Special Article

ENERGY ISSUES AND FORECASTS FOR SCOTLAND

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The role of energy in the Scottish economy is of crucial importance. As a basic input to industrial production it represents a major cost and indeed the price of energy was the key factor in the recent closure of the Invergordon aluminium smelter. Domestic consumption of various forms of energy are an important item of personal spending, particularly given the harshness of the climate. In addition, the energy industries are a major employer and the capital investments involved are substantial. The ubiquitous nature of 'energy' means that the policy decisions influencing the supply and demand of energy will affect practically everybody in the country. This paper examines some of the issues surrounding energy policy within Scotland. The first section provides a background on recent trends in energy supply and demand; the second assesses the principal influences and problems related to energy forecasting. The third section provides indicative forecasts of future outputs in the energy sector given various scenarios, while the final section examines some of the principal energy related issues facing Scotland in the 1980's.

Energy Demand and Energy Supply in Scotland

A number of measures exist by which energy demand can be assessed[1]. The discussion in this section concentrates on the heat supplied basis which measures the consumption of primary and secondary fuels after any conversion and transmission losses. Table 1 shows the energy consumption by final user in Scotland for 1971 and 1980.

The growth in total energy consumption over the period 1971-1980 was a modest 2%, but subsumed within this figure were substantial changes in the type of energy consumed. In particular there has been a significant movement away from solid fuels and an increased movement in both absolute and relative terms, towards gas. This trend was particularly marked in domestic consumption where the share of total consumption accounted for by solid fuels fell from 44.9% to 25.5%, whereas consumption of gas represented 37.8% in 1980 compared with only 17.6% in 1971. The only category of consumption not to show this trend was in transport where, largely for technological reasons, energy demand was almost exclusively centred on liquid fuels.

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TABLE 1 ENERGY CONSUMPTION BY FINAL USER IN SCOTLAND (HEAT SUPPLIED BASIS), 1971-1980

	1971 million therms	% of total	1980 million therms	% of total
Domestic Consumers:				
Solid Fuels	513	44.9	329	25.5
Gas	291	17.6	488	37.8
Electricity	345	30.2	359	27.8
Liquid Fuels	84	7.3	116	8.9
TOTAL	1,143	100	1,292	100
Industrial Consumers:				
Solid Fuels	619	28.7	294	16.1
Gas	120	5.6	325	17.8
Electricity	210	9.8	301	16.5
Liquid Fuels	1,204	55.9	904	49.6
TOTAL	2,153	100	1,824	100
Transport Consumers				
Solid Fuels	6	0.6	-	-
Electricity	3	0.3	6	0.5
Liquid Fuels - Road	715	74.0	880	73.5
- Other	243	25.1	312	26.0
TOTAL	967	100	1,198	100
Other Consumers				
Solid Fuels	172	21.2	86	10.0
Gas	50	6.2	150	17.4
Electricity	150	18.5	209	24.3
Liquid Fuels	432	53.3	415	48.3
TOTAL	810	100	860	100
Total Scotland				
Solid Fuels	1,310	25.8	709	13.7
Gas	371	7.3	963	18.6
Electricity	714	14.1	875	16.9
Liquid Fuels	2,678	52.8	2,627	50.8
TOTAL	5,073	100	5,174	100

Source: Scottish Economic Bulletin, No 24, Spring 1982

The principal reason for these changes was price movements resulting from firstly, an increased supply of natural gas from the UK continental shelf and secondly, a rapid increase in oil prices from 1973 onwards. For domestic consumers there was little real increase in the price of fuel but for individual components changed dramatically. The real price of gas fell by 50% while there were real price increases of 18% for coal, 20% for electricity and over 100% for liquid fuels[2]. For industrial consumers, the price changes were less marked. The changing pattern of industrial consumption was also affected by changes in the composition of industrial output, in particular the influence of energy intensive industries such as metal manufacture and bricks, pottery, glass and cement.

Examining energy consumption on a per capita basis shows that Scottish consumption in 1980 was lower than in the previous peak recorded in 1973, despite the fact that the absolute total of heat supplied was greater. The fall in consumption is a clear indication of the recession. The fluctuations in consumption in Scotland closely mirror those of the UK although there has been a narrowing in the relative per capita consumption. In 1971 Scottish per capita energy consumption was 94.9% of the UK total rising to 99.4% in 1980. Indeed in 1979 Scottish per capita consumption was marginally above that recorded in the UK. This is partly a result of the high level of Scottish GDP as a percentage of UK in that year as indicated in Table 3.

TABLE 2 TOTAL ENERGY CONSUMPTION PER CAPITA, UK

YEAR	SCOTLAND HEAT SUPPLIED		UK HEAT SUPPLIED	
	Total (M, Therms)	Per Capita (Therms)	Total (M, Therms)	Per Capita (Therms)
1971	5,073	972.3	57,001	1,025.0
1972	5,142	986.9	58,041	1,040.0
1973	5,461	1,047.8	61,034	1,091.6
1974	5,353	1,026.1	58,284	1,042.2
1975	5,089	977.5	55,876	999.6
1976	5,331	1,024.2	57,327	1,025.5
1977	5,395	1,036.5	58,533	1,048.0
1978	5,392	1,041.0	59,208	1,060.4
1979	5,739	1,110.7	61,720	1,104.5
1980	5,174	1,004.0	56,533	1,010.5

Source: Scottish Economic Bulletin, No 24, Spring 1982
Annual Abstract of Statistics, 1981

The relationship between the overall level of energy consumption and the overall level of economic activity is, of course, extremely close, an issue to which this paper will return. Before doing so it is necessary to detail the present capacity of the various energy industries.

The United Kingdom, and in particular Scotland, is widely considered to be rich in energy resources. Significant reserves of fossil fuels exist as do the raw ingredients of most renewable energy sources such as wind and waves. The other renewable source of energy, solar heat, is less prevalent.

TABLE 3 SCOTLAND PER CAPITA GDP AND HEAT SUPPLIED AS A PERCENTAGE OF THE UK, 1971-1980

	GDP PER HEAD AS % OF UK	HEAT SUPPLIED PER HEAD AS % OF UK
1971	93.0	94.9
1972	92.8	94.8
1973	94.6	96.0
1974	95.0	98.4
1975	96.7	97.8
1976	98.0	99.9
1977	96.3	98.9
1978	95.4	98.2
1979	97.3	100.6
1980	96.0	99.4

Source: Scottish Economic Bulletin, No 24, Spring 1982
Annual Abstract of Statistics, 1981

TABLE 4 EXISTING CAPACITY OF THE ELECTRICITY BOARDS IN SCOTLAND, 1981 - MEGAWATTS

	SSEB	NSHEB
Conventional Thermal	6,208	1,752
Hydro-electric and Pumped Storage	123	-
Steam	-	240
Diesel	-	120
Gas Turbine	195	13
Nuclear	1,300	-
Total Capacity	7,826	2,125
Maximum Simultaneous Demand on System (SMD)	4,106	1,637 (including Invergordon)
Overcapacity (expressed as a % of MSD)	90.6	29.8

Source: Annual Report of SSEB and Annual Report of NSHEB

Department of Energy estimates[3] state that the possible total of recoverable oil reserves on the UK Continental Shelf is 2,300 million tonnes and that the possible total of recoverable gas reserves are 1,559 thousand million cubic metres. Similarly there are large reserves of coal and it is widely accepted that Britain will continue to be self-sufficient in conventional energy until the next century.[4]

Within Scotland the energy industries are major employers and the gas, electricity and water industrial order employs 28,000 people. There is however considerable controversy surrounding the energy supply industries' future plans and, in particular, the electricity industry. Table 4 lists the existing capacities of the South of Scotland Electricity Board and the North of Scotland Hydro-Electric Board.

In addition to the existing capacity, the Torness nuclear plant is expected to add 1,300 MW in 1987/88. More immediately the 3,210 MW Peterhead is already partially in operation. It has been suggested[5] that this station will suffer the fate of the Inverkip Power Station opened at a cost of £174m in 1979, and remain in virtual cold storage. A recent study by McGuire[6] suggests that in 1987 overcapacity will represent between 36.2% and 56.9% (depending on assumptions surrounding Inverkip and Kincardine) of total output capacity. The debate surrounding the electricity industry is heightened by conflicting views on the relative merits of how to produce electricity, in particular the use of nucleur stations.

Forecasting Energy Demand

This section of the paper examines some of the considerations and problems of forecasting the demand for energy with particular reference to Scotland. It has long been recognised that a significant relationship exists between economic growth and energy demand. This has most commonly been expressed as an energy coefficient of less than one, implying that the growth rate of primary energy demand is less than that for GDP. Prior to the OPEC induced recession of 1973 this relationship was essentially stable and consequently forecasting energy demand was relatively straightforward. The sudden breakdown in the relationship after 1973 and, in particular, the very sharp fall in energy consumption between 1979 and 1980 has precipitated a fundamental reappraisal of demand forecasting techniques.

Before looking in more detail at influences on energy demand, it is worthwhile highlighting one of the major problems inherent in energy forecasting. This is the difficulties encountered in defining energy, a collective term representing an aggregation of different fuels according to some set of conventions and conversion factors. The basis for these adjustments is not, however, straightforward and represents both theoretical and practical problems. In particular, while similar aggregate energy values may arise from totally different fuel mixes, the nature of the energy using capital stock and the state of technology will largely determine the fuel mix with only marginal adjustments possible in the short term. Thus, ideally a forecast should not only specify aggregate energy demand but also its constituent items. To simultaneously estimate total energy demand and its constituent items would require extremely sophisticated modelling techniques. Nevertheless, despite these problems a number of crucial influences on energy demand can be identified and it is worthwhile examining each in turn.

While the simple relationship between GDP and energy consumption observed prior to 1973 has broken down, it remains the case that the overall level of economic activity is of major importance in determining the demand for energy. However, ideally, it is necessary to examine not only the overall level of economic growth but also the composition of output produced within the economy. Since energy is a derived demand, changes in the industrial structure will create different energy demands. This arises simply because the energy intensities of different sectors vary. It is likely that any structural shifts in the economy will be away from the energy intensive traditional heavy industries towards less energy intensive manufacturing industry and service industries. The implication for energy demand is clear. Even if a reasonable rate of GDP growth can be achieved, and this is by no means certain, the differing sectoral growth of output may well mitigate against any significant growth in energy consumption.

Related to this is the extent that investment in new capital equipment will be influenced by the overall rate of growth and its sectoral composition. The effect of investment is ambiguous. Should investment take the form of capital/labour substitution then, as capital equipment entails energy for its operation and construction, some increased demand for energy can be envisaged. A trend towards greater mechanisation and automation in industry may hence result in increased energy consumption. Conversely, if investment is directed towards the replacement of the existing capital stock by more energy efficient technology then considerable savings in energy used will be possible. Indeed the faster growing the economy, the more likely energy efficient investment will take place. The net effect of investment is therefore dependant on its precise nature. This in turn will largely be dependant on the relative prices of labour, capital and energy.

The price of energy, and of different types of energy, is of great importance. Yet it is perhaps the greatest imponderable as the history of oil prices over the past decade testifies. Not only does price affect the overall rate of consumption, but also influences the choice of fuel and the attractiveness of developing and introducing more energy efficient technologies. The price of energy is also of crucial importance in assessing the viability of major industrial developments. The closure of the Invergordon aluminium smelter and the subsequent attempts at resurrecting the plant have centred around the price at which electricity will be supplied. In addition, recent falls in the price of oil and excess electricity capacity have led to speculation[7] that research into alternative energy sources may be curtailed.

There are, of course, other factors influencing the demand for energy such as climate, demography, housing stock and the nature of transport. These tend to be fairly predictable in their effect. One interesting aspect, which is difficult to quantify, is the view that in certain areas of energy consumption a saturation point has been reached. The growth in domestic energy consumption correlates closely with increased ownership of appliances such as televisions, cookers, electric kettles and heating. As Mackay[8] points out, as most households have these items the growth in demand for electricity will be inhibited.

As all of these points suggest, forecasting the demand for energy is an exceptionally complex exercise. To comprehensively model all of these influences is beyond the scope of the present paper. However, using the Medium Term Model of the Scottish economy[9] it is possible to provide indicative forecasts of demand and, bearing the above points in mind, examine the implications for energy policy in Scotland.

Projections for Scotland to 1990

The Medium Term Model of the Scottish economy developed at the Fraser of Allander Institute is multisectoral and currently incorporates and forecasts information on industrial output and employment, technical structure and linkages between industries. While falling short of an ideal model of energy forecasting, the MTM can provide useful indicative forecasts of output in the Gas, Electricity and Water Sector given various scenarios. The results of these computer runs are presented in Table 5. Before discussing these results it is worthwhile briefly outlining the assumptions made and the potential of the model for more detailed forecasts.

The model is 'driven' by forecasts of final expenditure in the Scottish economy of twelve categories of demand. For the projections reported here, it has been assumed that these expenditures rise in a uniform manner equivalent to annual growth rates of Gross Domestic Product of 1%, 2% and 3%. Separate growth rates could, if desired, be specified for each of the categories of final expenditure so that it would be possible for example, to enter separate assumptions about the rate of growth of gross domestic capital formation. The second stage of the model, moves the forecast demands through a series of input/output equations in order to determine the output of each industrial sector. The coefficients of the input/output matrices may vary from year to year for a variety of reasons. Changes in technology, price induced input substitution, movements in import and export propensities will all affect the relationship between final demands and industry outputs. A variety of assumptions could be made about these items, but for the present paper only two are made. The model has run on the basis of no change in energy coefficients and on the basis of a 2% annual fall in the use of energy as an input. On the basis of these assumptions the model provides an indicative range of forecasts of total domestic output for Gas, Electricity, Water over the period 1982-1990.

As can be seen from Table 5 a wide range of output is possible. Depending on the assumptions, total output could grow by as little as 5% between now and 1990 or by as much as 27%. It is therefore worthwhile assessing which set of assumptions are more likely to prove correct and to introduce some of the caveats outlined in the preceding section.

TABLE 5 TOTAL DOMESTIC OUTPUT FOR GAS, ELECTRICITY AND WATER, SCOTLAND, 1982-1990 (1982 = 100)

		Annual Growth of GDP		
Annual Improvement in Energy Efficiency		**1%**	**2%**	**3%**
No Change	1982	100	100	100
	1985	103.8	106.9	110.1
	1990	109.1	118.1	127.6
2%	1982	100	100	100
	1985	102.3	103.4	108.5
	1990	105.9	109.2	123.9

Over the past decade real growth in GDP has not been pronounced in the Scottish economy. Presently the level of economic activity is extremely low and while some changes in the structure of the economy have taken place, it would be rash to expect significant, steady real growth of GDP over the rest of this decade. The upper rate specified of 3% would represent a major improvement in the economy but is in all likelihood overoptimistic. A more likely outcome is for the rate of growth to fluctuate between 0 and 2% annually. The composition of any growth is likely to be biased towards the service sectors, which are the less intensive users of energy. Bearing this in mind the indices presented would represent the upper bounds of possible domestic output.

The assumption of an annual saving of 2% per annum in energy inputs reflects the view that new investment will be more energy efficient, consumers are more conservation conscious and that price movements will encourage savings. It is widely accepted that there is already considerable scope for saving more energy through the wider adoption of new technology. Lewis[10] in a study estimates that a 30% overall saving of energy is possible by simply using existing conservation techniques. The potential savings assumed in this paper, are by these standards fairly modest.

Overall, the expected pattern of demand over the decade is likely to result in a level of output at the lower level of the range of forecasts. Growth of GDP will probably be, at best, modest while an improvement in the efficiency with which energy is used is expected. Such a scenario has, of course, implications for the energy supply industries. This and wider issues of energy policy are discussed in the following section.

Energy Issues in the 1980's

A variety of energy related issues will be of great importance for the Scottish economy during the 1980's. The energy supply industries, in particular electricity, will be faced with crucial investment decisions. This will not only be a debate between the type of fuels used but also whether or not any more capacity is necessary. The future of oil development is also opaque given recent price falls, and as is claimed by the operators,[11] a punitive tax system. Continued controversy will surround the debate over ownership and the government's desire to privatise BNOC and British Gas. Finally, the issue of conservation and the development of alternative sources of energy will continue to attract attention.

Currently the electricity industry in Scotland has a significant level of overcapacity, yet has other plants under construction. The justification given by the industry[12] for the building of new plant such as Torness is, in part, cost to the consumer. However, critics dispute this and argue that the cost assumptions used are consistently biased in favour of nucleur power.[13] In the absence of appropriate data, it is impossible for the present paper to comment on this. However, given the forecasts of McGuire and of this paper, it is clear that if present plants are maintained together with those under construction, then even greater overcapacity will exist. This begs a more fundamental question - should the adjustment to changing energy requirements by met by the supply industries or by influencing the pattern of demand?

Traditionally, the anticipated growth of GDP was seen by the energy supply industries as significant justification for commissioning large new investments which would take between 5 and 10 years to complete. Yet as outlined in the preceding sections, it is by no means certain that these relationships are currently relevant, and that other changes are likely to inhibit the growth of demand. Given the uncertainty of there being adequate demand, new large-scale investments must be extremely questionable. However, because of the lag between starting and finishing an investment project, together with the costs already incurred, the supply industries are extremely reluctant to scrap any partially completed projects.

The provision of additional supply capacity to meet growing demand is only one possible response. In the absence of any new supply capacity, a narrowing of the margin between total consumption and total capacity would have to be met by restricting demand. This does not have to be achieved by inhibiting economic activity but by stimulating greater energy conservation. The adjustment process by which this can be achieved is potentially a lot shorter than adjustments in supply. As pointed out by Lewis [14] and Shell, [15] substantial savings in industrial energy consumption is possible. Similarly, significant savings in personal energy consumption could be attained. In the short-term savings would be achieved by minor changes to energy using equipment such as adjusting time clocks and thermostats, characterised by low investments costs, rapid payback times and minimal disruption. In the medium term there are investments which involve significant modifications to existing equipment, while in the long-term totally new capital may be procured. In any case it is probable that the adjustments could be made in a period shorter than that required to build a new power station.

A reliance on conservation may, however, be regarded as riskier than a strategy based on a costly but easily administered expansion of supply. This is because conservation relies heavily upon the decisions of numerous, individual energy users. Supply authorities consequently take a risk averse strategy which implies 'better too much than too little'. However, if capital intensive investments are under-utilised they become increasingly costly thereby negating the arguments of the supply industries. Clearly, a much higher priority must be given to ensure that any large-scale investments made are necessary and that a fuller consideration of possible conservation strategies is undertaken should the margin between demand and supply become too narrow.

The oil industry in Scotland is curently facing an uncertain future. Recent falls in the price of oil have reduced the level of profit on North Sea developments. The wrath of the oil producers has, however, been aimed at the government and Petroleum Revenue Tax in particular. It has been claimed that present levels of taxation would result in the under-development of smaller fields in the North Sea[16]. Such claims have received academic backing through a recent study by Kemp and Rose[17]. Given the importance to the Scottish economy of oil activities, a continuation of such a punitive taxation system is likely to have detrimental effects beyond the companies concerned. Indeed the revenue accruing to the government may well be smaller as fields which lie undeveloped yield no revenue whatsoever. Clearly some revision to the present tax regime is necessary, with perhaps differential taxation schemes introduced depending upon the size and relative cost of developing new fields.

It is also worth reiterating the suitability of Scotland for the development of renewable energy resources. Current trends in demand and relatively low supply costs are likely to inhibit the commercial development of these resources in the immediate future. This should not, however, provide an excuse for curtailing research, as it is such fundamental work which will lay the foundation for energy supplies in the more distant future. Certainly such work is of much greater importance than the issue which currently dominates the energy debate, that is the controversy over the plans to privatise BNOC and British Gas. This paper does not intend to enter the debate, which largely reflects political motives. However, it is worth noting that should these corporations be broken up any overall energy strategy may prove harder to implement. The newly constituted private supply industries will, quite rightly, pursue their own interests. If, as is claimed, this results in lower prices then an increased demand can be anticipated with detrimental effects on conservation plans.

In summary, the coming decade will prove crucial for the energy-related industries in Scotland. The various debates have been volatile to date and it is likely they will intensify as the policies currently being evolved are implemented. While the various vested interests and pressure groups fight their ground, the resulting effects will be felt by practically every group in the economy. Currently energy policy is determined in a partial and fragmentary manner; nucleur against alternative resources, private versus public ownership, supply industries against conservation interests. The nature of these issues is such that a long-term strategy must clearly be determined which examines them as a whole.

FOOTNOTES

1. These definitions are contained in the 'Digest of United Kingdom Statistics' published by Department of Energy.

2. Energy Demand in Scotland during the 1970's, Scottish Economic Bulletin, No 22, Spring 1982.

3. Digest of United Kingdom Energy Statistics, 1981 (Figures as at 31 December, 1980).

4. The Times - Energy: A Special Report, 24 March, 1982.

5. Sunday Standard, 28 March 1982.

6. McGuire A. - Excess Capacity and the Demand for Electricity in Scotland - Scottish Journal of Political Economy, Vol 24, No 1, February 1982.

7. The Times 29 April 1982.

8. Mackay G A, Energy Policy in Scotland, in 'Scotland 1980' (Ed D Mackay), 1977.

9. D Bell et al The Development of a Medium Term Model for Scotland I:

Projections to 1984. Fraser of Allander Institute, Research Monograph No 10, 1982.

10. Lewis C W, - The Potential for Energy Conservation in UK Industry. ENERGY, Vol 4 pp1175-1184, 1979.

11. Sunday Times, 2 May 1982.

12. Annual Report of the SSEB.

13. Scotsman, 9/5/82 - Robin Cook, MP for Edinburgh Central.

14. Lewis C W op.cit.

15. Shell 'Energy Conservation - The Prospects of Improved Energy Efficiency' Group Planning, 1978.

16. Scotsman, 1 May 1983 - Mr Philip Shelbourne, Chairman of BNOC.

17. Kemp A G and Rose D - 'The Reform of Petroleum Taxation of the UK Continental Shelf'. University of Aberdeen, North Sea Study Occasional Papers, No 15, January 1982.