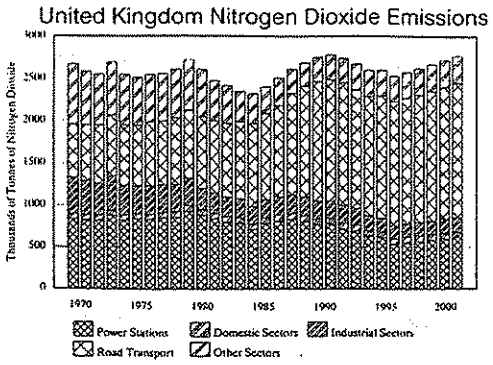
Sulphur dioxide, associated with acid rain, is expected to fall even more as a result of the shift out of coal. Power stations, responsible for 2,722 thousand tonnes of sulphur dioxide emissions in 1990 of a total of 3,782, are forecast to only emit 1,379 thousand tonnes. Although flue-gas desulphurisation (FGD) retrofitting of many coal power stations should minimise the impact, power station emissions are expected to rise gradually afterwards as electricity generators start using more coal again. The other main source is the industrial sector; sulphur dioxide emissions from the industrial sector are forecast to fall from 585 in 1990 to 488 thousand tonnes in 2000. Total UK emissions are expected to be 41% below the 1980 level of 4,899 thousand tonnes in 1993, 51% below in 1998 and 48% below in 2000. It is still unclear whether the UK will manage to reduce emissions 60% by 2003.

Nitrogen dioxide, also associated with acid rain and respiratory diseases, just reached its highest level in 1990 at 2,860 thousand tonnes. Nitrogen dioxide results not from the fossil fuel but from the air that is combusted with fossil fuels. As a result, the transport sector is the greatest source of nitrogen dioxide emissions, responsible for 52% of total emissions. Forecasts suggest emissions from the transport sector will continue to rise to 1,594 thousand tonnes by 2000 or 57% of the total 2,772 thousand tonnes of emissions. Thus, although emissions are likely to fall slightly in the middle of the decade as a result of efficiency improvements from using more CCGT plants and catalytic convertors will become gradually more widespread, by the end of the decade nitrogen emissions may start to increase again from the

upward pressure by road and air fuel combustion. Since 1980, when total emissions were 2,392 thousand tonnes, the level of emissions have risen most years and forecasts suggest they are unlikely to fall sufficiently to meet any targets set in international agreements. It appears that without some form of intervention, levels of nitrogen emissions will continue to rise beyond 2000. And, as nitrogen dioxide is increasingly associated with respiratory diseases, health effects and costs resulting from increasing road and air fuel combustion are likely to rise.







CONCLUSION

Roger Fouquet

Summary Forecast

With energy prices staying close to inflation and economic activity continuing to expand, all sectors - except iron and steel - are expected to have a growing demand for energy, particularly electricity and natural gas, and to a lesser extent petroleum products; final user coal demand will continue to fall. Transport and miscellaneous sectors are likely to observe the highest growth rates in demand for energy.

The electricity generated to meet requirements will come increasingly from natural gas power stations, crowding-out coal use. The main increase, after 1993, is expected in 1995; afterwards both fuels' use will rise again. Inputs of heavy fuel oil, replaced to some extent by orimulsion, and nuclear power, as the Magnox reactors are wound down, are expected to fall slightly over the decade.

Overall natural gas use will continue to rise, as will petroleum products, particularly light fuel - due to the continued growth in the transport sector. Primary coal demand will drop in 1995, and grow modestly thereafter. Nuclear power is anticipated to shrink slightly. Renewables will continue to grow modestly - no break through is expected.

The shift out of coal towards natural gas will ensure that the UK meets its target of stabilising carbon dioxide emissions at the 1990 level by 2000. Beyond 2000, electricity generators and the transport sector may push emissions back up. Sulphur dioxide emissions are expected to fall, meeting the 1998 target agreed upon in the Large Combustion Plant Directive of reducing emissions 40% below the 1980 level; whether the UK will achieve the 2003 target of reducing emissions by 60% is less certain, even as more power stations install FGD systems. Achieving the same targets for nitrogen dioxide appears to be unlikely, even as catalytic converters on cars become more widespread. These and other projections of emission reductions are vital in determining the government's position on environmental legislation - domestically, within the European Union and around the world.

The Forecasting Service

This occasional paper sought to assess and update last year's forecast, as well as improve the modeling of decision-making, present new scenarios and discuss the new forecasts made as a result of the changes. The new forecasts did not produce many major changes, the main sectors and fuels appear to follow similar paths and growth rates. Details have changed somewhat; this is inevitable. Hopefully, because of the improvement to the model by introducing an average energy price variable, the elasticity estimates will more reliable. Projections of explanatory variables are subject to the same risk of errors as before. On the whole, therefore, forecasts should be more reliable than previously, and they were quite close to the actual 1993 figures.

The three scenarios provided some indication of the impact of increased competition in domestic sector's energy supply industries and additional taxes imposed on road users. The results were as expected. Natural gas and electricity rice reductions in the domestic sector, resulting from additional competition, are

expected to lead to an increase in the demand for natural gas, and a decrease in the demand for other fuels. Electricity demand would rise also, if its price falls by more than the average energy price. Because of the model for road fuel consumption, prices only affect demand indirectly. This means that any price rise, even one as substantial as a doubling of the real price of energy in the sector, would have little effect on demand. Although, it is clear that demand is price-inelastic, consumption will no doubt react more to a doubling of real prices than the model indicates.

The model and forecasts also provide a useful guide to primary energy demand and environmental consequences. Because of the emphasis of present energy policy on environmental matters, they might be considered additional information with which to make decisions about the appropriate action to take in relation to energy use and its environmental consequences.

Policy Implications

The principle focus of policy related to energy use is either for meeting budgetary or environmental targets. VAT on domestic fuel has remained at 8%, due to large opposition to raising it a further 9.5%. Naturally, revenue from this source will not be as great. This, however, means Government has had to increase taxes on road fuel. Taxation of road fuel enables government to reduce the budget deficit where objection is less politically sensitive and give the appearance of tackling today's most serious issue in the fight to reduce the impact of economic activity on the environment.

However, since the transport sector is relatively price-inelastic, the effectiveness of taxes to reduce road fuel use is small. The important factors in determining price-elasticity are the individuals' willingness to pay for the service, mobility, and the ability to substitute either the fuel or the mode of transport to have the service. Individuals appear to be willing to pay a high price for mobility. If, for example, mobility is required for getting to work, it is necessary - and willingness to pay is relatively high. But, if there were ways of receiving the same service for cheaper - either by using another, cheaper fuel, by using a car that used less fuel or by using a mode of transport that was cheaper - individuals would be likely to reduce demand for road fuel. The first option, changing fuel, is not at present a very attractive switch; diesel is more or less than same price, and electric cars are considered even be more expensive. Buying a more efficient car is an attractive choice; cars, however, are only bought on average every five years - meaning there will be a long lag between the price rise and the adjustment to more efficient cars. Finally, individuals might seek alternative modes of transport to provide (nearly) the same service. In the UK, the train is an obvious alternative, but there are many criticisms about that quality of this alternative service is considerably inferior to that of the car. It appears that in order for prices to have an effect on road fuel use, there must be alternative fuels, cars and modes of transport.. The likelihood of Government creating price-elastic demand for fuel is through encouraging the production of more fuel-efficient cars and ensuring that alternative modes of transport, such as integrated public transport systems, can provide substitutes to cars. In addition, the provision of related-information is an important tool for enabling individuals to make the appropriate decision; without information substitution is unlikely to occur. Reduction in the growth of road fuel will probably become the main priority towards energy/environmental policy.

Electricity generators will, however, need to continue to reduce carbon, sulphur and nitrogen dioxide, and particulate emissions. Government might think of moving away from command-and-control measures, which do not seek to minimise overall costs of pollution abatement nor encourage continued reductions in pollution. Instead, it might introduce more market-based incentives, particularly for large players like electricity generators. Following the US initiative, a market for permits to emit sulphur dioxide might be an effective way of reducing emissions with minimal disruption to the economy.

For different environmental problems, the appropriate abating mechanism might change, therefore, each case must be understood. If the Government considers the markets will not provide the correct level of environmental abatement un-aided, then it should approach air pollution as a more integrated problem, since there is so much overlap between carbon, sulphur and nitrogen dioxide and particulate emissions. The most probable change over the next decade in terms of energy/environmental policy is the increasing use of market-base mechanisms to encourage abatement of environmental pollution. For them to work as required, policy-makers will need to understand how they work, and what their costs and benefits. This will only come through further analysis of the relationships between the economy, energy use and the environment.

Appendix
Energy Demand and Environmental Forecasts

- **Sectoral Final User Demand Forecasts**
  - Agriculture Sector
  - Domestic Sector: Base Scenario
  - Domestic Sector: Gas and Electricity Price Reduction Scenario
  - Iron and Steel Sector
  - Other Industry Sector
  - Miscellaneous Sector
  - Public Administration and Defence Sector
  - Transport Sector: Base Scenario
  - Transport Sector: Compliance with Royal Commission's Recommendation 29

- **Total Final User Demand Forecasts**
  - All Classes of Consumers

- **Electricity Generators Demand Forecasts**

- **Environmental Forecasts**
  - Carbon Dioxide Emissions
  - Sulphur Dioxide Emissions
  - Nitrogen Dioxide Emissions

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK AGRICULTURE SECTOR FORECASTS: BASE SCENARIO

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. GDP DEFLATOR	7.1%	6.4%	6.5%	4.3%	3.4%	2.6%	3.9%	4.1%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	−4.9%	3.8%	−1.9%	−0.6%	−6.3%	−6.2%	−1.4%	2.0%	3.0%	3.0%	6.0%	5.5%
OIL	13.2%	18.9%	3.0%	−10.2%	6.7%	16.2%	14.9%	2.0%	−2.8%	5.7%	4.1%	4.0%
GAS	−9.2%	5.1%	−1.9%	0.6%	1.7%	2.3%	4.1%	3.3%	3.1%	3.5%	4.5%	4.5%
ELECTRICITY	7.1%	−0.3%	2.9%	7.1%	5.0%	1.9%	0.7%	1.2%	2.0%	3.7%	6.0%	5.5%
3. AGRIC. PRODN.	1.0%	3.4%	1.8%	4.9%	−3.2%	2.6%	1.4%	1.5%	1.5%	1.5%	1.5%	1.5%
4. EMPLOYMENT	−4.4%	−1.1%	−2.5%	−5.2%	−1.8%	−4.2%	−4.6%	−3.6%	−3.6%	−3.6%	−3.6%	−3.6%
FORECASTS												
OIL	−8.4%	0.3%	2.4%	−1.2%	1.8%	−0.6%	−1.2%	−2.0%	−2.1%	−2.1%	−2.2%	−2.2%
GAS	6.7%	6.3%	2.9%	14.3%	10.0%	6.8%	6.5%	7.8%	7.3%	6.8%	6.3%	6.0%
ELECTRIC	−3.6%	−2.2%	1.5%	−2.2%	3.1%	−2.2%	−0.8%	−0.5%	−0.5%	−0.5%	−0.5%	−0.5%
OTHER	−2.9%	5.7%	−2.8%	−12.5%	−3.2%	3.3%	0.0%	3.2%	3.1%	3.0%	2.9%	2.9%
TOTAL ENERGY	−5.6%	0.0%	2.2%	−0.4%	2.4%	−0.2%	−0.4%	−0.5%	−0.5%	−0.5%	−0.5%	−0.5%
FORECASTS												
LEVELS (in Millions of Therms)						1994	1995	1996	1997	1998	1999	2000
COAL	4	3	5	3	3	3	2	2	2	1	1	1
OIL	329	330	338	334	340	338	334	327	320	314	307	300
GAS	32	34	35	40	44	47	51	55	59	63	67	71
ELECTRIC	135	132	134	131	135	132	131	130	130	129	129	128
OTHER	32	32	32	31	30	31	31	32	33	34	35	36
TOTAL ENERGY	528	528	544	539	552	551	549	546	544	541	539	536

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK DOMESTIC SECTOR FORECASTS: BASE SCENARIO

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. RPI	7.5%	9.4%	5.9%	3.8%	1.6%	2.6%	3.9%	4.1%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	4.6%	11.3%	−6.0%	8.0%	9.0%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
OIL	20.5%	17.2%	−13.5%	−12.0%	9.5%	0.1%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
GAS	0.6%	6.9%	6.2%	0.0%	1.0%	6.0%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
ELECTRICITY	4.5%	6.8%	8.2%	5.0%	6.0%	3.3%	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%
3. PDI	5.2%	8.9%	−0.5%	2.3%	2.7%	0.9%	2.3%	2.8%	2.8%	2.8%	2.8%	2.8%
4. TEMP	2.0%	4.0%	−4.8%	7.0%	−11.2%	7.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5. POPULATION	0.3%	0.3%	0.7%	0.3%	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%	11.9%	−3.8%	−3.6%	−3.8%	−4.1%	−4.3%	−4.5%	−4.6%
OIL	−1.9%	4.0%	10.4%	4.9%	5.2%	0.9%	−0.5%	−0.1%	−0.1%	0.0%	0.2%	0.4%
GAS	−3.3%	3.4%	11.2%	−1.2%	3.0%	3.7%	2.4%	1.7%	1.4%	1.1%	0.9%	0.8%
ELECTRIC	−0.1%	1.7%	4.6%	1.4%	0.9%	1.2%	1.6%	2.6%	3.4%	4.0%	4.5%	4.8%
OTHER												
TOTAL ENERGY	−3.7%	0.7%	10.4%	−2.8%	0.9%	2.4%	1.6%	1.4%	1.3%	1.3%	1.3%	1.3%
FORECASTS												
LEVELS (IN MILLIONS OF THERMS)						1994	1995	1996	1997	1998	1999	2000
COAL	1642.0	1347.0	1646.0	1212.0	1356.0	1304.0	1257.6	1210.3	1160.5	1110.1	1060.3	1011.8
OIL	951.0	989.0	1092.0	1146.0	1206.0	1216.7	1211.2	1209.5	1208.3	1208.6	1211.0	1215.8
GAS	9914.0	10250.0	11395.0	11263.0	11605.0	12031.0	12322.6	12536.8	12706.8	12846.9	12967.1	13074.6
ELECTRIC	3148.0	3200.0	3347.0	3394.0	3426.0	3468.2	3525.3	3617.6	3740.6	3890.6	4064.6	4260.3
OTHER												
TOTAL ENERGY	16146.0	16264.0	17950.0	17441.0	17593.0	18019.9	18316.7	18574.2	18816.2	19056.2	19303.1	19562.5

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK DOMESTIC SECTOR FORECASTS: GAS AND ELECTRICITY PRICE REDUCTION SCENARIO

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. RPI	7.5%	9.4%	5.9%	3.8%	1.6%	2.5%	3.6%	4.2%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	4.6%	11.3%	−6.0%	8.0%	9.0%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%	6.5%
OIL	20.5%	17.2%	−13.5%	−12.0%	9.5%	0.1%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
GAS	0.6%	6.9%	6.2%	0.0%	1.0%	6.0%	5.5%	5.0%	5.0%	5.0%	5.0%	5.0%
ELECTRICITY	4.5%	6.8%	8.2%	5.0%	6.0%	3.3%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
3. PDI	5.2%	8.9%	−0.5%	2.3%	2.7%	0.9%	2.3%	2.8%	2.8%	2.8%	2.8%	2.8%
4. TEMP	2.0%	4.0%	−4.8%	7.0%	−11.2%	7.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
5. POPULATION	0.3%	0.3%	0.7%	0.3%	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%	11.9%	−3.9%	−4.0%	−4.4%	−5.1%	−5.7%	−6.1%	−6.4%
OIL	−1.9%	4.0%	10.4%	4.9%	5.2%	0.9%	−0.6%	−0.3%	−0.5%	−0.7%	−0.8%	−0.8%
GAS	−3.3%	3.4%	11.2%	−1.2%	3.0%	3.6%	2.3%	2.6%	2.5%	2.4%	2.4%	2.4%
ELECTRIC	−0.1%	1.7%	4.6%	1.4%	0.9%	1.2%	2.1%	2.7%	3.1%	3.4%	3.6%	3.8%
OTHER												
TOTAL ENERGY	−3.7%	0.7%	10.4%	−2.8%	0.9%	2.4%	1.6%	1.9%	1.9%	1.9%	2.0%	2.0%
FORECASTS												
LEVELS (IN MILLIONS OF THERMS)						1994	1995	1996	1997	1998	1999	2000
COAL	1642.0	1347.0	1646.0	1212.0	1356.0	1303.5	1251.7	1196.6	1135.1	1070.5	1005.1	940.3
OIL	951.0	989.0	1092.0	1146.0	1206.0	1216.3	1209.0	1205.1	1198.7	1190.7	1181.5	1171.6
GAS	9914.0	10250.0	11395.0	11263.0	11605.0	12022.4	12301.3	12618.1	12933.2	13247.8	13564.8	13886.9
ELECTRIC	3148.0	3200.0	3347.0	3394.0	3426.0	3468.1	3541.7	3638.7	3751.6	3879.5	4020.7	4173.5
OTHER												
TOTAL ENERGY	16146.0	16264.0	17950.0	17441.0	17593.0	18010.3	18303.6	18658.5	19018.6	19388.4	19772.0	20172.3

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK INDUSTRY IRON AND STEEL SECTOR FORECASTS: BASE SCENARIO

	PERCENT CHANGE PER YEAR 1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. GDP DEFLATOR	7.1%	6.4%	6.5%	4.3%	3.4%	2.6%	3.9%	4.1%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	−4.9%	3.8%	−1.9%	−0.6%	−6.3%	−6.2%	−1.4%	2.0%	3.0%	3.0%	6.0%	5.5%
OIL	13.2%	9.2%	−12.6%	−3.4%	6.3%	16.2%	14.9%	2.0%	−2.8%	5.7%	4.1%	4.0%
GAS	−9.0%	5.1%	−1.9%	0.6%	1.7%	2.3%	4.1%	3.3%	3.1%	3.5%	4.5%	4.5%
ELECTRICITY	7.1%	−0.3%	2.9%	7.1%	5.0%	1.9%	0.7%	1.2%	2.0%	3.7%	6.0%	5.5%
3. I+S PRODUCTION	2.0%	−0.2%	−5.4%	−0.6%	1.3%	2.4%	1.4%	1.1%	1.1%	1.1%	1.1%	1.1%
FORECASTS												
COAL,COKE,BREEZE	−4.5%	−6.2%	−4.2%	−4.2%	−3.1%	−3.8%	−7.7%	−8.5%	−5.8%	−5.6%	−5.3%	−5.2%
OIL	6.9%	−9.3%	0.7%	−4.4%	25.4%	−3.9%	−3.3%	−1.9%	−1.2%	−0.8%	−0.3%	0.2%
GAS	4.7%	−1.1%	−12.6%	9.9%	8.6%	−1.2%	−2.1%	−0.9%	−0.3%	−0.2%	−0.1%	0.1%
ELECTRIC	1.5%	−8.8%	−1.3%	−5.2%	3.1%	−1.6%	−2.7%	0.3%	1.3%	2.0%	2.6%	3.2%
OTHER												
TOTAL ENERGY	−1.3%	−5.5%	−4.8%	−1.3%	−7.2%	−3.1%	−5.5%	−5.1%	−3.2%	−2.8%	−2.4%	−2.0%
FORECASTS												
COAL,COKE,BREEZE	1820	1707	1635	1567	1518.0	1460.5	1348.6	1234.2	1162.2	1097.6	1038.9	985.3
OIL	324	294	296	283	355.0	341.2	329.9	323.5	319.8	317.3	316.5	317.2
GAS	467	462	404	444	482.0	476.1	466.1	461.7	460.4	459.3	459.0	459.5
ELECTRIC	340	310	306	290	299.0	294.2	286.4	287.3	291.1	296.8	304.6	314.3
OTHER												
TOTAL ENERGY	3220	3042	2896	2859	2654.0	2572.0	2431.0	2306.8	2233.5	2171.1	2119.0	2076.4

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK OTHER INDUSTRY SECTOR FORECASTS: BASE SCENARIO

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. GDP DEFLATOR	7.1%	6.4%	6.5%	4.3%	3.4%	2.6%	3.9%	4.1%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	−4.9%	3.8%	−1.9%	−0.6%	−6.3%	−6.2%	−1.4%	2.0%	3.0%	3.0%	6.0%	5.5%
OIL	13.2%	9.2%	−12.6%	−3.4%	6.3%	16.2%	14.9%	2.0%	−2.8%	5.7%	4.1%	4.0%
GAS	−9.2%	5.1%	−1.9%	0.6%	1.7%	2.3%	4.1%	3.3%	3.1%	3.5%	4.5%	4.5%
ELECTRICITY	7.1%	−0.3%	2.9%	7.1%	5.0%	1.9%	0.7%	1.2%	2.0%	3.7%	6.0%	5.5%
3. IP	4.3%	−0.3%	−3.9%	−0.2%	2.1%	4.0%	5.1%	4.1%	4.0%	4.0%	4.0%	4.0%
FORECASTS												
COAL	−11.7%	−8.6%	4.2%	2.5%	−18.6%	6.5%	4.4%	0.6%	−1.6%	−3.6%	−5.6%	−6.7%
OIL	−8.8%	−6.3%	9.2%	−5.8%	5.1%	−4.9%	−2.5%	2.0%	2.5%	3.1%	3.8%	3.5%
GAS	2.1%	7.2%	−9.6%	−4.2%	0.9%	0.9%	3.1%	−1.8%	−3.2%	−3.9%	6.3%	0.6%
ELECTRIC	2.4%	2.4%	−1.1%	−4.0%	0.6%	3.2%	6.5%	5.1%	4.4%	4.6%	4.8%	4.6%
OTHER												
TOTAL ENERGY	−2.6%	−0.3%	−1.0%	−2.0%	−6.6%	0.6%	2.7%	1.4%	0.7%	0.5%	3.7%	1.8%
FORECASTS												
LEVELS (IN MILLIONS OF THERMS)						1994	1995	1996	1997	1998	1999	2000
COAL	1777	1625	1693	1735	1412.0	1504.3	1571.0	1580.1	1555.0	1499.3	1415.4	1320.9
OIL	3141	2944	3215	3029	3184.0	3027.5	2953.1	3011.3	3085.7	3180.1	3302.5	3417.2
GAS	4044	4337	3919	3756	3788.0	3821.3	3939.2	3867.2	3743.8	3597.3	3822.8	3844.5
ELECTRIC	3052	3125	3091	2967	2985.0	3079.2	3280.1	3447.2	3599.2	3764.9	3945.2	4125.3
OTHER												
TOTAL ENERGY	12578	12543	12417	12169	11369.0	11432.2	11743.5	11905.9	11983.8	12041.7	12485.8	12707.9

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK MISCELLANEOUS SECTOR FORECASTS: BASE SCENARIO

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. GDP DEFLATOR	7.1%	6.4%	6.5%	4.3%	3.4%	2.6%	3.9%	4.1%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	−4.9%	3.8%	−1.9%	−0.6%	−6.3%	−6.2%	−1.4%	2.0%	3.0%	3.0%	6.0%	5.5%
OIL	13.2%	8.4%	−12.6%	−3.4%	6.3%	16.2%	14.9%	2.0%	−2.8%	5.7%	4.1%	4.0%
GAS	−9.2%	5.1%	−1.9%	0.6%	1.7%	2.3%	4.1%	3.3%	3.1%	3.5%	4.5%	4.5%
ELECTRICITY	7.0%	−0.3%	2.9%	7.1%	5.0%	1.9%	0.9%	1.2%	2.0%	3.7%	6.0%	5.5%
3. GDP SERVICES	2.6%	0.7%	−0.9%	−0.1%	2.3%	4.0%	5.1%	4.1%	4.0%	4.0%	4.0%	4.0%
FORECASTS												
COAL	−19.3%	80.4%	−8.4%	−35.5%	14.3%	−4.5%	−4.5%	−4.6%	−1.1%	2.9%	7.9%	14.1%
OIL	−7.4%	0.2%	−3.9%	−5.1%	0.0%	−0.6%	−6.5%	−3.0%	−2.1%	−1.6%	−1.4%	−1.4%
GAS	−1.4%	3.6%	16.5%	−7.6%	5.5%	−2.7%	−1.0%	3.5%	4.7%	5.8%	6.7%	7.4%
ELECTRIC	6.1%	−2.1%	4.8%	−3.7%	2.0%	−0.4%	2.4%	4.6%	5.1%	5.6%	5.8%	5.9%
	−6.7%	−1.4%	−26.1%	−39.2%	−3.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL ENERGY	0.5%	1.5%	7.8%	−6.6%	3.5%	−1.5%	−0.2%	5.3%	5.0%	4.8%	4.6%	4.4%
FORECASTS												

LEVELS (in Millions of Therms)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
COAL	46	83	76	49	56	53	51	49	48	50	54	61
OIL	514	515	495	470	470	467	437	424	415	409	403	397
GAS	1699	1760	2050	1894	1998	1945	1926	1994	2089	2210	2359	2534
ELECTRIC	1798	1761	1845	1776	1812	1805	1848	1932	2032	2145	2269	2402
OTHER	70	69	51	31	30	30	30	30	30	30	30	30
TOTAL ENERGY	4127	4189	4517	4220	4366	4301	4292	4519	4745	4971	5198	5424

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK PUBLIC ADMINISTRATION AND DEFENCE SECTOR FORECASTS: BASE SCENARIO

	PERCENT CHANGE PER YEAR											
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. GDP DEFLATOR	7.1%	6.2%	6.5%	4.3%	3.4%	2.6%	3.9%	4.1%	4.5%	4.5%	4.5%	4.5%
2. PRICES OF												
COAL	−1.9%	3.8%	−1.9%	−0.6%	−6.3%	−6.2%	−1.4%	2.0%	3.0%	3.0%	6.0%	5.5%
OIL	12.4%	19.3%	3.0%	−10.2%	6.7%	16.2%	14.9%	2.0%	−2.8%	5.7%	4.1%	4.0%
GAS	−9.2%	5.1%	−1.9%	0.6%	1.7%	2.3%	4.1%	3.3%	3.1%	3.5%	4.5%	4.5%
ELECTRICITY	7.1%	−0.3%	2.9%	7.1%	5.0%	1.9%	0.9%	1.2%	2.0%	3.7%	6.0%	5.5%
3. GDP PUB. ADMIN	0.0%	0.0%	0.6%	0.2%	−0.6%	0.5%	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%
FORECASTS												
COAL	−15.2%	−0.4%	−4.0%	−11.0%	−10.3%	−2.3%	−2.8%	−2.6%	−2.6%	−2.6%	−2.6%	−2.6%
OIL	−12.4%	−3.8%	3.4%	4.0%	−1.7%	−5.0%	−6.0%	9.5%	6.5%	5.0%	4.1%	3.5%
GAS	−43.0%	1.4%	13.2%	8.6%	−22.5%	3.6%	6.1%	7.8%	10.2%	10.7%	10.3%	9.9%
ELECTRIC	0.2%	2.0%	17.8%	12.1%	1.1%	1.5%	2.9%	2.5%	2.1%	1.7%	1.2%	0.8%
OTHERS	−13.8%	3.6%	−12.1%	−13.7%	−22.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL ENERGY	−7.2%	−0.1%	6.6%	4.6%	−10.4%	0.1%	1.3%	6.1%	6.3%	6.1%	5.8%	5.5%
FORECASTS												
	LEVELS (in Millions of Therms)					1994	1995	1996	1997	1998	1999	2000
COAL	228	227	218	194	174	170	165	161	157	153	149	145
OIL	941	905	936	973	956	908	853	935	996	1045	1088	1126
GAS	1202	1219	1380	1498	1161	1202	1276	1376	1516	1678	1852	2035
ELECTRIC	646	659	776	870	880	893	920	942	962	978	990	998
OTHER	56	58	51	44	34	34	34	34	34	34	34	34
TOTAL ENERGY	3073	3068	3361	3579	3205	3208	3249	3447	3665	3888	4112	4337

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK TRANSPORT SECTOR FORECASTS: BASE SCENARIO

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. RPI	7.5%	9.4%	5.9%	3.8%	1.6%	2.6%	3.9%	4.1%	4.5%	4.5%	4.2%	4.2%
2. PRICES OF												
DERV	14.7%	10.4%	−0.3%	8.9%	5.2%	7.6%	8.9%	9.1%	9.5%	9.5%	9.2%	9.2%
MOTOR SPIRIT	10.1%	10.3%	4.0%	9.2%	6.7%	7.6%	8.9%	9.1%	9.5%	9.5%	9.2%	9.2%
AVIATION FUEL	10.2%	11.1%	4.0%	4.5%	6.2%	7.6%	8.9%	9.1%	9.5%	9.5%	9.2%	9.2%
ELECTRICITY	12.4%	18.9%	3.3%	5.0%	6.0%	1.9%	0.2%	1.2%	2.0%	3.7%	6.0%	5.5%
3. ROAD PASS KMS	6.9%	2.4%	−0.1%	0.0%	0.0%	−0.3%	−0.5%	1.7%	1.7%	1.7%	1.7%	1.4%
FREIGHT PASS KMS	8.5%	−0.5%	2.2%	−2.0%	−0.3%	−0.1%	−0.3%	2.6%	2.6%	2.6%	2.6%	0.3%
VEHICLES OWNED	3.8%	2.0%	−0.7%	0.3%	1.0%	−0.6%	−0.8%	4.1%	4.1%	4.1%	4.1%	0.3%
4. AIR PASSENGERS	6.2%	3.5%	−6.5%	10.8%	5.8%	6.0%	6.6%	7.2%	7.2%	7.2%	7.2%	7.2%
AIR FRT/CARGO	5.8%	3.6%	−6.1%	10.7%	11.1%	3.9%	4.3%	3.7%	3.7%	3.7%	3.7%	3.7%
5. RAIL PASS KMS	2.0%	1.2%	2.9%	−1.3%	0.4%	2.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
RAIL FREIGHT KMS	−6.6%	−8.9%	−3.4%	1.3%	1.9%	3.0%	2.0%	3.5%	3.5%	3.5%	3.5%	3.5%
ELEC. ROUTE	3.9%	8.1%	−0.5%	0.5%	1.2%	1.0%	2.0%	3.0%	3.0%	3.0%	3.0%	3.0%
6. PERS. DISP. INC.	5.3%	2.8%	−0.5%	2.3%	2.7%	0.9%	2.3%	2.8%	2.8%	2.8%	2.8%	2.8%
FORECASTS												
OIL ROAD	4.3%	2.7%	−0.7%	2.2%	1.0%	2.8%	1.4%	1.7%	1.6%	1.7%	1.9%	2.1%
OIL AIR	5.8%	0.3%	−6.3%	8.2%	6.6%	1.1%	1.0%	4.1%	3.9%	3.8%	3.8%	3.8%
RAIL ELEC	−3.6%	14.8%	−0.8%	1.6%	−24.0%	19.1%	7.5%	4.1%	3.0%	2.6%	2.4%	2.4%
RAIL/WATER OIL	6.9%	−1.3%	3.8%	−1.0%	−0.2%	0.4%	1.0%	1.3%	1.5%	1.5%	1.5%	1.6%
OTHER												
TOTAL ENERGY	4.6%	2.5%	−1.4%	2.4%	1.8%	2.5%	1.3%	2.1%	2.0%	2.0%	2.2%	2.3%
FORECASTS												

LEVELS (in Millions of Therms)

OIL ROAD	15007	15409	15298	15627.0	15785.0	16221.4	16447.9	16722.8	16994.3	17285.1	17611.3	17973.1
OIL AIR	2901	2911	2728	2952.0	3146.0	3179.5	3210.3	3342.8	3474.0	3606.9	3743.1	3883.7
RAIL ELEC	108	124	123	125.0	95.0	113.2	121.6	126.6	130.4	133.8	137.1	140.3
RAIL/WATER OIL	817	806	837	829	827.0	8.0	837.9	849.0	862.1	874.7	888.2	849.0
OTHER												
TOTAL ENERGY	18834	19306	19044	19505.0	19853.0	20344.0	20617.7	21041.2	21460.8	21900.5	22379.7	22899.3

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

UK TRANSPORT SECTOR FORECASTS: COMPLIANCE WITH ROYAL COMMISSION'S RECOMMENDATION 29 (Doubling of 1994 price of fuel by 2005)

PERCENT CHANGE PER YEAR

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MAIN ASSUMPTIONS												
1. RPI	7.5%	9.4%	5.9%	3.8%	1.6%	2.6%	3.9%	4.1%	4.5%	4.5%	4.2%	4.2%
2. PRICES OF												
DERV	14.7%	10.4%	−0.3%	8.9%	5.2%	7.6%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%
MOTOR SPIRIT	10.1%	10.3%	4.0%	9.2%	6.7%	7.6%	11.4%	11.4%	11.4%	11.4%	11.4%	11.4%
AVIATION FUEL	10.2%	11.1%	4.0%	4.5%	6.2%	7.6%	8.9%	9.1%	9.5%	9.5%	9.2%	9.2%
ELECTRICITY	12.4%	18.9%	3.3%	5.0%	6.0%	1.9%	0.2%	1.2%	2.0%	3.7%	6.0%	5.5%
3. ROAD PASS KMS	6.9%	2.4%	−0.1%	0.0%	0.0%	−0.3%	−0.6%	1.7%	1.7%	1.7%	1.7%	1.2%
FREIGHT PASS KMS	8.5%	−0.5%	2.2%	−2.0%	−0.3%	−0.1%	−0.5%	2.6%	2.6%	2.6%	2.6%	0.1%
VEHICLES OWNED	3.8%	2.0%	−0.7%	0.3%	1.0%	−0.6%	−0.8%	4.1%	4.1%	4.1%	4.1%	0.4%
4. AIR PASSENGERS	6.2%	3.5%	−6.5%	10.8%	5.8%	6.0%	6.6%	7.2%	7.2%	7.2%	7.2%	7.2%
AIR FRT/CARGO	5.8%	3.6%	−6.1%	10.7%	11.1%	3.9%	4.3%	3.7%	3.7%	3.7%	3.7%	3.7%
5. RAIL PASS KMS	2.0%	1.2%	2.9%	−1.3%	0.4%	2.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%
RAIL FREIGHT KMS	−6.6%	−8.9%	−3.4%	1.3%	1.9%	3.0%	2.0%	3.5%	3.5%	3.5%	3.5%	3.5%
ELEC. ROUTE	3.9%	8.1%	−0.5%	0.5%	1.2%	1.0%	2.0%	3.0%	3.0%	3.0%	3.0%	3.0%
6. PERS. DISP. INC.	5.3%	2.8%	−0.5%	2.3%	2.7%	0.9%	2.3%	2.8%	2.8%	2.8%	2.8%	2.8%
FORECASTS												
OIL ROAD	4.3%	2.7%	−0.7%	2.2%	1.0%	2.8%	1.2%	1.6%	1.6%	1.7%	1.8%	2.0%
OIL AIR	5.8%	0.3%	−6.3%	8.2%	6.6%	1.1%	1.0%	4.1%	3.9%	3.8%	3.8%	3.8%
RAIL ELEC	−3.6%	14.8%	−0.8%	1.6%	−24.0%	19.1%	7.5%	4.1%	3.0%	2.6%	2.4%	2.4%
RAIL/WATER OIL	6.9%	−1.3%	3.8%	−1.0%	−0.2%	0.4%	1.0%	1.3%	1.5%	1.5%	1.5%	1.6%
OTHER												
TOTAL ENERGY	4.6%	2.5%	−1.4%	2.4%	1.8%	2.5%	1.2%	2.0%	2.0%	2.0%	2.1%	2.3%
FORECASTS												

LEVELS (in Millions of Therms)

OIL ROAD	15007	15409	15298	15627.0	15785.0	16221.4	16424.1	16682.8	16945.3	17228.4	17544.9	17898.1
OIL AIR	2901	2911	2728	2952.0	3146.0	3179.5	3210.3	3342.8	3474.0	3606.9	3743.1	3883.7
RAIL ELEC	108	124	123	125.0	95.0	113.2	121.6	126.6	130.4	133.8	137.1	140.3
RAIL/WATER OIL	817	806	837	829	827.0	8.0	837.9	849.0	862.1	874.7	888.2	849.0
OTHER												
TOTAL ENERGY	18834	19306	19044	19505.0	19853.0	20344.0	20593.9	21001.2	21411.8	21843.9	22313.3	22824.3

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

FINAL USER DEMAND – ALL CLASSES OF CONSUMERS: BASE SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
COAL	3701	3317	3640	3195	3003	3017	3029	2922	2815	2709	2602	2495
OIL	24925	25103	25235	25633	26269	26538	26646	27218	27790	28363	28935	29507
GAS	17328	18029	19152	18849	19074	19677	20234	20602	20969	21337	21704	22072
ELECTRICITY	9282	9368	9589	9611	9750	9939	10282	10685	11088	11492	11895	12298
OTHER	2833	2667	2538	2419	2366	2085	1956	1878	1801	1723	1646	1568
TOTAL	58069	58484	60154	59707	60462	61256	62147	63306	64464	65623	66781	67940

FINAL USER DEMAND – ALL CLASSES OF CONSUMERS: GAS AND ELECTRICITY PRICE REDUCTION SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
COAL	3701	3317	3640	3195	3003	2851	2764	2723	2681	2640	2599	2558
OIL	24925	25103	25235	25633	26269	26582	27234	27847	28460	29072	29685	30297
GAS	17328	18029	19152	18849	19074	21358	21836	22180	22524	22868	23213	23557
ELECTRICITY	9282	9368	9589	9611	9750	9850	9887	9954	10022	10090	10157	10225
OTHER	2833	2667	2538	2419	2366	2431	2381	2350	2319	2289	2258	2227
TOTAL	58069	58484	60154	59707	60462	63072	64102	65054	66007	66959	67912	68864

FINAL USER DEMAND – ALL CLASSES OF CONSUMERS: GAS AND ELECTRICITY PRICE REDUCTION SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
COAL	3701	3317	3640	3195	3003	2851	2764	2723	2681	2640	2599	2558
OIL	24925	25103	25235	25633	26269	26582	27234	27847	28460	29072	29685	30297
GAS	17328	18029	19152	18849	19074	21358	21836	22180	22524	22868	23213	23557
ELECTRICITY	9282	9368	9589	9611	9750	9850	9887	9954	10022	10090	10157	10225
OTHER	2833	2667	2538	2419	2366	2431	2381	2350	2319	2289	2258	2227
TOTAL	58069	58484	60154	59707	60462	63072	64102	65054	66007	66959	67912	68864

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

FUELS USED IN UK ELECTRICITY GENERATION FORECASTS

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
COAL	19048	19400	19656	18725	11536	11138	9547	9627	9706	9786	9865	9945
OIL	2204	2715	2883	2578	2436	2436	1782	1782	1782	1782	1782	1782
GAS	82	86	468	1019	4250	5100	9350	9520	9690	9860	10030	10200
NUCLEAR	5954	5549	5928	6665	8190	8580	8385	8229	8073	7917	7761	7605
HYDRO	537	596	535	677	573	573	573	573	573	573	573	573
OTHER	0	0	0	0	564	564	564	564	564	564	564	564
IMPORTS	1206	1122	1541	1568	1599	1631	1664	1697	1731	1766	1801	1837
TOTAL	29031	29468	31010	31232	29149	30023	31865	31993	32122	32250	32378	32506

UK PRIMARY ENERGY DEMAND FORECASTS: BASE SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
COAL	32596	28642	31122	27589	28080	28548	28712	28057	30326	28267	27659	25904
PETROLEUM	36134	38732	39220	36418	32602	32033	32602	33292	33211	28988	26471	26552
GAS	7235	10264	11105	13283	13913	14763	15691	16276	17784	17779	18020	17930
NUCLEAR	2262	2418	2301	2808	2496	2964	3276	3081	3159	3081	3120	3666
HYDRO	420	420	458	458	458	420	458	458	497	420	535	535
EL.IMPORTS	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	78647	80476	84206	80556	77549	78728	80739	81164	84977	78535	75805	74587

SURREY ENERGY ECONOMICS CENTRE ENERGY MODEL

CARBON DIOXIDE EMISSIONS: BASE SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Power Stations	52	54	53	51	47	47	43	43	44	45	45	46
Domestic Sector	22	22	24	23	22	23	23	23	23	23	23	23
Industrial Sector	36	36	35	32	28	27	27	27	27	27	27	27
Road Transport	33	34	34	34	35	35	36	36	37	38	38	39
Other Sectors	13	12	13	15	14	14	14	15	16	16	17	18
TOTAL	**156**	**158**	**159**	**155**	**146**	**146**	**143**	**145**	**147**	**148**	**151**	**153**

SULPHUR DIOXIDE EMISSIONS: BASE SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Power Stations	2640	2722	2534	2427	1883	1803	1379	1428	1476	1524	1572	1620
Domestic Sector	138	118	115	103	109	103	98	93	87	82	77	72
Industrial Sector	594	585	576	601	543	500	483	481	481	483	486	488
Road Transport	61	63	58	62	63	65	66	67	68	69	70	72
Other Sectors	288	294	291	307	306	301	295	305	313	320	327	318
TOTAL	**3721**	**3782**	**3574**	**3500**	**2905**	**2771**	**2321**	**2373**	**2426**	**2478**	**2532**	**2570**

NITORGEN DIOXIDE EMISSIONS: BASE SCENARIO

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Power Stations	769	777	718	694	629	614	534	550	566	582	598	614
Domestic Sector	68	68	75	73	68	69	70	70	70	69	69	68
Industrial Sector	211	207	207	199	181	165	159	159	160	162	168	172
Road Transport	1418	1434	1450	1398	1405	1443	1462	1486	1509	1535	1563	1594
Other Sectors	288	294	291	307	312	309	305	311	316	320	324	324
TOTAL	**2842**	**2860**	**2835**	**2750**	**2595**	**2600**	**2530**	**2576**	**2621**	**2668**	**2721**	**2772**

LIST OF SURREY ENERGY ECONOMICS DISCUSSION PAPERS (SEEDS 56-81) AND *SEEC OCCASIONAL PAPERS 1-2*

SEEDS Number

Forthcoming:

The Acquisition of Information on Energy Related Environmental Attributes
Roger Fouquet

Electricity Privatisation in England and Wales: Progress and Problems
Colin Robinson

SEEC OCCASIONAL PAPER
No.2 *The S.E.E.C. United Kingdom Energy Demand Forecast (1995-2000) Update*
David Hawdon (Ed): Roger Fouquet, David Hawdon, Peter J G Pearson, Colin Robinson and Paul Stevens *ISBN 185237151X* *July 1995*

81 The Nuclear Review
David Hawdon (Ed): Elroy Dimson, Robin Jeffrey, Martin O'Neill, M.P., Colin Robinson and Mike Staunton ISBN 1852371501 April 1995

80 Regulation as a Means of Introducing Competition
Colin Robinson ISBN 185237148X February 1995

79 Privatising Nuclear Power: evidence for the review of future prospects for nuclear power
Colin Robinson ISBN 1852371455 November 1994

78 Energy, Externalities and Environmental Quality: Will Development Cure the Ills it Creates?
Peter J G Pearson ISBN 1852371447 October 1994

77 The Demand for Car Fuel Efficiency: An Hedonic Price Approach
Robert Witt ISBN 1852371439 October 1994

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David Maddison ISBN 1852371412 July 1994

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Joseph G Hirschberg ISBN 1852371404 June 1994

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Joseph G Hirschberg ISBN 1852371390 June 1994

73 Liberalisation of the Energy Market: A Favourable Supply-side Shock for the UK Economy?
Colin Robinson ISBN 1852371382 June 1994

72 Recent Studies of the Demand for Energy in the UK
D Hawdon (Ed): Joyce Dargay, Roger Fouquet, Andrew Henley, Keith Miller and John Peirson ISBN 1852371331 November 1993

71 An Econometric Study of the Demand for Gasoline in the Gulf Cooperation Council Countries
M Nagy Eltony and Mohammad Almahmeed ISBN 1852371315 October 1993

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LIST OF SURREY ENERGY ECONOMICS DISCUSSION PAPERS (SEEDS) AND *SEEC OCCASIONAL PAPERS* (contd)

SEEC OCCASIONAL PAPER

No.1 *The S.E.E.C. United Kingdom Energy Demand Forecast (1993-2000)*
David Hawdon (Ed): Roger Fouquet, David Hawdon, Peter J G Pearson, Colin Robinson and Paul Stevens *ISBN 185237134X* *16 December 1993*

SEEDS Number

70	International Bargaining and the EC Large Combustion Plant Directive Roger Fouquet	ISBN 1852371129	July 1993
69	Fuels for Electricity Supply after the UK Coal Review Peter J G Pearson (Ed): Anthony Baker, Nigel Evans, PMS Jones and Colin Robinson	ISBN 1852371099	May 1993
68	Electricity in the Third World Peter J G Pearson (Ed): Andrew Barnett, Gerald Foley, Francis McGowan and Peter J G Pearson	ISBN 1852371080	May 1993
67	The Economics of Pit Closures in the UK Peter J G Pearson (Ed): A Baker et al (3 papers)	ISBN 1852371064	January 1993
66	The Political Economy of Energy Privatisation Colin Robinson	ISBN 1852371056	December 1992
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