

ENERGY DEMAND AND ENERGY POLICY
IN SCOTLAND

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Over the last few years there has been a very marked increase in interest in energy issues and energy policy. The immediate cause was the success of OPEC (the Organisation of Petroleum Exporting Countries) in quadrupling crude oil prices in 1973 and 1974. This has had a profound effect on the state of the world economy and international relations, and has resulted in attempts by most countries to find alternative sources of energy. One other source, nuclear power, has itself generated further controversy, particularly in the light of accidents in a few countries.

Scotland is no exception to this renewed interest in energy policy. Like all industrialised countries, we have suffered the deflationary effects of the huge rises in oil prices. However, we have the tremendous fortune of our own indigenous oil and gas resources in the North Sea, and thus have benefited from the oil price rises. The nuclear debate has been particularly keen in Scotland because of the electricity authorities' wish to build a new nuclear station at Torness in East Lothian, problems with an existing station at Hunterston in Ayrshire, the possibility of building a commercial fast breeder reactor at Dounreay in Caithness, and the argument over mining for uranium in various parts of the country.

It seems an opportune time therefore to examine energy needs and energy policy, and the purpose of this paper is to discuss the various options open to Scotland and the likely pattern of events over the next few years.

Recent Experience

Before discussing the future it is necessary to consider in some detail events over the past decade. The best starting point

is the pattern of demand, both in aggregate terms and from the point of view of individual fuels. In the current Scottish context five fuels can be distinguished usefully: coal, oil, natural gas, hydro-electricity and nuclear electricity. It may be that in future other energy sources — such as peat, solar energy, wind and wave power — may become important, but at the present time they make a tiny contribution.

Table 1 shows energy consumption for each year since 1970¹. The latest available figures are for 1977 but those for 1978 and 1979, when published, are unlikely to show significant changes. The unit of measurement in the table is the petajoule, which is a measure of primary fuel input. There are alternative measures of fuel production and consumption — such as tons of coal equivalent or therms — but in the present context it does not matter which is used. There are also various different definitions of production and consumption — such as primary fuel input, heat supplied and useful heat — which are of more significance, but this aspect can also be ignored, although the related aspect of energy efficiency is discussed below².

Table 1

SCOTTISH FUEL CONSUMPTION (IN PETAJOULES)

	1970	1971	1972	1973	1974	1975	1976	1977
Coal*	352.1	309.1	299.6	344.2	290.6	306.9	313.7	311.8
Petroleum	381.8	400.7	424.0	448.4	424.9	375.7	376.1	382.6
Natural gas	2.4	26.3	38.5	47.0	59.2	64.6	70.7	76.7
Nuclear electricity	38.6	38.6	38.6	36.0	37.5	37.8	50.4	64.4
Hydro- electricity**	53.5	45.1	38.3	34.3	49.4	55.9	52.1	45.4
Total	828.4	819.8	837.3	909.8	861.5	840.9	863.0	880.9

* Including other solid fuels.

** Including some imports of electricity.

The table shows that over the seven years Scottish energy consumption has increased by 6.3%, equivalent to about 0.9% per year. There have been fluctuations in aggregate demand, however: consumption declined slightly in 1971 and more markedly in 1974 and 1975 but since then there appears to have been a reversion to the steady growth experienced in the 1950s and 1960s. Over the 20 years to 1970 the average annual rate of growth was just over 2%.

The fall in 1971 was a consequence of the industrial problems in that year and the 1973 and 1974 declines are an obvious consequence of the OPEC price rises. It is possible that the 1979 price rises will have a similar short-term effect. It is interesting to note that energy consumption in 1977 was still less than the 1973 figure.

Of more importance, however, are the changes in the composition of demand. These can be seen from Table 1 and also from the % shares in Table 2. Four main trends are clear. Firstly, there is the sharp decline in coal consumption, both in absolute quantity and % share: consumption declined from 13.3 million tons in 1970 to 11.3 in 1974, with a subsequent increase to 12.3 million in 1977; coal's % share fell from 42.5% in 1970 to 33.7% in 1974 and although there was an increase in 1975 it has again been falling to its 1977 level of 35.4%. Twenty years ago coal provided more than three-quarters of our energy needs so the industry's decline has been very rapid. It is little consolation that there has been a similar decline in the rest of the UK and in most other Western European countries.

Table 2

PERCENTAGE SHARES OF TOTAL CONSUMPTION

	1970	1971	1972	1973	1974	1975	1976	1977
Coal	42.5	37.7	35.6	37.8	33.7	36.5	36.4	35.4
Petroleum	46.1	48.9	50.6	49.3	49.3	44.7	43.6	43.4
Natural gas	0.3	3.2	4.6	5.2	6.9	7.7	8.2	8.7
Nuclear electricity	4.7	4.7	4.6	4.0	4.4	4.5	5.8	7.3
Hydro- electricity	6.5	5.5	4.6	3.8	5.7	6.7	6.0	5.2
Total	100	100	100	100	100	100	100	100

Secondly, there has been a contrasting rise in natural gas consumption. Since the replacement of manufactured town gas by North Sea gas, its share has risen sharply from less than 1% to 8.7% in 1977 and later figures will certainly show a continuation of that trend. Most of the increase has been in the domestic sector.

Thirdly, there has been the reversal in the growth record of the oil industry: in 1970 oil overtook coal as our major fuel but the OPEC price rises have checked the almost inexorable growth, and consumption has been static since 1975.

Finally, there is the slow growth in the production of hydro

and nuclear electricity. Hydro's share has fluctuated between 3.8% and 6.5% over the period; nuclear's production and % share were static in the early 1970s but the commissioning of the Hunterston B station brought increases in 1976 and 1977. This growth should be seen, however, in the context of official predictions of a tenfold increase in nuclear production during the 1970s and the continuing delays and problems of the nuclear industry are discussed in more detail below.

These changes are all self-evident and need little further explanation. There is one point I would like to consider in more detail, however, because of its future importance and that is the relationship between economic growth and energy demand. Most energy authorities and government departments use the concept of an energy coefficient in forecasting demand. The energy coefficient is the ratio of the growth of demand for energy to the growth in GDP (gross domestic product) or some other similar measure of economic output. Given that the latter is much easier to forecast (or so most economists allege) it is a simple — and useful — means of obtaining a rough picture of energy growth. In the UK since the 1950s an average annual growth in GDP of about 2.7% has been associated with an annual growth of primary energy consumption of about 1.7% — giving a crude energy coefficient of about 0.7. There are some drawbacks in using such a coefficient for forecasting purposes, but they are not important in the present context. If we assume an annual rate of growth in Scottish GDP of around 3% over the next decade, total energy consumption would rise from its 1977 level of 880.9 petajoules to around 1,040 in 1985 and 1,155 in 1990.

Is this energy coefficient and its implied relationship acceptable? This is really the crucial question and its implications for the future are discussed in more detail below. In the context of what has happened since 1970 it is impossible to be dogmatic because there have been a lot of strange happenings. For example, industrial production in Scotland has increased by (only) 6.0% over the period 1970-77; despite the oil price rises energy consumption has risen by 6.3%. In the years when there were declines in industrial production (1971, 1974 and 1975) there were also declines in energy consumption and in the other years of increased industrial output there was increased energy consumption. Certainly for 1971, 1972 and 1973 there is a very

close correlation between industrial output and energy consumption; but in 1974 industrial production fell by 2.0% and energy consumption by 5.8%; in 1976 industrial production increased by 0.6% and energy consumption by 2.7%; and in 1977 industrial production increased by 0.4% and energy consumption by 2.1%. One possible explanation of the divergence in experience in 1976 and 1977 is that there has been a time-lag in operation, but we would need data for the period 1978-80 before we could be reasonably certain of that.

Some useful additional evidence is given in the paper by Hampson and Thomson³ where they disaggregate consumption by sector and show significantly different responses to the events of 1973 and 1974. In the domestic sector there was no significant decline whereas the drop in industrial consumption was almost double that in all other sectors. There was a small decline in the transport sector, with private motorists reducing petrol consumption more than commercial road transport but still by not much. Given the importance of the industrial sector it should be remembered that the industrial recession itself was caused in part by the OPEC price rises so the disentangling of cause and effect is difficult.

A crucial point to bear in mind at the outset is that the demand for energy is a derived demand. In other words, the primary demand is for appliances and energy-using goods and it is the stocks of these and their utilisation which determine the demand for energy. One implication of this is that in the short run the price elasticity of demand for energy — and, to a lesser extent, for individual fuels — is not very important because changes in the stocks of goods and appliances are very slow. An obvious example is the domestic heating sector, where the initial capital costs are substantially greater than the running costs and to change from oil to gas is not a short-term choice. Another example is the demand for petrol, which has fallen surprisingly little since the OPEC price rises, simply because petrol represents a relatively small part of the cost of motoring. The longer the time period, however, the easier it is to change the pattern of demand and it may well be that the real effects of the oil revolution will not be felt until the early 1980s.

Forecasting Future Consumption

Some rough estimates were given above: if an energy

coefficient of 0.7 was used and Scottish GDP grew 3% per year, total energy consumption would increase from its 1977 level of 881 petajoules to 1,040 in 1985. In million tons coal equivalent the rise would be from 31.7 in 1977 to about 37.5 in 1985.

This provides a reasonable starting point and luckily more detailed forecasts have been made by the South of Scotland Electricity Board (SSEB)⁴. These are shown in Table 3 and are of particular interest because they represent the "official" picture based on existing UK policies. Two points should be made at the outset regarding these forecasts. Firstly, the SSEB are an interested party and it is in their interest that electricity's share of the energy market should continue to grow. Secondly, the SSEB have been strongly committed to a substantial nuclear power programme. They were the main proponents of the steam-generating heavy-water reactor (SGHWR) but have recently accepted the Government's preference for an advanced gas-cooled reactor (AGR) programme. In May 1978 the Secretary of State for Scotland announced that Torness would go ahead, but based on an AGR system rather than a SGHWR.

Table 3

SSEB FORECASTS OF ENERGY CONSUMPTION
(million tons coal equivalent)

	1974 tons (%)	1980 tons (%)	1984 tons (%)
Oil	12.0 (38.7)	14.0 (36.8)	15.0 (35.7)
Coal	4.0 (12.9)	4.0 (10.5)	4.0 (9.5)
Gas	2.0 (6.5)	3.0 (7.9)	4.0 (9.5)
Electricity	13.0 (41.9)	17.0 (44.7)	19.0 (45.2)
— of which oil	2.0	3.0	4.0
— coal	7.0	8.0	8.0
— hydro	2.0	2.0	2.0
— nuclear	2.0	4.0	5.0
TOTAL	31.0	38.0	42.0
Total coal	11.0 (35.5)	12.0 (31.6)	12.0 (28.6)
Total oil	14.0 (45.2)	17.0 (44.7)	19.0 (45.2)
Total gas	2.0 (6.5)	3.0 (7.9)	4.0 (9.5)
Total hydro	2.0 (6.5)	2.0 (5.3)	2.0 (4.8)
Total nuclear	2.0 (6.5)	4.0 (10.5)	5.0 (11.9)

Source: South of Scotland Electricity Board.

Note: The figures here are not directly comparable with those in Table 1 because of differing definitions.

With future policy there are two major issues: the total size of the energy market and the distribution of demand among the various competing fuels. Differences of opinion about the former have not been great and it has not been a major policy issue. Nevertheless, it would be sensible to repeat the doubts expressed tentatively above.

Given the events of 1973-75 it would be unwise to predict with great confidence that energy consumption will continue to grow in line with the rate of economic growth. It may, but it may not. It certainly did in the 1950s and 1960s, but the experience of the 1970s is so confused that we shall have to wait for another two or three years before we know if the relationship is likely to continue. Thus, it is rather unfair of the SSEB's Director and General Manager, Donald Miller, to say, as he did recently⁵, that "What people are saying when they suggest that there will be no growth in electricity demand, is that there will be no economic growth and that they don't believe there is going to be increased standards of living." There is a valid point of view that energy growth may be less than the rate of economic growth — in other words that the old relationship has broken down. This is not my view — nor that of Mr Miller — but it may prove to be correct and certainly warrants careful consideration. There is also the valid point of view that electricity's share may fall and this is discussed in the next section.

In the light of this uncertainty, however, the sensible strategy is to be sufficiently flexible to cope for the maximum likely demand. Problems of overcapacity are much less than those of undercapacity and it is therefore much better to err on the side of optimism.

The Roles of the Different Fuels

This is the major policy issue and the one that has caused — and undoubtedly will continue to cause — the greatest debate. Taking electricity first, it is arguable that UK energy policy is too committed to electricity generation and that Scotland has an even greater dependence. The expectation for the UK is that although electricity may have difficulties in the period to 1980 the rate of growth over the period to 1990 should average between 3% and 4% per year. Given the great uncertainty about energy demand and energy policy, and the obvious need to make decisions on the basis of an acceptable range of forecasts, this

view of the Department of Energy/SSEB could turn out to be correct. On the other hand, there is a good deal of evidence to suggest that it might be substantially awry and therefore it is necessary to examine the alternative case thoroughly. In the present context only a brief summary is possible but there appear to be four main points.

Firstly, electricity consumption in the UK as a proportion of GNP is much higher than any other country in the world, including those more industrialised such as the USA and West Germany. Some examples for 1975 are⁶:

Country	ratio
Australia	3.81
Canada	4.39
France	2.18
West Germany	1.79
Italy	2.87
Japan	2.99
Sweden	3.82
UK	5.13
USA	3.47

Secondly, the generation of electricity is a relatively inefficient way of producing energy, although for many consumers it has been a very convenient form. The important factor is the conversion of heat energy into mechanical energy. The level of efficiency depends upon the maximum and minimum temperatures of the working fluid used, usually steam. These temperatures are limited by engineering considerations and in practice the overall efficiency of even the most efficient power station is less than 35%. The average is about 30%. In practice, this means that only one-third of the heat energy latent in the primary fuel is released as electricity, with the rest of the heat being discharged to the environment, through the medium of cooling water, as waste heat. Also the further losses sustained in the transmission and distribution of electricity from power stations to consumers must be taken into account; in 1975, these losses amounted to approximately 10%; and the overall efficiency for the UK electricity industry was therefore around 27%. In contrast, the efficiency of other energy forms is usually substantially higher. Given the recent rises in energy prices, and the country's balance-of-payments problems it is not surprising that

the Government is keen to increase the efficiency of energy use — as exemplified by the “Save Energy” campaign — and electricity must inevitably be the main target.

Thirdly, changes in relative prices will strengthen the above trends. The official view is that electricity will steadily increase its penetration of the energy market, to the extent that by the year 2025 it would account for about 60% of total energy supply to consumers, but this appears to ignore the effect of increasing prices on demand. Experience since the early 1950s shows that even modest rises in relative prices have had a depressing effect on demand, bearing in mind the time-lags involved because energy is a derived demand, the primary demand being that for energy-consuming appliances. The recent large increases in electricity prices have rendered it uncompetitive in many sectors in comparison with North Sea gas and this has given rise to a number of official complaints by the electricity industry. At least until the late 1980s gas should continue to be much more competitive for uses such as central heating.

Fourthly, some economists have been arguing that the current problems affecting the electricity industry are not simply a short-run consequence of the industrial recession, OPEC price rises, etc., but are in line with a long-run trend which implies that the growth in demand for electricity will continue to slow down and possibly even fall in the foreseeable future. The basic argument is that in some markets a “saturation point” has been reached — for example, with many domestic appliances such as televisions, cookers, refrigerators, electric kettles, etc. The growth in electricity consumption since the 1950s correlates very closely with the growth in ownership of these domestic appliances. Now that most households have these appliances, the growth in demand for them must slow down and must therefore have an adverse effect on the demand for electricity, principally in the domestic market (already badly hit by the inroads made by natural gas into the central heating market).

A great deal of detailed work would have to be done to test the appropriateness and validity of the four points above, and unfortunately time is not available to do this, but to us there does appear to be sufficient justification in each of the four points to suggest that the official Department of Energy/SSEB forecasts of electricity demand are too optimistic.

On present plans, the excess electricity capacity will worsen rather than improve over the next few years. In 1978 the SSEB had an installed capacity of 7,572 MW (megowatts) and the maximum demand was 4,228 MW. The average thermal efficiency of the conventional plant was 33%⁷. The NSHEB had an installed capacity of 2,109 MW and the peak demand (on the mainland system) was 1,576 MW. In addition the North Board also takes some electricity from the Atomic Energy Authority's prototype fast reactor at Dounreay⁸. Thus at the present time there is substantial excess capacity — about 45% — although both Boards probably need 25-30% spare capacity as a safety margin in case of plant breakdowns. The bad winters of 1977/78 and 1978/79 caused particular problems in that respect for the North Board and the South Board has had problems with the Hunterston B nuclear station.

This installed capacity of just under 9,600 MW (plus Dounreay) will increase in 1979 with the commissioning of the third unit at the Inverkip oil-fired station (680 MW) and in 1980 with the Peterhead oil/gas-fired station (1,320 MW). Approval has also been given for the Torness nuclear station (1,320 MW) for commissioning in the late 1980s and the North Board are keen to build a pump storage scheme (of up to 3,200 MW) at Craigroyston on Loch Lomond. There are also tentative plans for a new coal-fired station in Fife and a third nuclear station at Hunterston, and, on a smaller scale, the North Board are considering expansions in Shetland, Orkney and the Western Isles.

Even if the SSEB's forecasts of electricity demand in Table 3 proved correct, the implication is that this surplus or spare capacity will continue, even taking into account the phasing out of older, less efficient coal stations. There is little doubt that this argument will be a common one in the public inquiries and related discussions about the proposed new stations.

Nevertheless, it is more a matter of timing than anything else because at some stage in the future the excess will disappear. Leaving aside the nuclear versus non-nuclear debate, a station at Torness will be needed in the near future: the SSEB say by the late 1980s, whereas the above figures suggest by the mid-1990s at the earliest. The cynics among us will probably say that this is therefore rather an unnecessary debate because our performance in building power stations is so bad that Torness will not be completed by the late 1980s in any case!

The Craigroyston pump storage scheme is in a different category because of its nature as a "cheap reserve" for use only in terms of peak demand. Nuclear (or other) stations which have low running costs and pump storage schemes are sensible complements and the argument of excess capacity does not really apply to Craigroyston.

The final point on electricity concerns the nuclear debate and this is not the place to discuss it. Suffice to say that there is increasing public concern about the dangers of nuclear stations — both conventional and fast breeder — and it is obvious that the Department of Energy and the electricity authorities will have to do a great deal to satisfy the majority of the public that an expansion of our nuclear capacity is safe. Only the nuclear enclave in Caithness seems to welcome uranium mining and/or a commercial fast breeder station and in the light of the increasing sophistication of environmental groups the planning process will undoubtedly take a long time.

In the short run, this would leave the choice for electricity of oil, gas and coal, and here again I have some doubts about existing policies. Oil and gas are attractive sources of fuel because of the North Sea discoveries, although oil-fired power stations would continue to depend on imported oil from the Middle East and other countries, but to the extent to which North Sea oil and gas are used for power generation and similar uses, my strong view is that it is a misallocation of resources. From the Scottish point of view, the main benefits from these new indigenous sources would come from the establishment of a major refining and petro-chemical industry. The main reason for this is that the type of oil discovered in the North Sea has a much higher proportion of the "lighter fractions" than oil from the Middle East, for example, and is therefore better used for petrochemicals than industrial fuel; also, there have been large discoveries of associated gas in the northern North Sea, and these similarly offer opportunities for processing. In fact, gas processing is likely to be on a much greater scale than oil refining and processing, although at the present time there are few signs of the opportunities being grasped, and it could well be that much of the oil and gas will be used for other purposes or exported, either to England or Wales or overseas⁹. It is rather ironic that Shell-Esso have been experiencing planning problems in their attempts to build petrochemical

plants in Fife as severe as the electricity boards in their attempts to build power stations at Torness and Craigroyston.

With gas, there are some added considerations because of the current arguments within the energy industry that the price of gas is too low. The real price of energy is now what it was in 1951/52, with the exception of gas which in real terms has fallen steadily over the last twenty years. A consequence of this is the pressure for rapid depletion of the North Sea fields which is undesirable not only in its own right, but also because of the problems it creates for the coal and electricity industries. There is certainly a case for setting a higher selling price in order to allow gas to concentrate on two very important markets — the premium domestic market and the petrochemical feedstock market. Another reason is that if, as seems likely, a transition from natural gas to synthetic natural gas is required in the foreseeable future, then the pricing of the natural material should increasingly take account of the long-run cost of the substitute material.

This then leaves coal with a more important role in the Scottish energy market. Coal consumption and production are currently running at around 11 million tons per year, of which 8 million tons go to power stations in Scotland. It is difficult to believe other than that the non-power station use will continue to decline steadily in the future, and therefore the crucial issue is coal's use for electricity generation. Traditionally, Scottish coal has been high-cost, even within the UK industry: in the financial year 1974/75 the loss per ton to the National Coal Board of Scottish coal was £0.96, compared with £0.29 in Great Britain as a whole, presumably largely because productivity was lower in Scotland, 39.5 tons per man-shift compared with 45.0 tons in Great Britain. Rising oil prices have made coal much more competitive, however, and there is a strong economic case for re-examining the National Coal Board's plans for Scotland. On social grounds also, there is the usual argument that the real resource cost of coal is significantly lower than the market price because of the unemployment which would be created in the mining areas if closures took place, and this applies much more to Scotland than to England and Wales. To the economist this argument is not strong, but it should be borne in mind, particularly since the National Coal Board employ around 27,000 people in Scotland.

On the face of it, there appears to be a good case for some of the newer power stations to be coal-fired, which would allow the industry to maintain its sales to the SSEB at around 8 million tons per year plus about 0.5 million tons of slurry. A long-term commitment to do this would make forward planning much easier, and encourage the commercial exploitation of new discoveries.

The change in relative prices has given a similar boost to the prospects of alternative energy sources such as solar energy, wind and wave power, but it is very unlikely that these will make more than a minor contribution in the near future. At the local level there are some possibilities — such as district heating schemes — but otherwise the problems are much greater than the environmental lobby recognises and a great deal more planning is required. In the short run we have no alternative to the conventional fuels discussed above.

Conclusions

The two crucial questions which energy policy has to answer are:

1. What is the likely pattern of aggregate demand over the next 10-15 years?
2. What will be the role of the various fuels?

It should be clear from the above that there can be different answers to these questions, which implies that the energy debate will continue in Scotland for some time to come. The Torness confrontations may recur at fairly regular intervals.

I have tried to avoid the nuclear versus non-nuclear argument because it is outwith the scope of the present paper, but I have attempted to set out fairly the main arguments about the size and nature of the future energy market.

There is considerable agreement on the first question above. It seems reasonable to assume for planning purposes that total energy demand will grow at between 2% and 2.5% per year. Although there was an absolute fall in consumption in 1974 and 1975, Table 1 suggests that growth has started again and that these two years should be seen as a hiccup in a long-term trend rather than a major change.

On the other hand there is considerable disagreement about the second question and this has been the crux of the arguments

in Scotland. In particular there is a body of opinion wishing to constrain the growth of nuclear electricity and to a lesser extent (and for different reasons) the domestic consumption of natural gas. The obverse of that is the encouragement of the Scottish coal industry and alternative energy sources. It is probably reasonable to conclude that an expansion of the coal industry is out of the question and that the best hope is to maintain production and consumption at roughly current levels. Many hopes for alternative sources are also over-optimistic at the national level.

There can be little doubt, however, that the more open discussion of needs and policies has been very beneficial in recent years and that the non-official lobby is acquiring increasing knowledge and expertise. The result must be slower but better policy decisions.

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