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AN ANALYSIS OF THE PATTERN OF ENERGY CONSUMPTION IN THE UNITED KINGDOM AND SCOTLAND DURING THE PERIOD 1955 - 1974

by

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Abstract

There are two principal objectives of this study. The first is to compare the trends of energy consumption between Scotland only and the whole of the United Kingdom and, to examine the causes for any differences that may exist between the two trends. The second objective is to analyse on an aggregate level, the structure of demand for (a) the consumer demand for energy and (b) the derived demand for energy.

The consumer demand model is estimated by using a direct utility function, the functional form being a modification of the generalised constant elasticity of substitution (GCES). The assumption behind the model is that the consumer allocates his expenditure between two homogeneous goods namely energy and "non-energy". The derived demand model is estimated by using a production function, the functional form again being a modified GCES. The model is based on the assumption that output is generated by the combination of three aggregate factor inputs namely energy, labour and capital.

The parameters for both the utility function and the production function are estimated by using non-linear programming routines that minimise the sum of squares of the residuals. From a knowledge of the utility function the price and income elasticities of demand for both energy and "non-energy" and the elasticities of substitution between energy and "non-energy" are calculated. From a knowledge of the production function the price elasticities of demand for labour, capital and energy and the partial elasticities of substitution between energy, labour and capital are calculated.

One of the central features of the analysis is that energy consumption is measured in terms of effective energy instead of final

energy which means that the efficiencies with which energy is utilised have been taken into account explicitly in the measure of consumption of energy.

The main conclusions of the study with regard to the comparison between Scotland and the whole of the U.K. in the trends of energy consumption are (1) that the overall trends in the consumption of the principal forms of energy (i.e. coal, petroleum etc.) are similar, (2) that the overall efficiency of the energy sector in Scotland is lower compared to the rest of the U.K. and (3) that the share of electricity in the domestic sector and the share of petroleum in the industrial sector are significantly higher in Scotland compared to the rest of the U.K.

The main conclusions with regard to the structure of demand are (1) that energy is an inferior good if the unit of consumption is final energy units and it is a normal good if the unit of consumption is effective energy. Since there are no a priori reasons to consider energy as an inferior good, an analysis of energy in terms of effective energy seems more appropriate than one in terms of final energy, (2) if energy is measured in effective energy units, the hypothesis that the utility function is well-behaved can be rejected (3) the overall structure of demand in Scotland is similar to that of the whole U.K. and (4) that a methodology has been established by which all the relevant elasticities of capital, labour and energy can be computed from the derived demand model.

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The responsibility for any errors of fact contained in this thesis belong to the author only.

CONTENTS

Contents (cont)

Contents (cont.)

Contents (cont.)

Contents (cont.)

Contents (cont.)

Contents (cont.)

Contents (cont.)

LIST OF FIGURES USED

List of Figures (cont.)

LIST OF TABLES USED (excluding the Appendix Tables)

List of Tables (cont.)

APPENDIX TABLES

Appendix Tables (cont.)

Appendix Tables (cont.)

Appendix Tables (cont.)

Appendix Tables (cont.)

LIST OF ABBREVIATIONS USED

Abbreviations	Meaning
A.A.S	Annual Abstract of Statistics
A.G.B.	Audits of Great Britain
A.R.S.	Abstract of Regional Statistics
B.G.B.	British Gas Board
B.R.B.	British Railways Board
C.B.I.	Confederation of British Industry
C.E.G.B.	Central Electricity Generating Board
D.O.E.G.	Department of Employment Gazette
D.S.S.	Digest of Scottish Statistics
F.E.S.	Family Expenditure Survey
F.S.	Financial Statistics
I.P.	Indsitute of Petroleum
M.D.S.	Monthly Digest of Statistics
N.C.B.	National Coal Board
N.E.D.O.	National Economic Development Office
N.I.E.	National Income and Expenditure
N.I.E.S.R.	National Institute for Economic and Social Research
N.S.H.E.B.	North of Scotland Hydro-Electricity Board
S.A.S.	Scottish Abstract of Statistics
S.G.B.	Scottish Gas Board
S.R.I.	Stanford Research Institute
S.S.E.B.	South of Scotland Electricity Board
U.K.	United Kingdom
U.K.D.E.S.	United Kingdom Digest of Energy Statistics

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S.G.B.	Scottish Gas Board
S.R.I.	Stanford Research Institute
S.S.E.B.	South of Scotland Electricity Board
U.K.	United Kingdom
U.K.D.E.S.	United Kingdom Digest of Energy Statistics

CHAPTER 1

Introduction

There are two principal objectives of this study. The first is to establish the trends of energy consumption in the United Kingdom and in Scotland during the period 1955 to 1974 and to examine the reasons for any variations that may exist between the two trends. The second objective is to analyse on an aggregate level, the structure of demand for (a) the consumer demand for energy and (b) the derived demand for energy. Although there are severe limitations in analysing energy demand at an aggregate level (since different forms of energy that are used for different purposes are not perfect substitutes of each other), aggregate demand studies are still necessary when the objective is to analyse such problems as the role of energy in the economy or the demand for energy compared to the demand for other goods.

The central hypothesis behind the present analysis is that energy does not provide utility in itself but provides utility only in so far as it serves the purposes for which it is consumed. Therefore, it is contended, that an analysis of energy consumption must take into account the efficiencies with which energy is utilised, i.e. that energy should be measured in terms of effective energy instead of final energy. Since estimates of utilisation efficiencies (needed for estimating effective energy) are not readily available from published statistics, it was necessary that a major part of the research effort be devoted to a careful compilation of energy consumption in terms of effective energy. It is hoped to show that significantly different results may be obtained and hence significantly different conclusions may be drawn, if the analysis is based on effective energy instead of final energy.

The consumer demand for energy, mentioned above, consists of domestic energy demand plus the energy demand of transport consumed for private purposes (i.e. for leisure and recreation). This demand is analysed by a model that allocates consumers' expenditure between two categories of consumption, (1) energy and (2) "non-energy". The derived demand for energy is equal to the net of total energy demand minus the consumer demand. This demand is analysed by a model which allocates the total expenditure between three categories of demand, (1) energy, (2) labour and (3) capital.

The study is organised into ten chapters. The general background to the problems of analysing energy demand is introduced in Chapter 2. The chapter contains both a definition of the energy terms used in this study and discussions of the concept of effective energy, of the scope, objectives and limitations of this study and of the general problems of energy modelling.

A historical perspective on the patterns of energy consumption is the theme of Chapter 3 in which is analysed the patterns of energy consumption from a global viewpoint and is examined the relationships in Britain between energy consumption and economic development since the Industrial Revolution. In order to provide a greater insight into the trends of energy consumption in Scotland (analysed later in Chapter 5), the chapter also includes a discussion of the structure of the Scottish economy and the development of the energy industries in Scotland.

A survey of the current literature on energy studies is carried out in Chapter 4 in which the studies are classified into eight groups and the studies particularly relevant to our present investigation are discussed.

In Chapter 5 the main trends of energy consumption in the U.K. and in Scotland are analysed.

A detailed discussion of the energy studies concerned with the structure of energy demand (mentioned in Chapter 4 as one of the eight groups) is carried out in Chapter 6. The reason for this separate treatment of this particular group of studies is that these studies use models similar to the ones used in the present study and consequently the results from these studies could be compared later with results from the present study.

In Chapter 7, the models used in the present study are discussed in detail. As mentioned earlier, the total demand for (effective) energy is divided into two components, the consumer demand and the derived demand and a separate model is built for each of these two components of demand.

A major exercise was undertaken for compiling data on effective energy consumption. A detailed discussion of the nature, sources and the organisation of the data is presented in Chapter 8; the data being included in the Appendix.

The results obtained from the models of consumer demand and derived demand are discussed in Chapter 9.

The study finishes in Chapter 10 with the statement of the conclusions of the present study and the recommendations for future research.

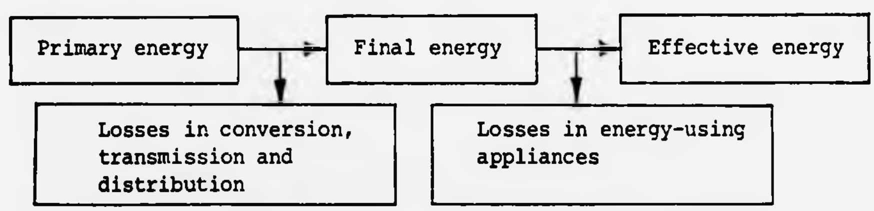
CHAPTER 2

General Background

2.1 Definitions of terms used in energy studies

The literature on energy studies contains a large number of energy terms such as primary energy, secondary energy, final energy, delivered energy, gross energy, net energy, many of which are used interchangeably and in loose context. In order to provide a basis for the energy terms used in this study, definitions of these energy terms are presented in this section. We start with a diagrammatic representation of an energy system.

Fig. 2.1 An energy system



What this diagram is intended to convey is a picture of an energy economy which has a certain amount of "non-converted" or primary energy, some of which is converted into other forms of energy (e.g. the burning of coal to produce electricity, the conversion of crude oil into motor spirits, gas etc.) to give a total amount of "final energy" in the forms in which it is consumed by industry (which is an intermediate consumer) and the final consumers. However, consumers and industry do not desire this energy in itself, but desire it to produce heat, light, power and transport (or more strictly, to produce certain desired effects such as temperature rise, illumination, movement etc.) How much of these outputs (i.e. heat, light etc.) they obtain depends on how efficient the energy-using appliances are for producing these outputs. Therefore, to get a more accurate picture of the final consumption of energy, it is useful to convert the final energy into effective units or "effective energy".

Primary or "non-converted" energy may be obtained from such sources as the hydrocarbon fuels (coal, oil, gas etc.), uranium, the sun, geothermal heat, falling water, wind, tide, wood, peat, dung and others. On a strict definition, the solar energy may be considered to be the main primary energy since most other sources of energy (such as hydrocarbon fuels, wind etc.) are or have been derived from it. However, at present, the consumption of solar energy is usually ignored for national energy accounting purposes and hence, avoiding the stricter definition, the primary energy in the U.K. may be considered to consist mainly of:

(1) Coal

(2) Crude Oil

(3) Natural gas

(4) Nuclear electricity (from fission of uranium) and

(5) Hydro electricity (from falling water).

These five are the forms of primary energy of large overall consumption values for the U.K., although in specific locations and situations other forms are still in use. The U.K. has a relatively large reserve of peat (equivalent to approximately 300×10^9 million therms) and 65 per cent of this reserve is located in Scotland (Tweedie (1975)). However, the low calorific value of peat relative to its weight and its unsuitable geographical distribution (away from the major centres of population) have so far prevented its use in commercial quantities. Among the other sources of primary energy a small quantity of wood is still used for heating, particularly in the remote areas, while the energy produced from wind, tide etc. is negligible at present.

Final energy may be defined as the energy produced by the energy industries for final consumption (i.e. primary energy minus energy lost in conversion from primary to final energy). In the U.K., final energy consists mainly of:

(1) Coal and other solid fuels such as coke, breeze and manufactured fuels (sunbrite, phurnacite, multiheat etc).

(2) Petroleum products such as motor spirits, fuel oil and kerosene. This category includes all products from crude oil except those used as feedstocks for industry such as naphtha, industrial spirits and bitumen.

(3) Town and natural gas.

(4) Electricity.

Effective energy may be defined as the amount of energy available to the consumer after the utilisation efficiencies of energy-using appliances have been taken into account.

In the literature, primary energy is sometimes referred to as gross energy, final energy is sometimes referred to as delivered energy or secondary energy, and effective energy is sometimes referred to as useful energy.

The amounts of primary and final energy used annually in the U.K. are available from official statistics. However, the amount of effective energy used is not published and had to be estimated for the present study. The concept of effective energy is discussed in detail in Section 2.2 below and the problems of estimating effective energy are discussed later in Section 8.

2.2 The concept of effective energy

There are two main problems in any study of aggregate energy demand. These are (1) the problem of measurement of energy i.e. whether energy should be measured in terms of primary energy, final energy or effective energy and (2) the problem of aggregating consumption of different forms of energy for different purposes (such as electricity for lighting and gas for heating) into one single commodity called energy. These problems are discussed here in terms of the utility functions and the production functions.

Energy does not produce utility in itself, it produces utility by serving the needs of the processes for which it is consumed. There are, in the main, four processes for which energy is consumed and these are (1) heat, (2) light, (3) power and (4) transport.

For the consumer, the utility function may be represented as

$$U = U(C, H, L, P, T) \qquad (2.1)$$

where C is consumption of goods other than energy,

H is consumption of heat,

L is consumption of light,

P is consumption of power and

T is consumption of transport.

The consumptions of heat, light, power and transport are achieved by the consumption of energy in association with the energy-using appliances and this can be written as

$$\left.\begin{aligned} H &= f_h(K_1 \ldots K_n, \; E_1 \ldots E_m) \\ L &= f_l(K_1 \ldots K_n, \; E_1 \ldots E_m) \\ P &= f_p(K_1 \ldots K_n, \; E_1 \ldots E_m) \\ T &= f_t(K_1 \ldots K_n, \; E_1 \ldots E_m) \end{aligned}\right\} \qquad (2.2)$$

where $K_1 \ldots K_n$ represent the quantity of energy-using appliances of types i = 1 ... n, and $E_1 \ldots E_m$ represent the quantity of energy consumption of types i = 1 ... m.

Combining equations (2.1) and (2.2), we get,

$$V(C, K_1 \ldots K_n, E_1 \ldots E_m) \equiv U(C, f_h(K_1 \ldots K_n, E_1 \ldots E_m), f_1(K_1 \ldots K_n, E_1 \ldots E_m), f_p(K_1 \ldots K_n, E_1 \ldots E_m), f_t(K_1 \ldots K_n, E_1 \ldots E_m)) \qquad (2.3)$$

If energy is measured in terms of final energy, then with technical progress enabling the consumer to obtain more heat, light etc. from a given amount of final energy, one has to write

$$V_t(C, K_1 \ldots K_n, E_1 \ldots E_m) = U(C, f_{ht}(\ldots), f_{lt}(\ldots)\ldots) \qquad (2.4)$$

so that the structure of utility depends, in principle, on technology or time (as expressed by the time-subscripted notations V_t, f_{ht} ... etc).

In a fully-articulated model, one would wish to recognise that technical progress comes about by the designing and use of new and better appliances. To borrow an expression from the literature of technical progress, technical progress would be considered as "embodied". The analysis of models of embodied technical progress is complex and the testing of such models even more complex, since one would require accurate data on the amounts of various "vintages" of appliance in use.

However, if technical progress is assumed to take the special form of being disembodied and energy-augmenting, one can write

$$f_{ht} = f_h(K_1 \ldots K_n, A_{h1}(t)\, E_1 \ldots A_{hm}(t)\, E_m) \qquad (2.5)$$

with similar relationships for light, power and transport.

$A_{hi}(t)\, E_i$ is the amount of effective energy, or energy in efficiency units, associated with energy of type i, to produce heat.

It can be seen from the equation (2.5) above, that the terms $f_h(\ldots)$, $f_l(\ldots)$, $f_p(\ldots)$ and $f_t(\ldots)$ in the right-hand side expression of equation (2.3) would be independent of time, if energy is expressed in efficiency units. Hence, by measuring energy in terms of effective energy, the structure of utility can be kept constant.

So, in terms of the first question raised in the first paragraph of this section, it would be more desirable to measure energy consumption in terms of effective energy, rather than final energy. The second question raised was whether different forms of energy used for different purposes can be aggregated to one commodity called energy. In terms of the consumer, the utility function, as given in equation (2.1) is,

$$U(C, H, L, P, T)$$

Ignoring the consumption of goods other than energy the equation (2.1) may be modified to

$$\begin{aligned} U(H, L, P, T) \equiv V(&f_h(E_1 \ldots E_m), f_l(E_1 \ldots E_m), \\ &f_p(E_1 \ldots E_m), f_t(E_1 \ldots E_m)) \end{aligned} \qquad (2.6)$$

In the U.K. energy is consumed mainly for providing heat; for example for the domestic sector in 1970 N.E.D.O. (1974a) provides a figure of 94 per cent as the proportion of energy consumed as heat (in final energy terms) and the C.B.I. (1975) provides a corresponding figure of 89 per cent for the industrial sector in 1973. In terms of the share of total energy consumption, it is transport which comes next to heat.

Both for the processes of heat and transport, and particularly for heat, the different forms of energy available in the U.K. (i.e. coal, petroleum, gas and electricity) are fairly good substitutes of each other. For the processes of light and power, the different forms of energy are not close substitutes since electricity is usually a more convenient form of energy compared to the others. However, since heat and transport account for the great bulk of energy consumption, equation (2.6) may be modified as

$$V(f_h(E_1 \ldots E_m), f_l(E_1 \ldots E_m), f_p(E_1 \ldots E_m), f_t(E_1 \ldots E_m)$$

$$\equiv \tilde{V}(f_h(E_h), f_l(E_l), f_p(E_p), f_t(E_t)) \quad (2.7)$$

where E_h is the total consumption of energy for heat,

E_l is the total consumption of energy for light,

E_p is the total consumption of energy for power and

E_t is the total consumption of energy for transport.

There are substitutions between the processes of heat, light, power and transport. For example, it is possible to consume more petroleum for transport as a preference over the consumption of more electricity for television or to use more electricity for power (for example, a clothes drier) as a preference over the use of more gas for space heating. Energy consumed as heat, light, power and transport may not be good substitutes but since most of energy is consumed as heat, the equation (2.7) may be modified as

$$\tilde{V}(f_h(E_h), f_l(E_l), f_p(E_p), f_t(E_t) \equiv \tilde{\tilde{V}}(f(E_h + E_l + E_p + E_t)) = \tilde{\tilde{V}}(E_T) \quad (2.8)$$

where E_T is the total energy consumption.

Although the aggregation represented in equation (2.8) involves some errors, this aggregation is, however, presently necessary for studying long-term trends of total energy consumption. It is, of course, more desirable to base the analysis on the concepts, as expressed in equation (2.7) - but as is explained later in Section 2.6.1.2, the existing data do not allow such a study to be made at the present time.

The arguments regarding (1) the suitability of using effective energy and (2) the validity of aggregating energy is equally applicable in the industrial sector as it is in the consumer sector.

The fact that effective energy is a more homogeneous quantity than final energy can be observed by comparing the prices of different forms of energy. The variation in price between the cheapest and the most expensive form of energy is much greater when energy is expressed in terms of final energy than when it is expressed in terms of effective energy. The situation for the year 1974 is as shown below.

Table 2.1 Domestic energy prices, U.K. 1974, current prices, pence/therm

	Final energy prices	Effective energy prices
Coal and other solid fuels	7.27	18.52
Petroleum	15.00	21.58
Gas	11.15	16.04
Electricity	33.88	35.66(46.42*)
Ratio between the most expensive and the cheapest	4.66	2.22

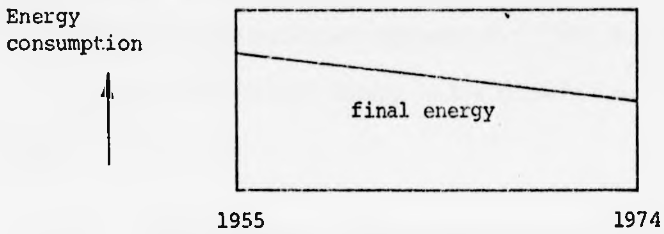
*The overall efficiency of electricity is 73 per cent due to the low efficiency of lighting and anciallary equipment which gives a price of 46.42 pence/therm. If the special uses of electricity (such as lighting; power for television, radio etc) are excluded for the purpose of comparison with other forms of energy, the utilisation efficiency is 95 per cent, giving a price figure of 35.66.

Sources: Appendix Tables 21a and 23.

It can be seen that the ratio of the prices between the most expensive and the cheapest forms of energy is much lower when energy is measured in effective energy terms than when it is expressed in final energy terms (2.22 as against 4.66). This suggests that compared to final energy, effective energy is a more homogeneous quantity and hence a more suitable unit for the analysis of energy consumption.

The differences in the time-trends of consumption that can arise due to the differences in measuring the energy either in terms of final energy or in terms of effective energy may be illustrated by considering domestic consumption of energy in Scotland during the period 1955 to 1974. The situation can be shown graphically as

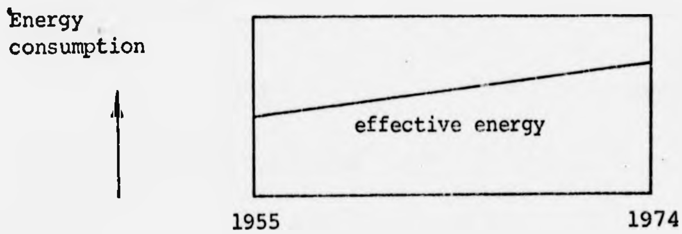
Fig 2.2 Domestic energy (final) consumption in Scotland



Source:
Text Curve
No. 5.7
Chapter 5

The above figure suggests that the energy consumption was lower in 1974 than in 1955 although the household income in 1974 was nearly twice that in 1955, in real terms. The explanation for this apparent contradiction lies in the unit of measurement of energy consumption. If energy consumption is expressed in effective energy units, the picture is modified as follows.

Fig. 2.3 Domestic energy (effective) consumption in Scotland



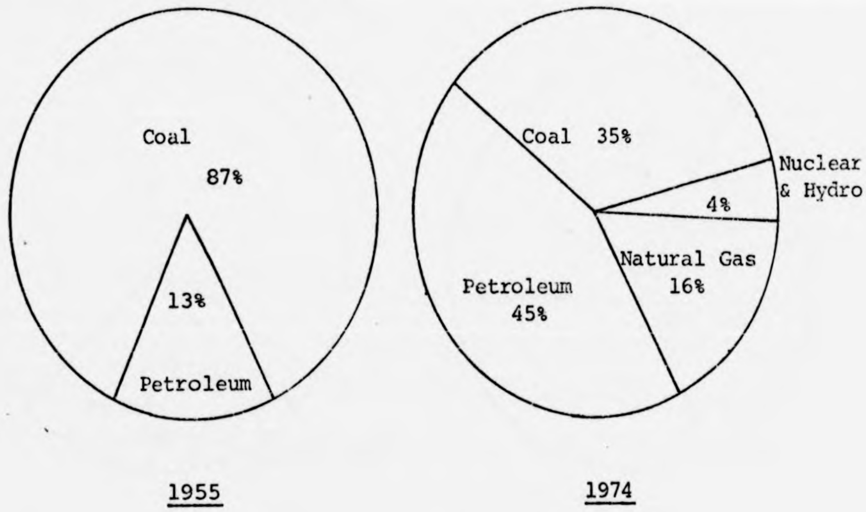
Source:
Text Curve
No. 5.7
Chapter 5

The reasons for this difference in the trends between final energy and effective energy consumption are discussed in the following section.

2.3 Characteristics of the United Kingdom energy market

The present market for primary energy in the U.K. consists of four principal sources of supply namely coal, petroleum, natural gas and primary electricity from nuclear and hydro generation. The most important developments in the energy scene since the 1950's have been the decline in the consumption of coal and the growth in the consumption of petroleum and natural gas. The change in the shares of the different forms of energy in the primary energy market are shown in Figure 2.4.

Fig. 2.4 Primary energy in the U.K. (percentage shares) (Heat supplied basis)

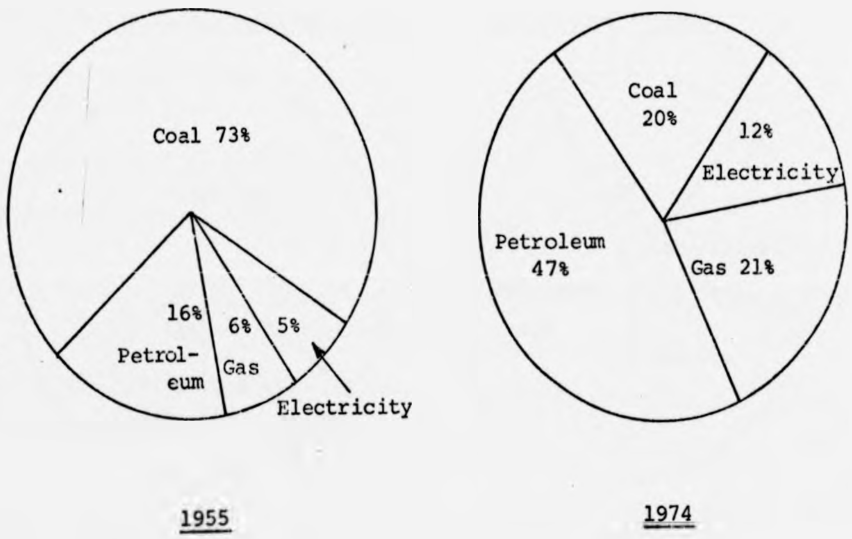


Source: Appendix Table 13d

It can be seen from these pie-charts that coal was overtaken by petroleum in terms of market share by 1974 (in fact the crossover occurred in 1971) and that natural gas which hardly featured as an energy source in 1955 (in fact not even as late as 1967) captured more than 15 per cent of the market by 1974.

The primary energy market reflects the inputs to the energy industries. The energy industries transform some of these primary energy carriers so that different forms of final energy, in the appropriate quantities, are made available for consumption. At present the four major forms of energy that are consumed in the final energy market are (1) coal and other solid fuels (2) petroleum products (3) gas and (4) electricity. The change in the shares of the different forms of final energy are shown in Figure 2.5.

Fig. 2.5 Final energy in the U.K. (percentage shares)
(Heat supplied basis)



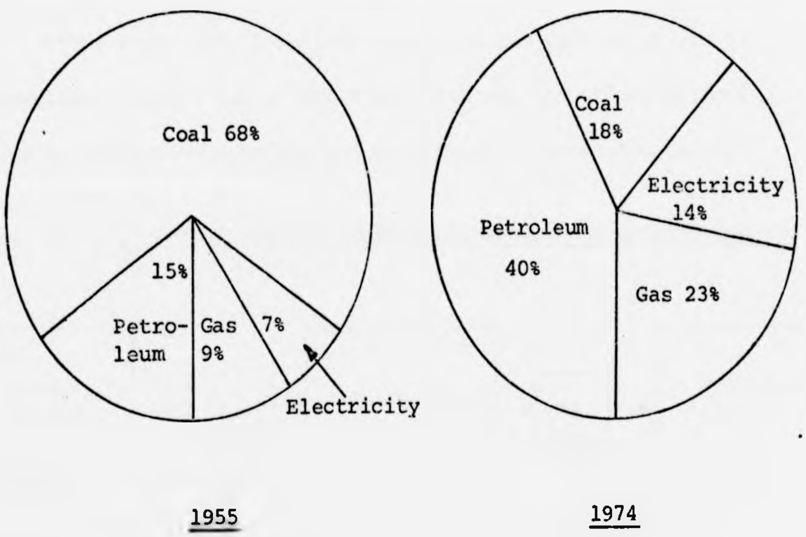
Source: Appendix Table 13e

The above figure illustrates that the pattern of final energy consumption has changed during the last two decades; shares of petroleum, gas and electricity have all increased while the share of coal has declined.

It is evident that different forms of energy are used with different efficiencies; for example the efficiency of an open coal fire may be as low as 25 per cent (meaning that 75 per cent of the available heat is lost through the chimney) whereas the efficiency of an electric space heater is nearly 100 per cent. In order to estimate the growth of energy consumption at the level of the consumer one must take into account the trends in the efficiency of utilisation of energy.

The theoretical argument behind the concept of effective energy has been set out in Section 2.2. If energy consumption is estimated in effective energy terms, the contribution of the different forms of energy may be summarised as follows.

Fig. 2.6 <u>Effective energy in the U.K. (percentage shares)</u>



Source: Appendix Table 15

The above figure shows that the changes in the pattern of effective energy consumption are very similar to the changes in the pattern of final energy consumption (see Figure 2.5). The two major differences between the level of final energy and effective energy consumptions are that (1) in 1974, the share of petroleum in the total energy consumption is lower when measured in effective energy terms, since much of petroleum is used for transport which has a low energy utilisation efficiency and (2) in 1974, the shares of gas and electricity in the total energy consumption is higher when measured in effective energy terms, since they are mainly used in the domestic sector with high efficiency.

A comparison of the trends in energy consumption in the U.K., in terms of primary energy, final energy and effective energy is given on the following table.

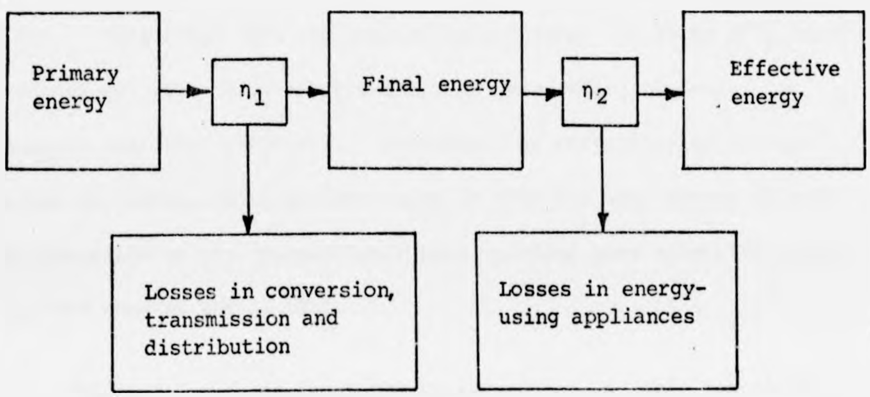
Table 2.2 Rates of growth of energy consumption, U.K., between 1955 and 1974

Consumption of:	Annual average percentage growth
Primary energy	1.23
Final energy	0.83
Effective energy	2.67

Source: Appendix Tables 13e and 15.

The reasons for these differences in the rate of growth of energy consumption may be explained with the aid of the following figure, which is a modification of Figure 2.1 presented earlier.

Fig. 2.7 An energy system, showing conversion and utilisation efficiencies



where η_1 represents the combined efficiencies of conversion from primary to final energy, and of transmission and distribution of final energy (henceforward referred to as conversion efficiency, for simplicity) and η_2 represents the average efficiency of utilisation.

The figures for these efficiencies were (Source: Appendix Tables 13e and 15):

$(\eta_1)_{1955} = 0.75$ $\quad$ $(\eta_2)_{1955} = 0.45$

$(\eta_1)_{1974} = 0.70$ $\quad$ $(\eta_2)_{1974} = 0.56$

The reason for $(\eta_1)_{1974}$ being less than $(\eta_1)_{1955}$ is the increasing share of electricity in the final energy consumption. It takes more than 1 unit of primary energy to produce 1 unit of electricity and consequently the greater the proportion of electricity in the final energy consumption, the less is the overall conversion efficiency (η_1).

There are two reasons why $(\eta_2)_{1974}$ is higher than $(\eta_2)_{1955}$. Firstly, the change in the mix of fuels in the primary energy basket resulted in a "higher quality" basket in 1974 compared to the one of 1955. This means that the less efficient fuels (in terms of present technology) were being substituted with more efficient fuels, for example coal with petroleum. Secondly, the efficiency of energy-using appliances had been increasing so that the same amount of coal or petroleum or gas (particularly coal) yielded more effective energy in 1974 than it had in 1955.

The growth rate of final energy depends on η_1 only and since $(\eta_1)_{1974}$ is less than $(\eta_1)_{1955}$, this means that the growth rate of final energy is less than the growth rate of primary energy, as is seen in Table 2.2.

The growth rate of effective energy depends on the combined effect of η_1 and η_2. $(\eta_1 \times \eta_2)_{1955}$ was 0.34, whereas $(\eta_1 \times \eta_2)_{1974}$ is 0.39. Since $(\eta_1 \times \eta_2)_{1974}$ is higher than $(\eta_1 \times \eta_2)_{1955}$, this means that the growth rate of effective energy is higher than the growth rate of primary energy, as is seen in Table 2.2.

The main trends of energy consumption both in the U.K. and in Scotland are discussed in greater detail in Chapter 5.

The consumption of final energy is usually broken down in the official publications into several end-use categories such as domestic, iron and steel industry, other industry, road transport, railways, water transport, public services, agriculture etc. For the analysis of demand most studies rearrange the categories so that total consumption is divided into four sectors which are (1) domestic (2) industrial (3) transport and (4) public services and miscellaneous. Most of the tables on energy consumption presented in the Appendix follow this convention of disaggregation into four sectors.

The domestic category applies to domestic customers sometimes supplied under individual contracts, the industrial category applies to all manufacturing, building and construction industries; the transport category includes road, rail, water and air transport; the public service category includes all central and local governmental agencies such as schools, hospitals and defence establishments; and the miscellaneous category applies to retail and distributive trades. Consumption in agriculture is usually shown separately unless it is included in the miscellaneous category. The above convention of end-use categories is usually followed in the official energy statistics; the exceptions are mentioned in Chapter 8 while discussing the data.

2.4 Objectives of the study

The two primary objectives of this study are as follows.

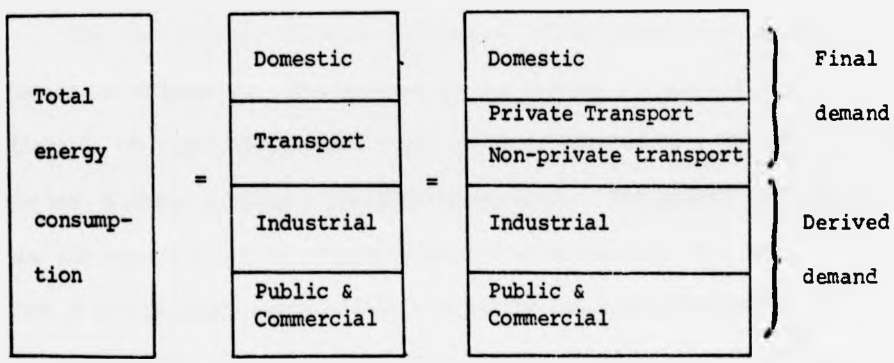
The first objective is to make a regional study of energy consumption with a view to help fill the gap between the "macro" and the "micro" studies on energy consumption. In general, energy studies have been concerned with either the "macro" aspects such as the demand or supply of energy on a national or a global scale - or the "micro" aspects such as the demand for energy in a particular industry or the demand for a particular fuel in the whole economy. What have been lacking, particularly in the U.K., are the "intermediate" studies, i.e. studies concerned with total energy (and not with a particular fuel only) on a geographical scale smaller than the national economy. Such a disaggregated study could provide not only an understanding of the regional energy needs but also a better understanding of the forces that determine the patterns of energy consumption. Following this line of argument the first objective of this study then is to establish the pattern of energy consumption in Scotland during the period 1955 to 1974 and to compare the patterns between Scotland and the whole of the U.K.

There are four main reasons why Scotland is chosen as the area of study. Firstly, Scotland has an economic structure fairly similar to that of the rest of the U.K. and it is also a reasonably-sized unit having a population of around five millions. These features of Scotland help to make comparisons between Scotland and the rest of the U.K. meaningful. Secondly, the changing supply situation due to the North Sea oil and gas may have an effect on energy demand in Scotland which is different from the effect on the rest of the U.K. A study of the structure of existing energy demand may provide valuable information for energy policy decisions in Scotland. Thirdly, Scotland is the only part in the U.K. (with the possible exception of Northern Ireland) for which separate data is available for most of the fuels. Finally, the location of the University of Stirling is in Scotland which makes it easier to gather additional data through local contacts.

The second objective of this study is to analyse the pattern of substitution between energy and "non-energy" and to obtain the appropriate income and price elasticities by using expenditure allocation models. In the domestic sector the consumer is assumed to allocate his expenditure between two commodities, energy and "non-energy"; the basis of allocation being the relative price. In this context "non-energy" consumption represents consumption of all things except coal and other solid fuels, petroleum, gas and electricity. In the production and distribution sectors of the economy possibilities of substitution are assumed to exist between three inputs namely energy, labour and capital.

In our analysis the total demand for energy is divided into two components, final demand and derived demand. Final demand consists of domestic energy plus private transport energy demands. Derived demand consists of industrial, public and commercial and non-private transport energy demands. Pictorially this can be shown as in Figure 2.8.

Fig. 2.8 Final demand and derived demand



Hence the second objective is to obtain the pattern of substitution between energy and "non-energy" in the final demand and between energy, labour and capital in the derived demand.

2.5 Scope of the study

The period under investigation is between 1955 and 1974. The reason for choosing 1955 as the starting point is that reliable data starting from that year could be obtained relatively easily, particularly for Scotland. Year 1974 is chosen as the end point because it is the latest year for which the required data are available at this time.

The three main features of this study are:

(1) the analysis is concerned with total energy consumption as opposed to the consumption of any particular fuel.

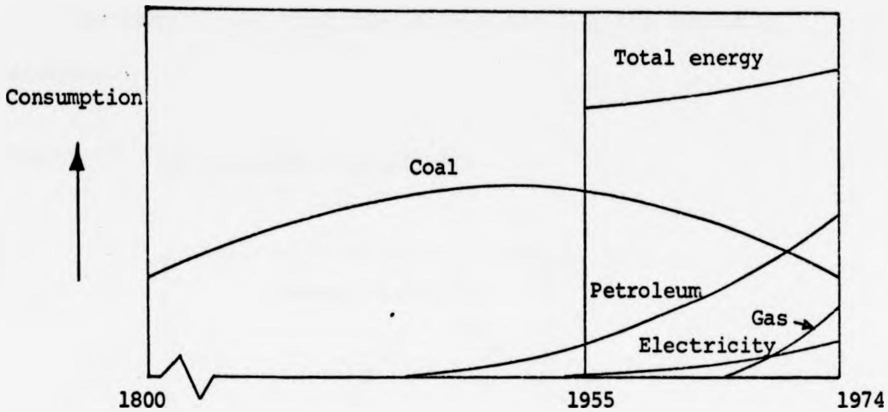
(2) the total energy consumption is measured in terms of effective energy and

(3) the total demand is divided into two components of final demand and derived demand - for analysing the structure of demand in detail.

The scene of the changing pattern of energy consumption in Britain is set in Chapter 3. The purpose of the chapter is twofold. The first is to place the present study which is limited to a 20-year period, within a wider historical background. The second is to show how the characteristics of energy demand were changing (for example from a predominantly domestic demand before industrialisation to a predominantly industrial demand after industrialisation) and how the substitutions between the fuels were taking place.

The place of the present study in terms of a historical time scale may be shown in the following figure.

Fig. 2.9 Energy consumption in historical time scale



(N.B. the figure is only illustrative and is not meant to be an accurate representation)

Although the discussion in Chapter 3 sets the scene of the patterns of energy consumption over a long time scale, there are two reasons for not conducting a detailed analysis over such a long time period. Firstly, the data on effective energy, which requires estimation of utilisation efficiency, is extremely limited for the period before 1955. Secondly, the main objective of our detailed analysis is to investigate the patterns of substitution between energy and "non-energy" and not the patterns of substitution between fuels (which is the main objective of the historical analysis). Future studies could, however, extend the analysis to cover a longer time horizon.

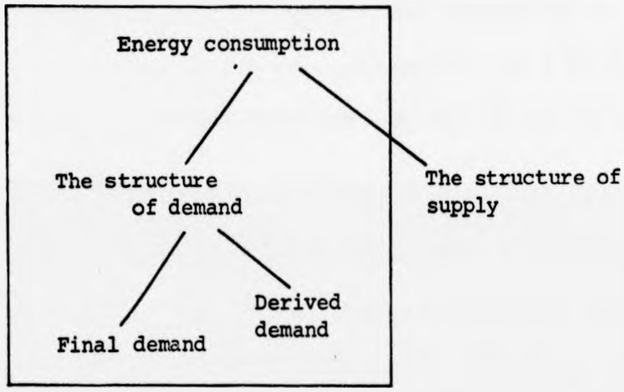
In summary, this study seeks the answers to two questions:

(1) Are there any significant differences in the trends of energy consumption between Scotland and the United Kingdom?

(2) Are there any significant differences in the structure of energy demand for (a) the final demand and (b) the derived demand - between Scotland and the U.K.?

The scope of the study may be represented by the following diagram:

Fig. 2.10 Scope of the investigation



Area of investigation

2.6 Limitations of the study

There are basically two sets of limitations of this study; the first and the main set of limitation is one of data and the second is one of analysis.

2.6.1 Limitations of data

There are several problems with regard to data and they can be separated into two categories. One is the inadequacy of the existing data base and the other is the errors introduced in the recompilations of data necessary to suit the needs of our analysis.

2.6.1.1 Inadequacy of the existing data base

(a) For Scotland, data on net capital stock and labour were not available for the period considered, and this prevented an analysis of the derived demand for energy in Scotland.

(b) For Scotland, the consumption of certain forms of energy was not broken down into the appropriate categories and in some cases (for example, for coke and breeze) consumption figures were not available for certain years. For example, the consumption of petroleum products was not broken down into sectors and a product-to-product transformation was made using the U.K. as a basis, to obtain the sectoral breakdown.

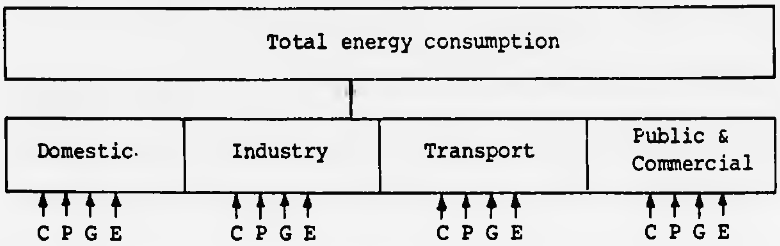
(c) A consuming sector may not always consist of the same sub-sectors of consumption. For example, industries consuming less than 1000 tons of coal per annum were included in the "miscellaneous" category up to 1967 but since 1967 have been included in the "industry" category.

(d) Certain sub-sectors of consumption are arbitrarily fitted into a category. For example, consumption in the combined premises consisting of a shop and a home should be divided between the domestic category and the miscellaneous category. Published statistics, however, usually put this item into the miscellaneous category.

2.6.1.2 Structure of existing data

At present the available data on energy consumption is broken down into sectors of consumption as shown in the following diagram.

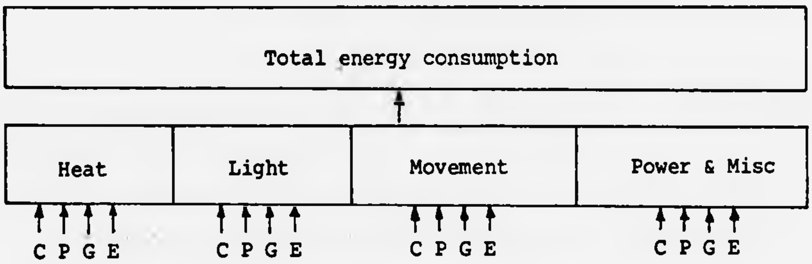
Figure 2.11 Structure of the existing data on energy consumption



Legend C = Coal
P = Petroleum
G = Gas
E = Electricity

Since energy is consumed to satisfy certain needs, breakdown of energy consumption in terms of these needs may be more useful. The alternative system of breakdown may be represented by the following diagram.

Fig. 2.12 An alternative system of breakdown of data



Legend C = Coal
P = Petroleum
G = Gas
E = Electricity

While a breakdown of data according to the system represented by Figure 2.12 will be more useful, such data hardly exist at present and our present analysis is based on the concept represented in Figure 2.11. Future studies could, however, investigate the effect of this alternative form of disaggregation.

2.6.1.3 Measurement of effective energy

Although effective energy is a useful concept the measurement of it is extremely difficult. Estimation of effective energy requires information regarding the age-structure, distribution and on-site efficiency of the entire range of energy-using equipment. Such information is not available on a reliable basis and estimation of effective energy in this study was based on the average efficiency of each form of energy in each sector. Clearly, this must have introduced some errors.

2.6.1.4 Disaggregation of transport energy demand into private and non-private components

In order to divide the total energy demand into consumer demand and derived demand, the transport energy demand had to be divided into two components namely the private and the non-private demand. The private energy demand of transport was added to the domestic energy demand to make up the total consumer energy demand. The derived energy demand was obtained by subtracting consumer energy demand from the total energy demand.

The total energy consumption in the transport sector is small compared to the energy consumption in the domestic sector. For example, in 1973, the consumption (in effective energy terms) in the transport sector was only 30 per cent that of the consumption in the domestic sector. Within the transport sector itself, road transport consumes around 70 per cent of the total energy and consumption by goods vehicles (which are used for non-private purposes) make up about 20 per cent of the energy consumption by road transport.

In view of the fact that (a) private transport energy consumption is small compared to the total energy consumption in the consumer demand category (approximately 9 per cent in 1973, if one assumes that half of all passenger-miles achieved by non-commercial vehicles i.e. cars, trains, buses, aircraft etc. can be attributed to travel for private purposes) and that (b) the present study is concerned with demand on a fairly aggregate level, a very precise estimation of private transport energy consumption was not considered to be worthwhile.

For the above reasons, the study by Gray (1969) on private motoring in England and Wales was used as the basis of estimating the private component of transport energy consumption. Since the consumption by private car constitutes about 55 per cent (in 1973, in effective energy terms) of the total energy consumption by non-commercial vehicles, the maximum error in our estimate of consumer energy demand is unlikely to be more than 2 per cent.

Full-scale surveys have been carried out by the Department of Environment (1974) on the pattern of national travel, in 1965 and in 1972/73 and information has been stored on magnetic tape regarding the purpose of journeys by cars, buses, railways etc (except aircraft). Such information has not been used in this study for reasons described above, but later studies on disaggregated demand could profitably use this information.

2.6.2 Limitation of the analysis

2.6.2.1 Limitation of the model

As has been discussed earlier in Section 2.6.1.2, the nature of the data has restricted us in analysing the demand for energy in a way in which the purposes for which energy is used, i.e. heat, light, power and transport, had not been taken into account. Ideally one would like to build a model so that demands for heat, light, power and transport are incorporated, so that the utility function would look like:

$$U = U (C, H, L, P, T)$$

which is the same as equation (2.1) described earlier, where H, L, P and T stand for heat, light, power and transport respectively, and C is the consumption of goods other than energy.

The consumption of energy for heat, light, power or transport depends on both the stock of energy-using appliances and the amount of energy (effective energy) used, so that H, L, P and T may be expressed as

$$\left.\begin{aligned} H &= f_1 (Ai, Ej) \\ L &= f_2 (Ai, Ej) \\ P &= f_3 (Ai, Ej) \\ T &= f_3 (Ai, Ej) \end{aligned}\right\} \qquad (2.13)$$

where Ai is the vector of energy-using appliances and

Ej is the vector of energy.

The maximising behaviour of the consumer, then, may be expressed as

$$\text{Max } U \text{ subject to } p\,C + q\,E + r\,(A, \bar{A}) \leq M \qquad (2.14)$$

where p is the price associated with "non-energy" goods C,

q is the price associated with energy E,

$\bar{A}$ is the original stock of appliances,

A is the new stock of appliances,

r is the cost of changeover from $\bar{A}$ to A and

M is the total expenditure.

Obviously, such a model will be of immense complexity and to-date none of the demand studies has attempted to build a model on this approach. But this difference between the existing models and the ideal model must be borne in mind for interpreting the results from any study.

2.6.2.2 Sensitivity analysis

The results from our analysis are dependent on the utilisation efficiency figures used to estimate effective energy and consequently it is important to test the sensitivity of the results to alternative estimates of utilisation efficiencies. However, only one set of utilisation efficiency has been used in this study but any future study should perform sensitivity tests.

CHAPTER 3

The Changing Pattern of Energy Consumption: A Historical Perspective

3.1 Introduction

The purpose of this chapter is to study the pattern of energy consumption from a global point of view and to show that whatever historical forms energy supply may take they reflect efforts to provide effective energy more satisfactorily.

The chapter is organised into four sections. In the first section we consider briefly the development of energy resources from the early periods of human history to the present. The scope of the discussion, both in space and in time, is contracted in the second section in which we analyse the nature of the changing pattern of energy consumption in Great Britain since the Industrial Revolution. In the third section, we take a look at Scotland with a view to analysing the pattern of its energy consumption as reflected in the development of its energy industries. In the fourth and final section some concluding remarks are presented.

3.2 Energy consumption before and since industrialisation

Throughout the past millenia an increasing supply of energy made possible the satisfaction of a greater variety of needs. The development of the art of raising crops and husbanding animals made it possible for man to enjoy a greater variety of food than that which was available when he was a hunter and gatherer. The growing needs for better shelter, better transport and even some material luxuries were being met with the help of an increasing range of energy sources. However, even at the end of the 17th century the per capita energy consumption remained very low compared to the present day standards of energy consumption.

The significant break with the past came with the Industrial Revolution which started in Britain. Large-scale exploitation of new sources of energy by means of mechanical converters (as opposed to biological converters of human and animal muscles of the earlier periods) began in earnest. The dominant characteristic of the industrial society was the scale of energy consumption and the fact that this consumption was primarily achieved by using "irreplaceable" instead of "replaceable" energy sources, i.e. by using fossil fuels instead of water, wind and muscle power (Cook 1971a), Cippola(1975)).

The early industrialisation in most countries, particularly in Britain, was based on the twin pillars of coal and steam engine as respectively the main source and the main converter of energy. It must, however, be noted that wood was the principal source of energy until it was replaced by coal (the replacement occurred quite late in some countries, for example in the United States it was the 1880's (Cook 1975b)) and that older converters such as watermill and windmill played important roles until the advent of the steam engine.

As industrialisation continued other sources of energy such as oil and gas started to be used in larger quantities mainly in the home. In still later periods, new forms of energy such as electricity and new converters such as the internal combustion engine started to open entirely new horizons for the application of energy for providing the needs for heat, light, power, transport and communication. The consumption of energy started to grow rapidly so that by 1970 the citizens of the United Kingdom began to use on average about 100,000 kilo calories per day which is 50 times the amount consumed by man at the dawn of civilization (Cook (1971a)).

It is to the changing pattern of energy consumption in Britain during and since industrialisation that we turn now.

3.3 Energy and industrialisation in Britain

By the middle decades of the 18th century innovations of various kinds - in agriculture, transport, manufacture, trade and finance were taking place in Britain which finally led to the breakthrough from an agrarian handicraft economy to one dominated by industry and machine manufacture. This transformation to an industrial economy did not take place suddenly since much of the 18th century technology was less of a departure than a completion of medieval developments (Lilley (1973)). The industrialisation started with traditional sources of power, such as the watermill and the windmill, but as industrialisation proceeded these began to be replaced by new sources of energy and new converters.

Within the larger context of technological change and industrial development, the period between the start of industrialisation to the present (approximately from 1750 to 1950) can be broadly divided into two phases. It can be seen how the pattern of energy consumption was intimately related to the changing character of industrialisation.

3.3.1 The first phase (c. 1750 to c. 1850)

This period was characterised by the dominance of the cotton and the iron industries. Cotton was the pacemaker of industrial change. Within a little more than a quarter of a century, cotton manufacture evolved from being one of the least significant industries to one of the most important (Deane (1964a)). This spectacular rise of the cotton industry can be explained in terms of the accelerating current of international and colonial commerce, and the innovations in the various fields of manufacturing, trade and commerce at home. The growth of the cotton industry led first to the breakthrough from an agrarian economy to a cottage industry and later to the factory system of manufacture. The most significant characteristics of the cotton industry were that (a) it was a consumer-good industry that already had a market; (b) some degree of mechanisation, achieved by practical men who were in most cases not trained in science, could produce striking results and (c) it could use the conventional sources of power.

In terms of the relationship of energy to the textile industry - the mechanical textile industry could be pictured as a kind of mill with wheels turned either by horses, by water or by wind. Cartwright drove his invention with a cow, Arkwright speaks of a "water-frame" and the first two power looms in Scotland (1793) were worked by a Newfoundland dog (Forbes 1958)). The cotton industry, in turn, with its demand for efficient methods for bleaching and for mechanical parts, gave a tremendous boost to the chemical and engineering industries.

The role of iron was somewhat different from that of cotton; while cotton initiated the change towards industrialisation it was iron which gave it further impetus and sustained the change. Being a "capital-good" industry the growth of iron depended on the establishment of an infrastructure of staple and consumer good industries - but iron was also a basic industry and changes in this basic industry significantly influenced the operation of many other industries.

The development which had great implications on energy consumption was the replacement of charcoal with coal in iron-smelting. For a long period of time there had been a growing shortage of wood necessary to make charcoal and the British iron industry was facing tremendous difficulty in arresting a decline (Birch (1967)). Sometime between the years 1709 and 1717, Abraham Darby I of Coalbrookdale successfully used pit coal in place of charcoal for iron-smelting; this iron being suitable to be used for castings (Ashton (1966), Flinn (1959)).

The iron industry was free from the tyranny of charcoal (Ashton (1963)) and its future was secured because it could now depend on the abundant supply of domestic coal. The new demand for coal resulted in the mines being dug deeper until water seepage became a major problem. Ingenious systems were devised to lead off the water or to pump it out of the pit by animal power. But the task was becoming impracticable; in one colliery in Warwickshire five hundred horses were employed to hoist the water, bucket by bucket (Landes (1972a)). The need was for an efficient pump. Thomas Savery developed a fire-engine in 1698 which worked partly by vacuum and partly by steam-pressure and this "miners' friend" became the first application of steam power for mine drainage (Dickinson (1963), Harris 1967)).

The limitation of the Savery pump was that it was unable to draw water from a depth of more than 40 feet. Thomas Newcommen overcame this difficulty in 1712 with his invention of the atmospheric steam engine which could draw water from depths more than 40 feet and the steam engine became a practical means for draining mines (Dickinson (1963)). With improvement in the performance of the engine, it became possible to use the engine for new applications such as driving mules in the cotton industry and raising water to drive the water-wheels of light industrial plants.

At this time, however, the steam engine was mainly used for draining mines and raising coal since the cost of the engine relative to its power was too high for it to be used in other industries. The next big step in engine development was achieved by James Watt who in 1769 introduced a steam engine with a separate condenser

(Dickinson (1963)). The performance of the engine was improved when John Wilkinson devised a method in 1774 by which cylinders could be bored to a greater accuracy. A better sealing was now achieved and the coal consumption was reduced to a third. But widespread applications of the steam engine in manufacturing industry had to wait until Watt solved the problem of converting the osciliatory motion to a rotary motion by the invention of the "sun-and-planet" gear in 1781. The steam engine was finally equipped to turn the wheels of industry and the supremacy of the water wheel came to an end.

Meanwhile the iron industry was also undergoing a major change. In 1746 Abraham Darby II successfully produced coal-smelted iron suitable for forging (Abraham Darby I having produced in 1709 coal-smelted iron suitable for casting) and in 1783 Henry Cort invented the puddling and rolling process whereby good-quality iron for the forge could be mass-produced at low cost (Raistrick (1953b)).

The growths of coal, steam engine and iron were mutually reinforcing. The increased demand for coal led to deeper mining, which in turn led to an increased demand for steam engine (for pumping water and bringing coal to the surface), which in turn led to an increased demand for iron and this in turn led to an increased demand for coal (for iron smelting). The increased demand for coal led also to an increased demand for transport which in turn led to an increased demand for steam engine and so on. It was the growth of railways which helped the production of coal and iron to treble in the course of only 20 years (1830 to 1850) and helped to create a steel industry (Habsbawm (1969)).

The important feature of this first phase of industrialisation, with regard to energy consumption, was that the demand for power was mainly industrial and that this demand was primarily met by the combination of coal and the steam engine with some support from older devices such as the watermill and the windmill. Domestic demand was small compared to the industrial demand; the needs for heating and cooking was mainly satisfied by coal (and also wood) while the need for lighting was met by the use of mineral and vegetable oil. Power was usually generated on site owing to the lack of efficient means of long-distance transmission, a fact borne out by the number of iron industries which were sited at or near a coal field.

In summary, during this first phase of industrialisation, covering approximately the period from 1750 to 1850, three features stand out. The first is that the demand for energy was mainly industrial, the second is that power was usually generated on site and the third is that the main problem in the field of energy was how to increase the size and efficiency of the steam engine.

3.3.2 The second phase (c.1850 to c.1950)

At the beginning of this period, the scene looked like this. Mechanised industries were significant but manufacture had not achieved an overwhelming place in the economic life of the country. Agriculture still remained the largest single industry employing over 20 percent of the working population. Production for export was still only a minor part of the total economic activity. Textiles, of which cotton constituted an overwhelming proportion, was the largest export industry, accounting for nearly 60 percent of the exports of all home-produced goods (Ashworth (1965)). Iron was the backbone of the capital goods industry and was on the ascendancy while steel was nothing more than a handicraft industry catering for a narrow specialised market. Finally, coal supplied nearly all the needs of industry and home, the production of coal in Britain accounting for nearly two-thirds of world's coal output.

But profound changes were taking place both at home and abroad which were to transform the economic structure and the pattern of energy consumption at the end of this period.

The income per person had already risen by a factor of two between 1750 and 1850 (Deane (1964b), Pollard (1969)). Between 1850 and 1950 it rose again by nearly three and a half times (Deane (1964c)). But more important than even this phenomenal growth of the national income was the distribution of income among the population. Unlike that in the period between 1750 and 1850 when greater part of the increase in national income went to the owners of the industry, in the period between 1850 and 1950 the prosperity of the working-class grew rapidly. Between 1850 and 1906 the real wages of the "average operative" rose by 80 per cent (Wood (1966)). This trend continued after 1906 (Mathias (1967)) and the 1870's marked a major turning point with the massive import of cheap foodstuff from the American continent.

The increasing prosperity of a rapidly growing population (that doubled between 1850 and 1900) had two important effects on the pattern of energy consumption. The indirect effect was that it called for a widening range of what were regarded as basic necessities from millions of households (Davis (1966)). A new type of demand has arisen and this, combined with the new sources of supply, new methods of mass production and the rapid development of transport, led to radical changes in the distributive trades (Jeffreys (1954)). The traditional retailing system consisting mainly of individual retailers selling at the doorstep began to be replaced by large-scale retailing.

Within the course of 50 years the numerous varieties of grocers, mercers, hosiers, daily markets, drapers, haberdashers, peddlers, chapmen, packmen, oilmen and others have been largely replaced by the larger co-operatives, multiple-shops and department stores. These new service industries grew rapidly so that by 1950, they were employing nearly half the working population (Deane (1964d)). This rise of the service industries had two effects on the pattern of energy consumption (a) there was now a sector of economy (service industry) whose energy demand rivalled that of the manufacturing industry and (b) the special characteristics of these service industries i.e. their high demand for lighting and heating and relatively low demand for power made them eminently suitable to use the new type of energy that was becoming increasingly available, namely electricity.

The direct effect of the increasing prosperity was that the pattern of the energy consumption at home started to change both quantitatively and qualitatively. The retailing revolution described in the previous paragraph helped reduce the expenditure on basic necessities and the disposable income could now be spent on greater comfort at home and on the novel devices that were becoming available. The result was an increase in the total energy consumption at home and a shift towards electricity. Towards the end of this period, the development of the motor car, led to a rapid growth in the consumption of motor fuels.

These are the ways in which the standards of living in Britain were changing in the second phase. The balance of the economic structure was also changing as we shall see now. The Crystal Palace Exhibition of 1851 marked the highest point in Britain's career as an industrial nation. In relation to other countries Britain was producing about two-thirds of the world's coal and more than half of the world's iron and cotton cloth. But competition was growing from both Europe and the United States of America. This new competition was described as "mid-Victorian alarms" by Burn (1961a) and "continental emulation" by Landes (1972b).

In spite of these challenges, the diffusion of benefits of the early industrialisation was still continuing and the national income was growing rapidly as described earlier. It was also the period in which Henry Bessemer invented a new method of making steel which resulted in the overtaking of iron by steel in terms of output - in a matter of three decades (Burn (1961b)). By the 1880's, however, the high growths of the previous decades began to slow down and it seemed that the main vehicles of industrialisation until then, such as coal, steam engine, iron and steel, heavy chemicals and the railways were no longer capable of maintaining the industrial advance.

It was not until a series of major innovations occurred around the turn of the century that the situation altered. These early years of the century saw the rise of electric power and motors, organic chemicals and synthetics, the internal combustion engine and automobile devices, precision manufacture and assembly-line production. These innovations heralded the fully-fledged modern industrial society (Landes (1972c)).

The availability of electric power changed the pattern of energy consumption both in the industry and in the home. Successful application of electrical power was made possible by a series of innovations, both within and outside Britain. These innovations are not discussed here since detailed descriptions of these are provided elsewhere (Jarvis (1958)).

The prime attribute of electrical energy is its mobility. It can be taken to any point along a pair of wires. This attribute of electricity freed work from its bondage to belts and shafts connected to the flywheel of the steam engine; power could be provided wherever it was wanted and in small or large amounts (Luten (1971)). Other important qualities of electricity are its ease of convertibility from other sources of energy (heat energy of a boiler or kinetic energy of falling water), its cleanliness and the fact that it does not need any storage and can be obtained instantly at the press of a switch.

The flexibility of electrical energy transformed industrial practice. Light, heat and power could be provided anywhere and in almost any amount; electricity could also be used in chemical processes and as a means of communication. But perhaps the effect of electricity on the pattern of energy consumption were even greater in the domestic and the service sectors. Households whose number has increased nearly five-fold between 1750 and 1900 (Deane (1969a)) and the vast number of retail outlets that have come into existence, could now use electricity for lighting and heating and also for providing power for the large variety of devices that run on electricity.

The invention of the internal combustion engine was another of the most important events in this period. For the same reason as that for electricity, the development of the internal combustion engine will not be described here, but can be read elsewhere (Field (1958)). The internal combustion engine provided industry with a more efficient means of obtaining power than the steam engine and the diesel engine started to replace the steam engine in industry, in road-transport and in the railways. With regard to its effect on energy consumption the light-weight high-speed petrol engine was even more important than the diesel engine. The petrol engine provided a small power plant that could be easily transported. This feature of the engine coupled with the mass-production technique led to our automobile age in which energy consumption for personal transport became a significant proportion of the total energy consumption.

The industrial scene in Britain was thus transformed during this second phase of industrialisation and at the end of the period the scene looked like this. Both agriculture and cotton had become minor industries each sharing less than 5 per cent of the national income (Deane (1969b)). Iron had been superseded by steel. A new chemical industry, that of synthetic chemicals had risen. Within the manufacturing sector the balance had shifted from consumer-goods to capital-goods industry (Hoffman (1968)) and in the economy the balance had shifted from manufacturing industry to the service industry (Deane (1964d)). Two industries which hardly existed in the first phase of industrialisation i.e. the electricity industry and the automobile industry, had radically altered the pattern of energy consumption.

So the changing pattern of energy consumption since industrialisation in Britain can be summarised as follows. The demand for energy in the first phase of industrialisation was mainly industrial demand and this demand was met primarily by the combination of coal and steam engine, the power being generated usually on the site. In the second phase of industrialisation, a rapidly rising standard of living coupled with the practical application of electricity made possible a steep increase in the domestic energy demand. The service industry which became prominent in this phase also helped increase the demand for electricity. Coal still remained the main source of energy but electricity had freed industry from the necessity of being located around a coal mine; the diesel engine considerably helping the industry towards that freedom. The application of petrol engine had inaugurated the automobile age whereby energy consumption for personal transport had become significant. Indeed, at the end of this phase, the industrial consumption of energy had been surpassed by the combined consumption in the domestic, transport and the commercial sectors.

So far we have discussed the interactions between energy consumption and industrialisation in Britain since the Industrial Revolution.

We now turn our attention to Scotland with a view to analysing (a) its pattern of energy consumption and (b) the development of its energy industries, concentrating on the latter.

3.4 Pattern of energy consumption in Scotland

We have seen, in the preceding section, how inextricably energy consumption is related to industrialisation and the structure of the economy. The sharing of a common border with England and a political union with her in 1707 had made it inevitable that the economy of Scotland should be influenced greatly by the developments in England. Scotland played a significant part in the initiation of the Industrial Revolution and was affected by industrialisation in a way which is not dissimilar to the way the rest of Britain was affected. But there were differences between the structure of the Scottish economy and the structure of the economy of England and Wales before the Industrial Revolution and some differences still remain, although not the same differences as before. In order to analyse the pattern of energy consumption in Scotland we need to look briefly at the structure of the Scottish economy in relation to that of the rest of Britain.

3.4.1 The changing structure of the Scottish economy

During the last 250 years the Scottish economy has moved from one of economic backwardness with respect to England at the time of the Union of 1707 to one with similar economic structure to England at present. In 1707 Scotland was a predominantly agricultural economy. There were small-scale activities in such industries as salt-making, sugar-refining, lead mining and the manufacture of iron, soap, glass and paper. Mining of coal was not only the most important of all industries, it was also a "growth industry". But the largest industry, in terms of numbers employed was that of textile (Lythe (1975a)). The main features of the foreign trade were the imports of high-quality manufactured goods from England and the Low Countries and the exports of raw materials such as coal and lead and of lower quality manufactured goods (Campbell (1971a)).

The Treaty of the Union was to influence the structure and the growth of the Scottish economy in several ways. It reorientated Scottish trading links from Europe to England, gave Scottish industries access to the market of the English colonies and helped the Scottish economy develop along complementary lines to the larger and more powerful economy of England (Campbell (1971b)).

The Industrial Revolution affected the Scottish industries in ways similar to that of the rest of Great Britain as described earlier. The foundation was based on cotton in the 18th century, on iron in the 19th century and still later on steel. Coal replaced charcoal in iron-smelting and became the main source of energy, the output of coal rising from less than 1 million ton in 1750 to more than 42 million tons by 1913 (Nef (1966a), Mitchell (1971)).

At the end of the second phase of industrialisation Scotland had become a highly industrialised and a highly mechanised society. Indeed, about 40 percent of the total population of Scotland had concentrated in or around Glasgow, a concentration that makes Glasgow more important to Scotland than even Greater London to England (McCrone (1969)). Agriculture had become a minor industry employing less than 5 percent of working population which means that the proportion of population engaged in agriculture is less in Scotland than in any other country save England.

The prosperity of Scotland was built on heavy industry and the trend accentuated with time. Eight heavy industries namely, shipbuilding, marine engineering, boiler making, construction engineering, locomotive manufacture, blast furnaces, iron foundries and steel making employed more than 40 percent of all those employed in the metal and engineering trades in Scotland compared to only 20 percent in England and Wales (Leser (1954a)) (Johnston (1971)).

On the other hand, the light-engineering industries had been slow to grow in Scotland. Industries such as motor vehicles, aircraft, chemical and electronic engineering had become the major growth industries in the rest of Britain and the comparative lack of these industries in Scotland had resulted in an overall slower growth of the economy in Scotland compared to the rest of Britain (McCrone (1965)).

In summary, the economy of Scotland had been transformed from its agricultural and rural nature to a fully industrialised and urban economy in the course of two hundred years. Compared to the rest of Britain, Scotland has lagged in terms of economic growth, due mainly to its greater dependence on the heavy industries which had been either stagnant or actually declining. But on the whole, at the end of the second phase of industrialisation, Scotland had become remarkably similar to the rest of Britain, in terms of the structure of its economy.

3.4.2 The development of the energy industries in Scotland

As we have seen earlier, the basic structure of the Scottish economy is not dissimilar to that of the British economy and in general, the historical growth of energy consumption in Scotland has been similar to that in the rest of Great Britain. The only significant differences have been in the geographical distribution of population and industry. Most of the Scottish population and economic activity is in Glasgow and the surrounding region; also the proportion of isolated pockets of population is higher in Scotland.

These factors have resulted in two significant differences in the pattern of energy consumption in Scotland. Firstly, such a distribution of population seems to have given an advantage to electricity, the consumption of which is higher per person in Scotland than in the rest of Britain. Secondly, good port facilities (and consequently lower sea-borne transport cost) around the central belt, where most of the industry is concentrated, has resulted in comparatively higher consumption of imported petroleum in the Scottish industrial sector (Mandal (1976a)).

Coal had been the most important source of energy in Scotland, as in the rest of Britain, throughout the period of industrialisation and it is only in the 1970's that petroleum has overtaken coal in the relative importance (Scottish Office (1974)). It is coal which provided the power for industry during the first phase of industrialisation and which, later in the second phase met the needs of a rapidly growing electricity supply industry. Not only in the industry, but also in the home, coal has been the principal source of energy. Indeed, the domestic sector has been more dependent on coal than industry; until 1968 the consumption of coal in the domestic sector had been greater than the combined consumption of petroleum, gas and electricity (Mandal (1976b)).

We now follow the developments of each of the energy industries in Scotland, coal, petroleum, gas and electricity in turn.

3.4.2.1 Coal Industry in Scotland

The first mention of coal in Scotland is found in a charter granted to the Abbot and Convent of Dunfermline for digging coal at Pittencrief (Bremner (1869a)). Before this time, there were evidences of the gathering of "sea-coal" brought to the shore by tidal action. Due to its emission of smoke, coal had great difficulty of being accepted as a fuel, either at home or in the industry and it was not until wood and consequently charcoal began to get scarce that coal began to be used. The slow acceptance of coal coupled with the difficulties of mining it, prevented widespread use of coal until well into the 16th century when it is recorded that coal began to be used both at the forge and at home (Bremner (1869b)).

The great Scottish coal belt could be considered to fall within a diagonal tract of land stretching north-east from Saltcoats and Girvan on the Firth of Clyde to Fife Ness and North Berwick on the North Sea. As the demand for coal began to rise landowners started to organise the digging of coal around the Firth of Forth where seam outcrop provided easy access to the reserve (Platt (1968a)). By 1540 coal was being used by the smiths in the central belt of Scotland (Lythe (1975b)). The biggest industrial demand for coal was for salt-making and the coalmasters were often owners of saltpans as well. The output of coal rose from 40,000 tons in 1550 to nearly 500,000 tons in 1700 (Nef (1966b)).

The demand for coal, from the increasing range of industries that were developing in the first half of the 18th century, was growing rapidly but potentially the largest single customer namely the iron industry was still using charcoal both for smelting and in the forge. It was not until after the establishment of the Carron Company in 1759 which used coke for smelting iron (Campbell (1961) (a process pioneered by Abraham Darby of Coalbrookdale in 1709) that coal became the main source of fuel and power for the Industrial Revolution in Scotland. The increasing demand for coal made it necessary to attract more men to work in the mines but this could not be achieved under the prevalent condition in which miners were virtually serfs. So the conditions were now created whereby the Scottish miners (and salt workers) were freed from their serfdom by the Acts of 1775 and 1799 (Duckham (1970), Bremner (1869c)).

The growth of the coal industry during this time is evident from the output figures: from around 2 million tons in 1800 it rose to nearly 7 million tons in 1850 and over 24 million tons by 1890 (Nef (1966b), Butt (1967a)). The peak of output was reached in 1913, both in Scotland and in the rest of Britain, the figure being 42 million tons in Scotland. Since 1913 output has declined almost steadily so that by 1945 the output stood at 21 million tons.

Within this steady decline in the output of coal, important changes have occurred in the pattern of output. First, there has been a trend away from the high-cost Lanarkshire coalfields whose output has declined both in absolute and in relative terms. In 1913 the Lanarkshire pits produced nearly 25 million tons which was equivalent to over 50 percent of the total Scottish output - these figures had declined to less than 10 million tons and 35 per cent respectively by 1950. Second, in spite of the trend away from the high-cost Lanarkshire coal, productivity in Scotland had fallen between 1913 and 1950 both in absolute terms and in relation to the rest of Britain (Leser (1954b)). This has resulted in the cost of coal, which on average is of slightly inferior quality than coal elsewhere in Britain, being higher in Scotland.

The Nationalisation Act of 1947 set up the National Coal Board and all the Scottish coalfields came under the Scottish Division. Output rose steadily until 1951 (until 1957 in the rest of Britain) but there was a sudden drop in consumption in 1958, both in Scotland and in the rest of Britain. This unexpected reversal was attributed to several factors such as mild weather, slight depression in the economy and increasing competition from petroleum. This decline was thought to be temporary (Platt (1968b)) but the industry has in fact gone into a decline ever since.

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Decline in the demand since 1957 brought about several important changes in the outlook and policy of the industry. First, the 1950 Plan for Coal which called for expansion was revised and a new Plan in 1959 looked for a reduced output. Second, it was realised that the coal industry was facing serious challenges from other sources of energy and hence must engage in competitive marketing and advertising; this led to the setting up of a new organisation for providing technical and commercial advisory services to the users of coal. The Clean Air Act of 1956 has also had an adverse effect on the consumption of coal. The fortune of the industry, however, depends mainly on the industry's policy regarding the burning of coal at the power stations, which in the 1970's were consuming nearly 60 percent of the industry's output.

3.4.2.2 Petroleum industry in Scotland

Petroleum has become in the 1970's the most important source of energy in Scotland as in the rest of Britain. The indigenous production of petroleum, however, had been small in relation to consumption until very recently when the situation started to change with the commencement of production from the North Sea oilfields. One of the main features of petroleum as a source of energy in Scotland had been the international character of its trade and Scotland, as indeed the rest of Britain, had depended on importing crude oil prior to refining and use at home. This also means that the petroleum industry has very few specific Scottish characteristics since the operation in Scotland had simply been a part of the nationwide activity of the multinational companies who market the product.

Scotland did, however, have an indigenous oil industry until 1962 and indeed when the industry was started in 1851 by James Young of Glasgow it was the only one of its kind anywhere (Butt (1963)). James

Young realised the potential of oil for lighting purposes and took out a patent in 1850 for heating butuminous coals to obtain paraffin oil. A factory was started at Bathgate in central Scotland but Young did not use shale or even bituminous coal at first but a kind of mineral oil which had been discovered in a coal pit near Alfreton in Derbyshire (Hendrie (1974), Forbes (1958)). But the spring at Alfreton soon dried up and Young started to use a coal which was very high in oil content and which was found in Boghead near Bathgate. But this coal was of limited supply and as demand grew a switch was made to produce oil from shale. Plentiful reserves had been discovered near Bathgate and the low cost of mining ensured the future of the industry.

In the meantime Drake had started in 1859 to produce oil in Pennsylvania in the United States and the shale-oil industry was forced to concentrate on those products such as sulphates of ammonia and paraffin wax which were not directly competitive in price to the cheap imported kerosene. Young's patent expired in 1864 and a number of competitive shale-oil plants sprang up and by 1871 the number rose to 50.

The production of shale-oil reached its peak of over 250,000 tons in 1913 and in 1919 the host of firms were merged under the auspices of the government-controlled Anglo-Persian Oil Company (later British Petroleum) into one unit called Scottish Oil Company. All refining activities were now concentrated at Pumpherston. Since 1945, BP's English oilfields started to send oil to Pumpherston for refining but the Scottish Oil Company declined rapidly due to increasing competition from imported oil mainly from the Middle East. In 1962 oil production from shale stopped and the refinery at Pumpherston was closed in 1965 (Brunstrom (1966a)).

The refining of petroleum in Scotland had been an important

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The refining of petroleum in Scotland had been an important activity since the establishment of a refinery at Grangemouth in 192. by the Anglo-Persian Oil Company. The refinery expanded rapidly after the Second World War and now meets the needs of the Scottish market. Until recently the crude oil was imported mainly from Middle East and African countries, the crude being delivered at Finnart on Loch Long on the west coast and being pumped through a 57 mile long pipeline to the Grangemouth refinery. The situation has changed with the advent of the North Sea oil so that an increasing proportion of the crude is being supplied from the Forties field through the Cruden Bay terminal.

Since 1918 systematic attempts have been made to find indigenous supply of petroleum, both by the oil companies and by the government. The explorations on land have been relatively unsuccessful and in Scotland only two minor fields, one at Pumpherston and the other at Midlothian have been discovered (Brunstrom (1966b)).

Explorations for off-shore oil have met with more success. The Continental Shelf Act of 1964 designated approximately 171,000 square miles, mainly in the North Sea, as areas in which the United Kingdom could exercise her rights with respect to the national resources on the sea-bed. Drilling for petroleum started in 1964 and to date fourteen fields, mainly around the Shetland Islands, have been declared commercial (Department of Energy (1976)). It is envisgaged that by 1980, the output from these oil fields would be equivalent to the demand for petroleum in the United Kingdom.

3.4.2.3 <u>Gas industry in Scotland</u>

Coal gas, in any quantity, was first produced by Lord Dundonald around 1781 at Culross as a byproduct in the production of tar by the distillation of coal. But the potentialities of coal gas for lighting was not grasped at the time and commercial application of gas is attributed to William Murdoch of Ayrshire who first lit a house at Redruth in Cornwall in 1792 and later in 1802 introduced gas lighting in the foundry of Boulton and Watt at Soho in Birmingham. In 1805 Professor Andrew Ure of Andersonian Institute demonstrated the potential of gas by lighting his lecture theatre by gas (Ray (1975), Butt (1976b)).

The American and the Napoleonic wars had reduced the supply of whale oil and the Russian tallow, and by the turn of the century the cost of lamp-oil and candles had risen sharply. Moreover, due to their proneness to fire the large number of cotton industries were paying heavy insurance premiums. Thus a market had been created for gas lighting if it could be made safe and economical.

The gas companies were slow to develop but once they became profitable around 1820 they began to grow rapidly. In 1818, 1,472 gas lamps were put into the city of Glasgow, the gas being supplied by the Glasgow Gas Lighting Company established in 1817 (Baird (1958a)). The demand for gas lighting grew steadily as can be judged by the growth in the number of street and stair (in the tenements) lights in Glasgow. The figure had risen from 1,472 in 1818 to 27,000 in 1870 and to 105,000 in 1913 (Baird (1958a)). Other parts of Scotland received gas supply later than Glasgow, for example, parishes in East Lothian started receiving gas supply in the 1830's with the establishment of the Haddington Gas Company (Snodgrass (1953)).

Gas was supplied by private firms until 1869 when an Act of Parliament provided the gas corporations with the authority of supplying gas. Gas lighting started to face increasing challenge when electric lighting became available. In Glasgow 1,541 electric lamps were first introduced into the streets in 1893 and by 1913 this figure had risen to 5,000 lamps. Although electricity was steadily replacing gas in lighting, the market as a whole for lighting was growing so that by 1955 there were still 60,000 gas lights along with 80,000 electric lights in Glasgow (Baird (1958a)).

The gas industry obtained an encouragement in 1885 when Karl Auer of Austria invented the gas mantle which provided brighter lights and burned less fuel. In the meantime the industry had begun to expand to other areas such as cooking and gas cooking appliances were first let out on hire in 1885 by the Glasgow Gas Corporation (Baird (1958b)). But even in this area gas had to face competition from coal at first and later from petroleum.

The growing competition mentioned above led to a slowing down of the growth of the gas industry since 1885. The industry was nationalised in 1948 and the Scottish Gas Board was established as a part of the British Gas Corporation. The industry remained static throughout the 1950's due mainly to its dependence on high-quality coal as a feedstock which was becoming increasingly scarce.

In the 1960's the gas industry went through three major developments (Reid (1973)). The first was the introduction of the oil-gasification process which helped the industry to reduce the cost of production, to improve its image to that of a "clean fuel" producer and to concentrate on marketing gas instead of both gas and coke which was the byproduct of the coal-gasification process. The second development was the import of liquid natural gas from Algeria to England. The new feedstock offered the industry further flexibility and led to the construction of a transmission and distribution network for distributing the town gas produced from this feedstock. Although the network did not extend up to Scotland, the morale of the entire industry was raised due to this new flexibility. The third development was the discovery of indigenous natural gas which is discussed below.

Exploration for natural gas, along with petroleum started with the passing of the Continental Shelf Act in 1964. The first gas field was discovered in 1965 by British Petroleum 45 miles east of Humber and four other major gas fields were discovered on the east coast of England in rapid succession. Recently gas fields have also been discovered off the east coast of Scotland. The advent of natural gas has resulted in the extension of the existing transmission and distribution network to cover Scotland and the gas industry has been transformed from being a gas-making industry to mainly a gas-processing and distributing industry. It is envisaged that by the late 1970's public supply in Britain will consist almost entirely of natural gas.

3.4.2.4 Electricity industry in Scotland

The electricity supply industry is of more recent origin than either of the three other energy industries of coal, petroleum and gas but electricity supply is comparatively more important in Scotland than in the rest of Britain. The consumption of electricity per person is higher in Scotland (by approximately 25 percent) and nuclear and hydroelectricity constitutes a higher proportion of the total primary energy (nearly twice as much compared to the rest of Britain).

Robert Davidson of Aberdeen is the first person who can be mentioned with regard to the use of electricity in Scotland. By 1837 he produced a "electromagnetic locomotive" which was supplied by primary batteries and a number of successful runs were made on the Edinburgh Glasgow railways with this device (Electricity Council (1973a)). There were no major developments for more than 50 years until a small public supply was made available from a plant in Fort Augustus, the plant consisting of both an oil engine and a water-wheel (Electricity Council (1973b)). The Electric Lighting Acts came into force in 1882 and 1888 granted local authorities power over the supply of electricity in their own areas and this marked an area of a steady growth of the public electricity supply.

The region of Scotland where the progress of electricity supply was most rapid was Glasgow. Electricity was being used in the industry in the 1880's and the electric power was used to illuminate Queen Street and St. Enoch railway stations. But it was not until 1890 that the first electric street lamps were used when a public supply of electricity became available (Loudon (1958)).

In 1943, the first Public Board in Great Britain was set up when the North of Scotland Hydro-Electricity Board was given the responsibility of developing hydro-electric resources in that region. When the electricity supply was nationalised in Britain in 1947 the N.S.H.E.B. obtained a wider responsibility over all public generation, transmission and distribution in that region. Electricity supply in the South of Scotland was the responsibility of two Area Boards under the British Electrical Authority. In 1955 these two Area Boards were merged into a South of Scotland Electricity Board independent of the B.E.A. and the structure of the electricity supply industry has remained the same since then (P.E.P. (1965)).

Two important events have occurred in the industry since then which ought to be mentioned. The first is the opening of the Longannet power station in Fife in 1970. This is presently the largest power station in the British system and has the unique feature of obtaining its coal supply from a complex of four collieries along a computer-controlled underground conveyor system of some 5½ miles (Electricity Council (1973c)). The second is the establishment of an aluminium smelter at Invergordon in 1971 which increased the electricity consumption within the N.S.H.E.B. considerably and which has now been connected to the electricity supply line from the Dounreay Prototype Reactor.

Scotland has also been the centre of much activity in the field of nuclear generation. The first power station was built at Chapelcross in Dumfriesshire in 1959 and two more stations have been built at Hunterston. In 1962 a small research "breeder" reactor was set up at Dounreay (D.F.R.) and encouraging results from this reactor has led to the construction on the same site in 1966, the Prototype Fast Reactor (P.F.R.).

3.5 Concluding remarks

The discussion in the preceding sections has shown how the characteristics of demand was changing (for example from domestic demand to industrial demand) during industrialisation and how substitutions between different forms of energy were taking place. It is to be concluded that were an application permitted a choice between different forms of energy, the fuel that could supply effective energy more satisfactorily was chosen. The competition between charcoal and coal for iron-smelting, between coal, petroleum and gas for heating and between gas and electricity for lighting all point to the above conclusion.

So far we have set energy consumption within its broader background of economic growth and industrialisation. We now turn our attention to the problem areas that have interested recent researchers in the field of energy studies..

CHAPTER 4

A Survey of Energy Studies

4.1 Introduction

Concern regarding possible depletion of some of the existing sources of energy has prompted a large number of studies in recent years. These studies cover a wide spectrum. At one end of the spectrum, the studies are concerned with the "macro" aspects of the problem, i.e. with the global long-term effects of energy consumption - a typical example being the study by Weinberg and Hammond (1971) which investigates the possible effects of global energy consumption up to the year 2050 on society and environment. At the other end of the spectrum, the studies are concerned with the "micro" aspects of energy consumption; an example being the study by Balmer (1974) on electrical power utilisation in the metal industries in the U.K.

The majority of energy studies may be classified under the following eight groups, in terms of the objective of these studies.

Group 1

Studies in this group are concerned with the relationship between various independent components of human activity that make up the global system i.e. the relationships between the sub-systems of agriculture, industry, population, energy consumption etc. These studies are concerned not with energy consumption as such but with energy as a sub-system of the global system under study.

Two examples of such studies may be mentioned here. The first is the one by Meadows (1972) which examines the five basic factors that limit the growth of the global system namely population, agricultural production, natural resources (which include energy), industrial production and pollution. The second study is that of Mesarovic and Pestel (1975) whose objectives are similar to that of Meadows but who carry out the analysis at a disaggregated level. The methodology of analysis in both the above studies is that of systems dynamics pioneered by Forrester (1971).

Group 2

The objective of this group of studies, similar to the objectives of the previous group, is to examine certain aspects of energy consumption on a global scale. The main difference between the two groups is that while the studies in group 1 are concerned with energy only in so far as energy consumption forms a part of the global system, studies in this group are concerned primarily with energy consumption.

Typically these studies investigate such problems as the relationship between price and cost of energy in the longer-term and the possibilities of substitution between various forms of energy. The methodology of analysis is usually that of simulation in which the relationships between the relevant activities are expressed mathematically and the future path of these activities is explored in accordance with that mathematical relationship. Studies by Rothkopf (1973) which analyses the world energy demand for the period 1900 to 2020, by Marchetti (1974) which examines the pattern of substitution between fuel on a global scale and by Deam (1974) which explores the structure of the world's oil and gas industry, fall into this group.

Group 3

Studies in this group are concerned with either the demand or the supply or both demand for and supply of energy for a particular economy. Depending on their objectives these studies employ a range of techniques such as trend projection, linear programming, econometric modelling, simulation or a combination of such techniques.

Examples of such studies are: for the U.K. the Department of Energy Model as described by Hutber (1974), the Cambridge Growth Model as described by Stone and Wigley (1968) and the National Institute for Economic and Social Research Model as described by Ray (1960) (1967) (1972); for the United States the Ford Foundation Model (1974) and for Ireland, the study by Booth (1966).

Group 4

This group of studies is concerned with the relationship between the growth of energy consumption and the growth of the economy, in particular the relationship between energy consumption and gross national product. Studies by Starr (1971), Adams and Miovic (1968) and Brooks (1972) belong to this group.

Group 5

This group consists of demand studies which investigate the pattern of substitution between energy and "non-energy". In the domestic sector "non-energy" stands for all items of household consumption other than energy, i.e. such items as food, clothing, rent, durable goods, entertainments etc. In the production sector "non-energy" stands for all inputs to production process except energy i.e. capital, labour, raw materials etc.

Examples of such studies are the one by Jorgenson (1974) for the U.S. domestic sector and by Berndt and Wood (1975) for the U.S. production sector.

Group 6

These are demand studies carried out at a more disaggregated level than that of group 5 and are concerned with either one particular form of energy or one particular sector of consumption or both.

Examples of studies in this group are, the household demand for electricity in Great Britain by Ruffell (1973), household demand for electricity in the U.S. by Halvorsen (1975), household demand for gas in the U.S. by Balestra (1967), industrial demand for electricity in the U.K. by Baxter and Rees (1968), demand for electricity (both industrial and residential) in the U.S. by Fisher and Kaysen (1962) and the demand for petrol for private motoring in the U.K. by Crammer (1959).

Group 7

The principal objective of this group of studies is to analyse the energy content (in physical terms) of goods and services. By tracing the flow of energy through the industrial system, these studies apportion the total energy consumed between the goods and services generated by that industrial system.

Studies by Chapman (1973a) which examine the energy cost of delivered energy and by Slessor (1973) which examine the energy requirements of food production belong to this group.

Group 8

All techno-economic assessment studies on energy may be classified under this group. Examples of such studies are the ones by Häfele and Manne (1975) which examine the strategies for a transition form fossil to nuclear fuels and by Manne and Marchetti (1974) which examine the prospects for a hydrogen economy.

The energy studies described above under the eight groups cover a very wide range and hence many are on topics beyond a reasonable scope for this study. Therefore more detailed discussion is included on only those studies which are relevant to our current investigation. In passing, it is of especial note that an excellent review of studies on the demand for electricity may be found in Taylor (1975).

Studies in group 5 are most closely related to our research and a separate chapter (Chapter 5) is devoted for a closer examination of these studies. Studies in groups 1 and 8 are of only minor relevance to this study and will not be further discussed here. The set of studies in group 2 are also of minor relevance to this study, but one particular study from this group will be discussed here owing to the uniqueness of the study. The rest of this chapter will mainly be devoted to discussing the studies from groups 3, 4, 6 and 7.

4.2 Studies concerned with the global long-term aspects of energy consumption (group 2)

The only study from group 2 discussed here is the one by Marchetti (1974) which analyses the secular growth of world energy consumption and the patterns of substitution between primary fuels.

Marchetti demonstrates that if wood and farm wastes are included in energy consumption the trend in world energy consumption between the period 1860 to 1960 can be represented by a 2 per cent growth line. Energy consumption in the U.S. during the same period may be represented by a 3 per cent growth line, this higher growth being caused by a 1 per cent faster population growth in the U.S. compared to the rest of the world in the same period.

For examining trends of interfuel substitution, Marchetti used the substitution model of technical change proposed by Fisher and Pry (1970) which states that the fractional rate at which a new commodity penetrates a market is proportional to the fraction of the market not yet penetrated. This can be represented mathematically by either of the following two equations.

$$\frac{1}{F} \cdot \frac{dF}{dr} = \alpha(1 - F) \qquad (4.1) \qquad \text{or} \qquad \ln\left(\frac{F}{1 - F}\right) = \alpha t + c \qquad (4.2)$$

where F is the fraction of market penetrated,

α and c are constants which depend on the characteristic of the commodity and of the market, and

t is time.

Marchetti contends that by using this simple model the data for more than a hundred years on the consumptions of wood, coal, gas and oil can be fitted satisfactorily. The conclusion from this study is that the trend in consumption of a fuel is determined by the competition between different fuels and the trend is largely insensitive to (a) the ultimate reserve of that fuel (b) the fluctuations in the price of that fuel and (c) minor fluctuations in the economic activity.

The model fits the global energy data reasonably well but it does not attempt to explain the reasons for (a) the growth of the energy consumption and (b) the important differences in growth between the different sectors (i.e. domestic, industrial) of consumption.

4.3 Studies concerned with the demand and/or supply of energy for a national economy (group 3)

There are three major approaches for assessing and forecasting the demand for energy. The first approach is to extrapolate the patterns of the past by curve-fitting technique. The second approach is that of simulation or scenario study which explores possible futures under different sets of assumptions i.e. which attempts to solve "what-happens-if" type of questions. The third approach is that of econometric analysis which relates energy consumption to certain explanatory variables such as the gross national product, consumers' expenditure, price etc and uses estimated future values of these explanatory variables to forecast energy consumption.

The first approach is usually followed for only relatively simple problems; most problems are studied by using either (a) the second or the third approach or (b) a combination of the two approaches. Simulation is preferred for the longer-term studies where the main objective is not to forecast energy consumption but to gain an insight into the interactions within the energy system. The econometric analysis is usually favoured for the shorter-term studies mainly due to the availability of powerful statistical tests for determining the validity of the analysis.

4.3.1 The U.K. Department of Energy Model

This is an interactive model described by Hutber (1974) which aims to balance supply and demand for each fuel in each market in the U.K. over time. The demand for the various fuels in the different market is influenced by their relative prices (also by other factors); the relative prices are themselves dependent on the relative cost of resources (investment, raw material, manpower etc) and the cost to a fuel industry is in turn influenced by the level of demand.

The model consists of three parts - a supply sub-model, a demand sub-model and a linkage between these two sub-models.

The supply sub-model consists of four separate models, one each for coal, petroleum, gas and electricity. With the exception of the petroleum-model, the supply sub-models aim to minimise the cost function of the industry subject to a set of constraints which include a constraint for the level of demand. The petroleum sub-model is at present a kind of "tap-model" which assumes that the U.K. could obtain whatever quantity of petroleum was required by the consumer and that the average price is determined outside of the model.

The demand sub-model divides the total energy market into the following sectors: domestic, industrial, commercial, public administration and transport. The structure of the demand sub-model is identical for each sector but the influences of various parameters are assumed to be different. The demand for each fuel in each market is established in three stages.

In the first stage the total demand for energy in that market is determined.

$$E_t = a_0 \; A_t^{\,a_1} \; P_t^{\,a_2} \; T_t^{\,a_3} \; e^{a_4 t} \qquad (4.3)$$

where E_t is the total demand for energy in the sector in period t

A_t is an activity indicator (for example consumer's expenditure in the domestic sector) in period t

P_t is the weighted average price of energy in the sector in period t

T_t is the temperature in period t

t is a trend variable.

In the second stage the ideal demand for each fuel is determined:

$$q_{it}^{*} = A_i \, P_{it}^{-\theta} \qquad (4.4)$$

where

q_{it}^{*} is the quantity of fuel purchased (ideal quantity) in period t

A_i represents the effects of non-price factors, such as advertising.

P_{it} is the price of fuel in period t

Total ideal demand Q_t is

$$Q_t = \sum_i q_{it}^{*} \qquad (4.5)$$

and

$$\gamma_{it}^{*} = \frac{q_{it}^{*}}{Q_t} \qquad (4.6)$$

where γ_{it}^{*} is the ideal share of fuel i in period t.

In the third stage the actual share of each fuel is allowed to be different from the ideal share:

$$\gamma_{it} = (\gamma_{i,\, t-1})^{\Phi} \quad (\gamma_{it}{}^{*})^{1-\Phi} \qquad (4.7)$$

which implies that purchasing behaviour is adjusted towards the ideal share but at a rate determined by the parameter Φ which represents a lag in the conversion of equipment.

The results that are published from this model tend to draw "scenarios" under different assumptions and as a result are not published in any detail.

4.3.2 The Cambridge Model

This model of demand for fuel, described by Stone and Wigley (1968) is a sub-section of a larger study initiated by Stone (1962) on the national economic growth in the U.K. The model is based primarily on the principle of substitution between coal and coke on the one hand and petroleum and gas on the other. The total demand for energy is divided into three categories:

(1) intermediate demand for industry;

(2) final demand by the household sector; and

(3) final demand by the government sector.

Two variants of the model are attempted, one for a slow exploitation of the North Sea gas and the other for a rapid exploitation.

The intermediate demand

The relationship between the actual consumption and the desired consumption of coal and petroleum by an industry is represented by:

$$\Delta \left(\frac{Z_{1j}}{Z_{2j}}\right) = \gamma \left[\left(\frac{Z_{1j}}{Z_{2j}}\right)^* - \left(\frac{Z_{1j}}{Z_{2j}}\right)\right] \qquad (4.8)$$

where Z_{1j} and Z_{2j} are the actual consumption of coal and petroleum respectively by the industry j,

$\left(\frac{Z_{1j}}{Z_{2j}}\right)^*$ is the desired consumption ratio,

Δ is the first difference operator and

γ represents a parameter such that $0 \leq \gamma \leq 1$.

The interpretation of equation (4.8) is that the change in the actual ratio of coal and petroleum from one year to the next is a proportion of γ of the difference between the ratio desired for the next year and the actual ratio existing in the present year.

The desired ratio is influenced by the relative price of coal and petroleum such that

$$\left(\frac{Z_{1j}}{Z_{2j}}\right)^* = \alpha + \beta \frac{P_1}{P_2} \qquad (4.9)$$

where p_1 and p_2 are the price of coal and petroleum respectively and α and β are parameters.

The model is modified to bring the consumption of coke and gas into the model, so that

$$g_j = \mu(Z_{1j} + Z_{3j}) + \xi(Z_{2j} + Z_{4j}) + \eta\omega \qquad (4.10)$$

where g_j is the output of industry j

Z_{3j} and Z_{4j} are consumptions of coke and gas respectively,

ω is the variation from average temperature,

μ, ξ and η are parameters.

The demand for electricity is represented by a linear time trend fitted to the input co-efficient (i.e. therms of electricity per £ of output).

The final demand in the household sector

For fuels other than motor spirits the demand relationship is represented by:

$$\log X_i = a_i + b_i \log \left(\frac{p_i}{p_f}\right) + c_i \log CE + d_i \log \omega \quad (4.11)$$

where X_i is the demand for fuel i, per head,

p_i is the price of fuel i,

p_f is the average weighted price of all fuels,

CE is the consumers' expenditure per head,

ω is the ratio of annual average temperature, to long run average temperature and

a_i, b_i, c_i and d_i are parameters.

The demand for motor spirits is expressed as

$$m = a + bt - cs \quad (4.12)$$

where m is the ratio of motor spirits (measured in ton) bought by domestic consumers to personal expenditure on all forms of transport (measured in £),

s is a dummy variable to eliminate the effects of restricted supply as a result of the "Suez Crisis" of 1956

a, b and c are parameters and t is time.

The final demand in the government sector

This demand is relatively small and is estimated mainly by projecting trends of past consumption.

Data for the years 1948 to 1964 were fitted to the model and projections made for the year 1972. Results from the model, when compared with the actual consumption, show that both the decline in the consumption of coal and the growth in the consumption of petroleum for the 1972 projections were underestimated.

4.3.3 The National Institute for Economic and Social Research (N.I.E.S.R.) Model

The main objective of the model as described by Ray (1960) (1967) (1972), which is periodically revised, is to forecast short- and medium-term demands for energy in the U.K., the method of analysis combining trend projection and econometric techniques. The original model attempted to establish the reasons for a slower growth of the total energy demand compared with the growth of the GDP during the period between 1950 to 1959. It isolated three sets of possible reasons. Firstly, the growth of energy demand in the domestic sector (which is not strongly related to the GDP) had been slower than that of the GDP. Secondly, there had been changes in the pattern of output and certain energy-intensive industries had grown less rapidly than the rest of the economy. Thirdly, there had been an increase in the "fuel efficiency" in that less fuel was being used in the industry for producing a given amount of output.

Final use of energy by main categories of consumer was estimated by the following set of equations.

Domestic	$\text{Log } Y^* = a_0 + a_1 CE + a_2 \log WED$	(4.13)
Iron and Steel	$Y^* = b_o + b_1 \text{ IIP}$	(4.14)
Public services and miscellaneous (including agriculture)	$\text{Log } Y^* = c_0 + c_1 \text{ GDP}$	(4.15)
Air transport	$\text{Log } Y = d_0 + d_1 \text{ GDP}$	(4.16)
Road transport	$\text{Log } Y = e_o + e_1 \text{ GDP}$	(4.17)
Other industries	$Y^* = f_0 + f_1 \text{ GDP}$	(4.18)

where Y is energy consumption in million therm,

GDP is the gross domestic product, 1963 = 100,

CE is consumers' expenditure at 1963 prices,

WED is the annual number of marriages in Great Britain, IIP is index of production in ferrous metals, 1963 = 100,

a_0, a_1, b_0 ... f_1 are parameters,

* denotes a series corrected for temperature.

The domestic energy consumption was corrected by using the following factors for the efficiency of utilisation:

coal	25 per cent
coke, breeze and other smokeless fuels	50 per cent
town gas	65 per cent
petroleum	70 per cent
electricity	90 per cent.

The use of GDP as a measure to represent the level of activity of sub-sectors of the economy limits the accuracy of the model. Previous forecasts from the model, when compared with actual consumption, show that the forecast for 1970 underestimated the decline of coal and the growth of petroleum in the consumption while the forecast for 1975 overestimated both.

4.3.4 Ford Foundation (1974) Project

The objective of the Project is to explore both the range of energy choices open to the U.S. up to the year 2000 and to identify the policies that match the choices. Three different scenarios called historical growth scenario, technical fix scenario and the zero energy growth (ZEG) scenario are explored.

The historical growth scenario assumes that energy consumption in the U.S. would continue to grow till 2000 at 3.4 per cent per annum, the average rate for the period between 1950 and 1970. The technical fix scenario assumes the rate of economic growth and the balance between manufacturing and service industries to be similar to that for the historical growth scenario. The main difference between the two scenarios is that in the technical fix scenario, energy is used more efficiently by employing energy-saving technologies, thus reducing the rate of growth of energy consumption to 1.9 per cent per annum. The ZEG scenario allows for economic growth but assumes a redirection of the economy to less energy-intensive activities such as a shift from manufacturing to service industries. The consequence of ZEG is to increase energy consumption at a declining rate up to 1990 when energy consumption reaches a plateau.

The analysis is based on the macro-econometric model developed by Hudson and Jorgenson (1974) which is discussed more fully later in Chapter 6. The model integrates the approaches of both the econometric modelling and the input/output analysis by explicitly taking into account both the demand and the supply of energy and relating them to U.S. economic growth. It is also to be noted that except for the transport sector, the model estimates the future requirements in all sectors in terms of effective energy (i.e. taking utilisation efficiency into account).

4.4 Studies concerned with the relationship between energy consumption and economic growth (Group 4)

The importance of the availability of energy as a stimulus or a constraint to economic development is generally well appreciated and a number of studies have attempted to explain the relationship.

Starr (1971) found approximate linearity between energy consumption per capita and gross national product per capita both for a particular country over time and for different countries that are in different stages of economic development at a given time. The energy coefficient has been defined as the percentage change in energy consumption associated with a 1 per cent change in the economic activity and Darmstadter (1971) shows that for advanced industrial economies such as the U.K., U.S. and West Germany this co-efficient is slightly less than 1.0.

Adams and Miovic (1968) analyse the situation in Western Europe for the period between 1950 and 1962 and conclude that the previous studies had obtained a figure less than 1.0 for energy co-efficient because the measurement of energy consumption had been in terms of primary energy. They contend that the demand for energy be analysed at the level of effective consumption which is where the consumer's choice is made instead of at the level of primary consumption. Adams and Miovic demonstrate that if the relative efficiencies of fuels are taken into account, the energy co-efficient for the West European economies becomes equal to or greater than 1.0 which suggests that energy consumption increases proportionally or more than proportionally with output.

Brookes (1972) uses the concept of relative efficiencies as proposed by Adams and Miovic for studying 22 countries from all parts of the world that are in different stages of economic development. He concludes that as a country moves through the various states of economic development from primitive subsistence agriculture to the fully industrialised state, its useful energy elasticity with respect to the gross national product falls progressively from a high value to unity.

A recent study by O'Neill (1975), based on a cross-sectional analysis of the U.K. primary energy consumption for the year 1968 suggests that as the income of the consumer rises a greater proportion of this income is spent on less energy-intensive goods and services. O'Neill obtains an energy co-efficient of 0.73 for the year 1968 and contends that the relationship between economic growth and primary energy consumption may be explained almost entirely by this income effect and that technological change over time (resulting in changes in the efficiency of fuels) plays a minor role in determining energy consumption.

The concept of energy co-efficient as used by these studies, is a useful one and whether one uses the primary energy or the final energy as the measure of energy consumption depends on the objective of the exercise. While it seems reasonable to use the measure of energy consumption in terms of primary energy for short-term studies, the long-term studies must measure energy in terms of final energy (and correct for the efficiency of utilisation) due to the possibility of a changing fuel-mix.

4.5 Studies concerned with the demand for energy, at a disaggregated level (Group 6)

There are a large number of studies in this group and we have selected only five out of them for detailed discussion in this section. While this selection is not meant to cover the width of interest of this group of studies, it conveys the general objectives and the methodology of such studies.

4.5.1 Houthakker (1951) - domestic demand for electricity in the U.K.

This is an analysis of electricity demand on domestic two-part tariffs for 42 provincial towns in 1937-1938 and Houthakker estimates an equation of the form:

$$\log X = \alpha \log M + \beta \log p_{-2} + \gamma \log g_{-2} + \delta \log h + \xi \quad (4.19)$$

where X is average annual consumption per consumer with a domestic two-part tariff,

M is average money income of household with a domestic two-part tariff,

p_{-2} is the marginal price of electricity, lagged 2 years

g_{-2} is marginal price of gas on domestic tariff lagged by 2 years

h is average holding of heavy domestic equipment (cookers, water-heaters and wash boilers) per consumer and

α, β, γ and δ are parameters; ξ is an error term.

The results from this model indicates that income, electricity price and gas price are all significant determinants of demand. The effect of stock of appliances (h) on electricity consumption is small.

4.5.2 Fisher and Kaysen (1962) - demand for electricity in the U.S.

Fisher and Kaysen analyse both domestic and industrial demand for electricity in the U.S. in this extensive study which covers the period between 1946 to 1957 and uses data for 47 states in the U.S. Here we discuss briefly the domestic demand model.

Fisher and Kaysen were the first to distinguish clearly between the short-run and the long-run demand. The short-run demand is identified with choice in the rate of utilisation of a fixed amount of electricity-using capital stock while the long-run demand is identified with choice in the size of the capital stock itself.

The short-run demand

The basic equation is written as

$$D_t = \sum_{i=1}^{n} K_{it} \quad W_{it} \qquad (4.20)$$

where D_t is total metered use of electricity by all households in period t

W_{it} is the average stock during period t of the ith capital good (i.e. energy-using appliance) measured in electricity consumption per hour of normal use,

K_{it} is the average intensity of use of ith capital good in period t, measured in electricity consumed per hour per unit of capital good and

n is the number of capital goods.

By expressing Kit as a function of price and income and by letting the stock of appliances grow exponentially according to the equation

$$\sum_{i=1}^{n} W_{it} = W_t^* = Wo\ e^{\delta t} \qquad (4.21)$$

they obtain

$$\Delta \ln D_t = \delta + \alpha \Delta \ln P_t + \beta \Delta \ln Y_t \qquad (4.22)$$

where P_t is the average price of electricity to households and

Y_t is the personal income in the community

By estimating equation (4.22) Fisher and Kaysen arrive at the following conclusions on the short-run demand for electricity. The first is that the states fall into two groups, one having a near-zero price elasticity and the other having a higher price elasticity, although less than one. These above groups can be identified as "mature" and "younger" economies thus implying that as all states "mature", short-run household demand will become even less sensitive to price. The second conclusion is that there are distinct differences in the income elasticity between highly urbanised and less-urbanised areas, with less urbanised areas having relatively low or even negative income elasticity.

<u>The long-run model</u>

Fisher and Kaysen consider that the usual stock adjustment model, where new purchases are assumed to be proportional to the difference between desired and actual stock, is unsuitable for determining purchases of electricity-consuming appliances. They argue that the choice of the individual household is mainly restricted to having none or one of a particular type of appliance. They propose a "disease" model which expresses the ratio of total stock in period t to the total stock in period t-1 to be a function of income, price etc. Specifically they estimate an equation

$$\ln W_{it} = A_i + \eta_{i1} \Delta \ln Y_t^E + \Delta \eta_{i2} \ln Y_t + \Delta \eta_{i3} E_{it}$$
$$+ \Delta \eta_{i4} \ln G_{it} + \eta_{i5} \Delta \ln H_t + \eta_{i6} \Delta \ln F_t + \eta_{i7} \ln M_t$$
$$+ \eta_{i8} \ln P_t^E + \eta_{i9} \ln V_{it}^E + U_{it} \quad (4.23)$$

where W_i is the stock of ith capital good

Y_t^E is per capita permanent income

Y_t is per capita personal income

E_i is the price of ith capital good

G_i is price of gas-using substitute, if applicable

H is the ratio of residential and rural electric customers to total population

F is number of marriages

M is total number of houses wired for electricity

P^E is average residential price of electricity and

V^E is average price per therm of gas.

Fisher and Kaysen draw the following conclusion from this long-run model. "Net changes in the stock of appliances seem mainly to depend on changes in long run income or changes in population and in the number of wired household per capita. The price of electricity seems to have nearly no effect; the price of appliances only relatively small ones".

4.5.3 <u>Baxter and Rees (1968) - industrial demand for electricity</u>

Baxter and Rees analyse the industrial demand for electricity in the United Kingdom during the period between 1954 and 1964 by estimating three different models.

The main model is based on the Cobb-Douglas type of production function which is expressed as:

$$Q = \alpha_0 X_1^{\alpha_1} X_2^{\alpha_2} \dots X_k^{\alpha_k} \qquad (4.24)$$

where Q is output,

X_j (j=1, 2 ... k) are the relevant inputs and

α_j (j=1, 2 ... k) are corresponding parameters

It is assumed that firms wish to minimise the total cost of production for any output, hence.

$$C = p_1 x_1 + p_2 x_2 + \dots p_k x_k \qquad (4.25)$$

where C is the total cost and

p_j (j=1, 2 ... k) are the input prices.

The minimisation of (4.25) subject to the constraint in (4.24), yields a demand function for electricity:

$$x_k = \beta_0 p_1^{\beta_1} p_2^{\beta_2} \dots p_k^{\beta_K} Q^{\beta_K+1} \qquad (4.26)$$

i.e. the demand for electricity is an exponential function of K input prices and output.

The second model is based on the same theme as that of the first model but it incoporates the effects of changes in fuel technology. It is assumed that the most important changes in fuel technology in many industries (during the period of analysis) would be reflected in the declining demand for coal, and consequently, coal consumption was included in the model as a surrogate for technical change.

The third model is based on the assumption that there exists a direct relationship between output and the consumption of electricity and any deviation from this relationship can be explained by changes in retail prices and in capital and labout intensity.

These three models are estimated for a combination of 12 equations using such explanatory variables as index of production, price of electricity, price index of all other fuels, average wage rates, employment, gross fixed capital formation, coal consumption, time and temperature. Applying these models to analyse the demand for electricity in 16 major industry groups, Baxter and Rees come to the following conclusions:- The chief determinants of growth in the demand of electricity were (1) output and (2) changes in technology, and relative price changes were less important than the two factors mentioned above.

4.5.4 Balestra (1967) - the demand for natural gas in the United States

The purpose of this study is to analyse the residential and commercial demand for natural gas in the U.S. during the period 1950 to 1962 and Balestra develops a dynamic model starting from short-run static-demand equation.

The basic static model is of the form

$$G_t = \beta_0 + \beta_1 P_t + \beta_2 Y_t \qquad (4.27)$$

where G_t is the per capita gas consumption,

P_t is the relative price of gas (deflated by an index)

Y_t is the per capita real income

Although the estimates from equation (4.27) compares well with the data, Balestra considers that the equation is unsatisfactory since the income variable explains most of the variations and becomes a "porte-manteau" for all changes in the competitive structure of the fuel market.

The next step is to incorporate some of the dynamic characteristics of the fuel market by allowing for a "stock effect":

$$G_t = S_t \cdot \lambda_t \qquad (4.28)$$

where S_t is the stock of appliances in period t and

λ_t is the normal rate of utilisation in period t.

Assuming that a double-logarithmic function accurately describes the behaviour of the consumer, the rate of utilisation is expressed as

$$\lambda_t = A\, P_t^{\alpha}\, Y_t^{\beta} \qquad (4.29)$$

Substituting (4.29) into (4:28) Balestra obtains

$$G_t = A\, P_t^{\alpha}\, Y_t^{\beta}\, S_t \qquad (4.30)$$

Since the stock of appliances S_t could not be obtained directly, S is assumed to follow a smooth exponential trend, so that

$$S_t = (1 + K)\, S_{t-1} \qquad (4.31)$$

substituting (4.31) into (4.30) and taking first differences)

$$\Delta\, G_t' = K' + \alpha\, \Delta\, p_t' + \beta\, \Delta\, Y_t' \qquad (4.32)$$

where $K' = \log\,(1 + K)$.

Equation (4.32) is estimated and the results are poor which leads Balestra to conclude that the short run model does not successfully represent the behaviour of the consumer in the gas market.

In developing the dynamic model Balestra argues that the demand for gas is a "derived" demand and is dependent on the total demand for fuels. The dynamic element in the model is represented by a "stock adjustment mechanism" which postulates that the planned stock is determined by the discrepancy that exists between the actual and the desired stock. This is expressed as

$$I_t = \rho\, I_t^{d} + (1 - \rho)\, I_{t-1} \qquad (4.33)$$

where I_t is the actual stock in period t

I_{t-1} is the actual stock in period t-1

I_t^d is the desired stock and

ρ is a measure of the speed of adjustment.

At this stage Balestra introduces the concept of "the new demand for gas" by arguing that because of the high transfer cost involved in the shift to a different type of fuel, the consumer cannot change his fuel-using appliances to which he is already committed, even if the relative price of gas were to change. Hence the consumer is restricted into making his choice only for the "new demand". The basic equation, that is estimated by first using cross-section data for 1962 and then by pooled cross-section and time-series data, is of the form:

$$G_t = A_o + A_1 P_{gt} + A_2 \Delta N_t + A_3 N_{t-1} + A_4 \Delta Y_t + A_5 Y_{t-1} + A_6 G_{t-1} \qquad (4.34)$$

where G_t and G_{t-1} are the consumptions of gas in period t and t-1

N_t and N_{t-1} are the populations in period t and t-1

Y_t and Y_{t-1} are the incomes in period t and t-1.

The conclusions from the model are that while the total demand for gas is relatively insensitive to the changes in the relative price of gas, the incremental demand for gas (consisting of both new demand and replacement demand) is more responsive to price changes.

4.5.5 Halvorsen (1975) - residential demand for electric energy

This analysis is concerned with the residential demand for electricity in the U.S. during the period between 1961 and 1969. The general form of the residential demand equation is

$$Q = A\ (P_m,\ W,\ u) \qquad (4.35)$$

where Q is the average consumption of electricity per consumer

P_m is the marginal price of electricity

W is the vector of all other relevant variables such as average real income per capita, average price of residential gas, index of wholesale prices of electrical equipment, percentage of population living in rural areas, percentage of housing units in multi-unit structures, average size of households, time and temperature

u is a disturbance term.

Since electricity is sold at declining block rates the price paid by each customer is inversely proportional to quantity purchased. Therefore, in order to identify equation (4.35) the model includes an equation for marginal price.

$$P_m = P_m\ (Q,\ Z,\ \nu) \qquad (4.36)$$

where Z is a vector of exogenous variables that determine the electricity rate schedule such as the cost of labour, the percentage of generation achieved by public-owned utilities, cost of fuel, percentage of population in rural areas, ratio of industrial sales to residential sales and time,

ν is a disturbance term.

The results from the model show that the estimates of the own-price elasticities lie within a range of -1.00 to -1.21, indicating that the absolute value of the long-run, own-price elasticity is at least unity. This conclusion is in direct contradiction to that of Fisher and Kayson (1962) described earlier who concluded that the price of electricity seems to have had almost no effect on the demand for electricity. Halvorsen argues that Fisher and Kaysen regressed the growth rate of appliance stocks on the levels of economic activity, hence "whatever the true causal relation between the economic variables and the stock of appliances the equation as formulated would indicate that there was no relation".

The limitations of the econometric analysis on energy consumption are discussed by Taylor (1975) and they can be summarised as follows.

1. Estimating a complete system of demand functions. According to the classical theory of consumer behaviour, the consumer maximises a utility function defined over n goods subject to his level of income. So far no econometric analysis of energy consumption has attempted to estimate a complete system of demand functions.

2. The problem of price. The consumer of energy, particularly the consumer of electricity is usually faced with a price schedule (not one price) from which energy is purchased in blocks at a decreasing marginal price. Hence the demand equation must include both average price and marginal price. Moreover, Taylor argues that the marginal price should refer only to the final block while the average price should exclude the final block. None of the studies so far has tackled the problem satisfactorily.

3. Short-run v. long-run demand. Since energy consumption is always associated in conjunction with the use of a capital stock (i.e. energy-using appliance), energy consumption is related to the demand for these capital stocks. In the short-run the demand for energy is reflected by the rate of utilisation of the existing capital stock while in the long-run the demand for energy is equivalent to the demand for the capital stock itself. No such data on capital stock is available at present and although Fisher and Kaysen (1962) estimated the capital stock in their study, they did not feel sufficiently confident (in the

accuracy of the data) to use the data in their analysis.

4. All the statistical problems of estimation such as due to auto-correlation and multicollinearity.

4.6 Studies concerned with analysing the energy content of goods and services (Group 7)

The studies discussed earlier in this chapter express the cost of energy in monetary terms since the money price of energy is expected to reflect the cost of energy in a properly functioning market system. The market mechanism for energy as a commodity is, however, distorted due to both government intervention through taxes, subsidies and quotas and due to the buying and selling of energy being concentrated in the hands of a few. Since the money price of energy may not reflect the energy content of goods and services, a group of researchers have endeavoured to express the energy content of goods and services in physical units.

There are, in the main, two methods by which the energy content of goods and services is evaluated. The first method is that of process analysis where the network of activities relating to the final product is defined and the energy requirement of each of these activities leading to the final product is analysed. This method obviously requires a knowledge of the particular production process involved. The second method is based on published economic statistics and usually employs the input/output analysis.

Several studies have been made, based on the process analysis. Chapman (1973a) studies the energy cost of delivered energy (i.e. primary energy required for delivering one unit of coal, coke, petroleum gas or electricity) and the energy cost of copper and aluminium (1973b). Leach (1973) has investigated the energy cost of food production and Slesser (1973) has demonstrated that a wide range of crops conform to a trend relating yield to energy.

The primary energy contents of goods and services in the U.K. have been derived by Wright (1975) from the U.K. input/output tables, the methodology of analysis is described below.

The input/output table is a square matrix A which gives the commodities necessary to make other commodities. Thus an entry A_{ij} in the ith row and jth column indicates the amount of commodity i (in money terms) required to produce £1.00 worth of commodity j. Thus the summation of all the items in the jth column gives the total input necessary to make £1.00 worth of commodity j.

For a given commodity, represented by vector $\underline{X}$, the input required is a vector $\underline{Y}$ such that

$$\underline{Y} = \underline{A}\,\underline{X} \tag{4.37}$$

where $\underline{A}$ is the matrix of the I/O table.

If the diagonal elements of $\underline{A}$ is assumed to be zero (i.e. if transactions within a single commodity group is ignored), the secondary input requirements are

$$\underline{Z} = \underline{A}\,\underline{Y} = \underline{A}^2\,\underline{X} \tag{4.38}$$

so that the total requirement for $\underline{X}$ is $\underline{A}\,\underline{X} + \underline{A}^2\underline{X} + \underline{A}^3\underline{X} + \ldots$

Hence the total requirement of the I/O table is

$$\underline{B} = \underline{A} + \underline{A}^2 + \underline{A}^3 + \ldots \tag{4.39}$$

$$= (\underline{I} - \underline{A})^{-1} - \underline{I} \tag{4.40}$$

where $\underline{I}$ is the identity matrix.

Matrix B is usually published along with the I/O table and this gives £ of primary energy for each commodity. Wright estimated the primary energy required (in physical units) for £1.00 worth of each commodity by referring to the Census of Production tables which give information both in physical and in money units. Wright also corrected the estimates for the import content of goods and services by assuming that imported goods have the same energy-intensity as the equivalent home-produced goods.

The results from energy analysis are valuable for the purposes of determining the relative energy-intensiveness of different economic activities and for locating the potential areas of energy conservation. The main criticism of energy analysis is that the results from this analysis are very sensitive to a change in technology or a change in the activity level of industry and hence such an analysis may be unable to indicate the long-term substitution possibilities between energy labour and capital.

4.7 Conclusions

There have been several approaches to energy modelling in the studies reviewed in this chapter. The following general comments on the structure of the demand models may be made in order to place the models used in the present study (discussed later in Section 7) into perspective.

4.7.1 Disaggregated models based on a single equation

These models are usually employed in disaggregated studies. Examples are the studies of demand for electricity in the domestic sector by Fisher and Kaysen (1962), demand for electricity in the industrial sector by Baxter and Rees (1968) and demand for gas in the residential and commercial market by Balestra (1967).

The general structure of these models may be represented as

$$D_t = f(P_t, Y_t) \qquad (4.4)$$

where D_t is the demand (usually for a particular form of energy in a particular market),

P_t is price which may be variously expressed as current price, price deflated by retail price index, price of the particular form of energy relative to the price of total energy, etc.

Y_t is income, expressed either in money or in real terms.

There are four major drawbacks of this single equation approach.

(i) The general problem of identifying the demand function since it is possible that the function estimated may be a supply function rather than a demand function.

(ii) Misspecification of the model due to the fact that the demand for a particular form of energy is influenced by (1) the overall demand of energy and (2) the cross-price effects of other forms of energy. Attempts have been made to take the above two factors into account by (1) deflating the price of a particular form of energy by the consumer price index and (2) expressing the price in relative terms to the aggregate energy price, respectively. But the approach is indirect and not fully satisfactory.

(iii) The assumption that price is given. This means that the demand is affected by price but not vice versa.

(iv) Non-price factors are omitted.

4.7.2 Disaggregated models based on a modified single equation

In these studies, such as that by Balestra (1967), attempts have been made to determine first the total demand for energy and then derive the demand for a particular form of energy. The structure of these models may be represented by a combination of the following two equations, equations (4.41) and (4.42) where

$$\tilde{D}_t = \tilde{f}\ (\tilde{p}_t,\ Y_t) \qquad (4.41)$$

and

$$D_t = f\ (p_t) \qquad (4.42)$$

where $\tilde{D}_t$ is the demand for total energy

$\tilde{p}_t$ is the price of energy relative to the price of all other goods

Y_t is real income,

D_t is the demand for the particular form of energy and

p_t is the price of that particular energy relative to the price of total energy.

This approach takes account of the fact that the demand for a particular form of energy is derived from the overall demand for energy but still suffers from all the other drawbacks of the straightforward single equation approach.

4.7.3 Short-run v. long-run models

Whether the various elasticities (such as that of income and price) refer to the short-term or to the long-term depend on the nature of the model.

As discussed earlier (comments under Section 4.5.5) the short-term models ignore the changes in the demand for energy-using appliances and assumes that (1) the stock of energy-using appliances remains constant and (2) the increase in consumption is achieved by a more intensive utilisation of the existing stock of appliances.

The long-term models, often referred to as dynamic models, attempt to take the changes in the demand for appliances into account. The usual procedure, due to the absence of reliable data on appliances, is to use some reaction mechanism (sometimes expressed as stock-adjustment mechanism) so that the actual consumption is allowed to be different from the desired consumption.

The relationship used in the Department of Energy Model by Hutber (1974) takes the form

$$\gamma_{i,t} = (\gamma_{i,t-1})^{\phi} \quad (\gamma_{i,t}^{*})^{1-\phi} \qquad (43)$$

where $\gamma_{i,t}$ is the actual share of fuel in in the total energy market in period t

$\gamma_{i,t-1}$	is the actual share of fuel i in period t-1
$\gamma_{i,t}^{*}$	is the ideal share of fuel i in period t
Φ	is a parameter representing the reaction mechanism.

The relationship used by Stone and Wigley (1968) takes the form

$$\Delta \left(\frac{Z_{1j}}{Z_{2j}}\right) = \gamma \left(\frac{Z_{1j}}{Z_{2j}}\right)^{*} - \left(\frac{Z_{1j}}{Z_{2j}}\right) \qquad (4.44)$$

where Z_{1j} and Z_{2j} are the actual consumption of coal and petroleum respectively by the industry j,

$\left(\frac{Z_{1j}}{Z_{2j}}\right)^{*}$ is the desired consumption ratio,

Δ is a difference operator and

γ is a parameter representing the reaction mechanism.

4.7.4 Models using a system of demand and supply functions

Obviously the ideal energy model would be one in which the full system, comprising a set of demand functions expressing the demand for different forms of energy as well as the demand for other goods, and a set of co-responding supply functions, is estimated simultaneously.

The model used by Hudson and Jorgenson (1974) (described later in Chapter 6) is based on such premises. This model combines the approaches of both econometric and input/output analyses and estimates the demand for 11 commodities, of which 4 are different forms of energy, simultaneously.

Three major features of this model are

(i) The model estimates the utility functions that are assumed to generate the demand functions and not the demand functions themselves.

(ii) The particular form of the utility function is transcendental logarithmic and

(iii) Energy is measured in terms of final energy.

The model used in this study (described later in Chapter 7) is based on the above model, but employs different functional forms for the utility and the production functions.

So far the discussion in this chapter has been concerned with bringing out the essential features of the various studies on energy consumption. The next chapter is devoted to an analysis of the major trends of energy consumption in the U.K. and in Scotland with a view to revealing the significant features of the energy sector.

CHAPTER 5

Main trends of energy consumption in the U.K. and in Scotland

5.1 Introduction

One of the principal objectives of this study is to compare the patterns of energy consumption between the U.K. and Scotland and explain the reasons for any variations that may exist between the two patterns. The purpose of this chapter is to examine the overall trends with a view to show the significant features of the energy sector.

The chapter is organised in three sections. In the first section, the trends of consumption of the individual forms of energy are examined, both in the primary energy sector and in the final energy sector. In the second section, the trends of total energy consumption, in terms of (a) primary energy, (b) final energy and (c) effective energy are shown and the trends in the efficiencies (a) of conversion and (b) of utilisation are examined. Trends in the prices of energy are also discussed with a view to establishing the relationship between energy price and energy consumption. In the third section, consumption of energy is disaggregated both by types of energy and by sectors, for investigating the differences between the patterns of the U.K. and Scotland in greater detail.

It is reminded that the measurement of effective energy is dependent on the values of utilisation efficiencies used and consequently the figures relating to effective energy depend critically on the efficiency figures used in this study.

5.2 Trends of consumption of the individual forms of energy

Figures 5.1 and 5.2 show the consumption of the individual forms of energy, in the U.K. and in Scotland respectively, in the primary energy sector. Figures 5.3 and 5.4 show the corresponding consumptions, in the final energy sector.

The figures show that over the 19 year period between 1955 to 1974, the overall trends for Scotland and the U.K. are similar. In the primary energy sector, the consumption of coal has declined, the consumption of electricity (nuclear and hydro) has remained fairly steady while the consumptions of both petroleum and natural gas have increased. In the final energy sector, the consumption of coal has declined even more steeply than in the primary energy sector (the difference resulting from the fact that a significant proportion of coal is used by the electricity generating industry), while the consumptions of petroleum, gas and electricity have all increased.

Although the overall general trends of energy consumption in Scotland is similar to those of the entire U.K., there are some important differences. These differences are brought out more clearly in Figures 5.5, 5.6(a) and 5.6(b) which show the ratio of per capita consumption between Scotland and the whole of the U.K. Figure 5.5 refers to the primary energy sector, Figure 5.6(a) refers to the final energy sector and Figure 5.6(b) shows the difference in the ratio (of per capita consumption) when energy is measured in effective energy terms instead of in final energy terms. The interpretations of the figures in these graphs are to be made as follows. For example, a figure of 0.875 for coal in the year 1975, in Figure 5.5 would mean that the per capita consumption of coal (in the primary energy sector) in Scotland in 1965 was 87.5 per cent of the per capita coal consumption in the U.K.

Figure 5.5 shows that, in the primary energy sector, the per capita consumption of total energy in Scotland was lower than the per capita consumption of total energy in the U.K. until 1972. Since 1972, the per capita consumption in Scotland has been higher than that of the U.K., mainly due to much higher per capita consumption of petroleum in Scotland. The situation with regard to (1) nuclear and hydro electricity and (2) natural gas (which are not shown on Figure 5.5 - but can be referred to in Tables 13 and 14) are as follows. In the earlier years in Scotland, both the nuclear and the hydro-electricity were more important compared to the rest of the U.K., so that the ratio of per capita consumption was 6.2 in 1955. Since the early 1960's, however, the nuclear generation of electricity has been faster in the rest of the U.K., so that in 1974 the above ratio had fallen to 2.62. The supply of natural gas was negligible in Scotland before 1970, but since then the supply has grown rapidly, so that in 1974 the per capita ratio of gas consumption became 0.452.

Figure 5.6(a) shows that, in the final energy sector since 1964 onwards, electricity has been more important in Scotland compared to the U.K. and since 1969 onwards petroleum has also become comparatively more important in Scotland.

Some important features of the energy sector in Scotland are revealed in Figure 5.6(b) which shows the ratio of total energy consumption (in per capita terms) when (a) energy is measured in final energy units and (b) energy is measured in effective energy units. Since the utilisation efficiencies in Scotland, for a given application using a given form of energy, are assumed to be the same as that for the rest of the U.K., the difference between the two curves reflects the difference in the energy mix. As long as the effective energy curve lies above the final energy curve, it means that the "quality of the energy mix" was higher in Scotland (i.e. the composition of the final energy was such as to yield higher overall utilisation efficiency), compared to the rest of the U.K. and vice versa. The figures show that up to about 1964, the "quality of energy mix" was lower in Scotland but since 1964, the quality of mix had been comparatively higher in Scotland.

The rates of growth of energy consumption in Scotland and in the U.K. are shown in Table 5.1 below.

TABLE 5.1 Rate of growth of energy consumption (Annual average percentage growth)

	1955 - 1974		1964 - 1974	
	U.K.	Scotland	U.K.	Scotland
Primary energy	1.2	1.1	1.3	1.8
Final energy	0.8	0.3	1.2	1.1

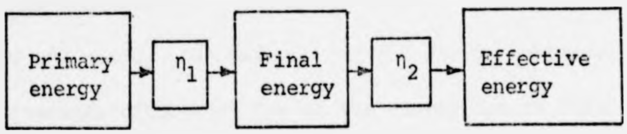
It can be seen from the above table that the rate of growth of final energy consumption in Scotland has been lower than that of the U.K. in comparison with the rate of growth of primary energy consumption. For example, during the period between 1955 to 1974, the consumption of primary energy in Scotland grew at a rate which is similar to that for the entire U.K. (1.1 per cent for Scotland and 1.2 for the U.K.) and yet the consumption of final energy grew by only 0.3 per cent in Scotland, compared to 0.8 per cent in the U.K. There are three main reasons for this discrepancy. Firstly, electricity which is "inefficient" in its conversion from primary energy, forms a higher proportion of final energy in Scotland. Secondly, the share of coal has declined less rapidly in the primary energy sector than in the final energy sector, in Scotland (meaning that more coal is consumed for electricity generation, compared to the U.K.). Thirdly, gas which is an efficient form of final energy has grown in the market less rapidly in Scotland.

5.3 Consumptions of primary, final and effective energy

It has been discussed earlier in Chapter 2 (Section 2.2, in particular Figures 2.2 and 2.3) that it is more suitable to express energy consumption in terms of effective energy than in terms of final energy. The differences in the trend of energy consumption caused by the difference in the units of measurement are shown in Figure 5.7. The consumption of final energy shows a decline from 1955 to 1974 while the consumption of effective energy shows an increase over the same period. The reason for this difference in the trends is that the efficiency of utilisation had been increasing over the years so that it was nearly 60 per cent in 1974 compared to only 30 per cent of 1955.

The above improvement in the utilisation efficiency had been brought about by two separate factors. Firstly, the efficiency of a given form of energy for a given application has been improving, for example the efficiency of coal-fire estimated to change from 25 per cent in 1955 to nearly 40 per cent in 1974. Secondly, the mix of energy was also changing so as to result in a higher utilisation efficiency, for example, natural gas had been replacing coal for cooking, heating etc.

Recalling Figure 2.7 of Chapter 2, the energy system may be viewed as



η_1 represents the efficiency of conversion (in fact, of transmission and distribution as well) from primary energy to final energy and η_2 represents the efficiency of utilisation. Hence $\eta_3 = \eta_1 \times \eta_2$ represents the efficiency with which primary energy is transformed to effective energy.

These three estimated efficiencies, for the U.K. and for Scotland, are shown in Figures 5.8 and 5.9 respectively. The trends in Scotland are similar to these for the entire U.K. The conversion efficiency (η_1) has declined over the years and the utilisation efficiency (η_2) has increased, and the rate of increase of the utilisation efficiency has been higher than the rate of decline in the conversion efficiency so that the overall efficiency ($\eta_3 = \eta_1 \times \eta_2$) has increased steadily over the period 1955 to 1974. The overall efficiency η_3 has been lower in Scotland compared to the U.K. due to the fact that the slightly higher value of the utilisation efficiency η_2 has not been able to compensate for the much lower value of the conversion efficiency. The situation for the year 1974 is as follows:

$$\frac{\eta_1 \text{ (Scotland)}}{\eta_1 \text{ (Total U.K.)}} = 0.94, \qquad \frac{\eta_2 \text{ (Scotland)}}{\eta_2 \text{ (Total U.K.)}} = 1.02$$

so that

$$\frac{\eta_3 = \eta_1 \times \eta_2 \text{ (Scotland)}}{\eta_3 = \eta_1 \times \eta_2 \text{ (Total U.K.)}} = 0.96$$

The consumption of energy in the U.K., measured in terms of primary energy, final energy and effective energy, are shown in Figure 5.10. It can be seen that in 1955, the utilisation losses were much higher than the conversion losses whereas in 1974, the two losses were of approximately equal magnitude. This points to the fact that over the years the consumer was obtaining energy in a form that could be used with higher efficiency than before, but the energy sector was achieving a lower conversion efficiency due to the conversion to this improved form.

The overall trends in the prices of domestic energy for the U.K. are shown in Figures 5.11 and 5.12. Figure 5.11 shows the prices of the four main forms of energy deflated by the retail price index, energy being measured in final energy units. Figure 5.12 shows the prices of energy, as in Figure 5.11, but energy in this case measured in effective energy units.

In terms of real final prices (Figure 5.11), the prices of both electricity and gas declined over the period 1955 to 1974, the price of petroleum remained fairly steady up to 1973 and the price of coal increased very slowly during this period. In terms of real effective prices (Figure 5.12), the prices of both electricity and gas (and particularly gas) declined sharply during this period, the price of petroleum also declined until 1972 and the price of coal remained nearly constant throughout this period. Overall, the real effective price of total energy remained fairly steady during the period between 1955 and 1974.

5.4 Consumption of energy in sectors

The consumption of energy in each sector as a ratio of the total consumption is shown in Table 5.2.

TABLE 5.2 Sector consumption of final energy (Percentage share of total)

	U.K.		Scotland	
	1955	1974	1955	1974
Domestic	0.286	0.258	0.285	0.227
Industrial	0.426	0.409	0.422	0.431
Transport	0.169	0.212	0.183	0.195
Public and commercial	0.119	0.121	0.110	0.147
	1.000	1.000	1.000	1.000

The main conclusion from the above table is that, in terms of the shares of total energy consumption by each sector, the situation in Scotland is very similar to that of the whole of the U.K. There are only three minor differences between Scotland and the U.K. and they are, (1) between 1955 and 1974, the share of consumption by the industrial sector has declined in the U.K. while it has increased in Scotland, (2) the decline in the share of consumption by the domestic sector has been greater in Scotland compared to the U.K. and (3) the share of consumption by the transport sector has grown less rapidly in Scotland compared to the U.K.

Apart from the fact that in the public and miscellaneous sector the consumption of gas in recent years has been lower in Scotland compared to the rest of the U.K. (for example, in 1974, in terms of final energy, the share is 7 per cent in Scotland and 15 per cent in the U.K. - sources Tables 13 and 14), there are no significant differences between Scotland and the rest of the U.K. in (a) the transport and (b) the public and miscellaneous sectors. The lower share of gas, mentioned above, is mainly due to the delayed development of the natural gas supply in Scotland (refer to Figures 5.1 and 5.2).

For the domestic sector, the shares of the total final energy demand by the different forms of energy are shown in Table 5.3

TABLE 5.3 Percentage shares in the domestic sector by each form of energy (final energy demand)

	U.K. (%)		Scotland (%)	
	1955	1974	1955	1974
Coal	84	33	86	37
Petroleum	2	10	1	10
Gas	9	36	9	21
Electricity	5	21	4	32
	100	100	100	100

It can be seen from the above table that although in 1955 the shares by all forms of energy were similar between Scotland and the U.K., by 1974 some important changes had occurred. Compared to the U.K., the consumption of gas is lower (21 per cent instead of 36 per cent) and the consumption of electricity is higher (32 per cent instead of 21 per cent) in Scotland. The delayed development of the natural gas supply in Scotland is the main reason for the differences mentioned above.

The share in the industrial sector by the four principal forms of energy are shown in Table 5.4.

TABLE 5.4 Percentage shares in the industrial sector by each form of energy (final energy demand)

	U.K. (%)		Scotland (%)	
	1955	1974	1955	1974
Coal	77	23	83	20
Petroleum	12	43	10	58
Gas	6	23	2	11
Electricity	5	11	5	11
	100	100	100	100

The table shows two significant differences between Scotland and the rest of the U.K. in the pattern of consumption; firstly with respect to petroleum and secondly with respect to gas. The share of petroleum has risen from 10 to 58 per cent in Scotland during 1955 to 1974 whereas the corresponding rise in the U.K. has been from 12 to 43. The share of gas in Scotland in 1974 has been significantly lower than in the U.K. i.e. a share of 11 per cent compared to 23 per cent. The main reason for this higher dependence on petroleum in Scotland is the delayed development of natural gas supply in Scotland. Another reason is that most of the heavy industry in Scotland is located in or around the Scottish mid-belt which is conveniently served by petroleum tankers.

The above differences between Scotland and the rest of the U.K., in the patterns of consumption in the domestic and the industrial sector, have important implications for energy policy with regard to the impact of the North Sea oil and gas in the Scottish energy sector. If the marketing policy for natural gas in Scotland were to be the same as the one that was adopted in the rest of the U.K. in the early states of the natural gas supply, two important changes are likely to occur within the energy sector in Scotland. Firstly, in the domestic sector, gas would compete with electricity and if the trends in the U.K. are repeated in Scotland, electricity would lose up to about 40 per cent of its share of domestic market. Secondly, in the industrial sector, if the trends in the U.K. are repeated in Scotland, petroleum may lose about 35 per cent of its share of industrial market to gas.

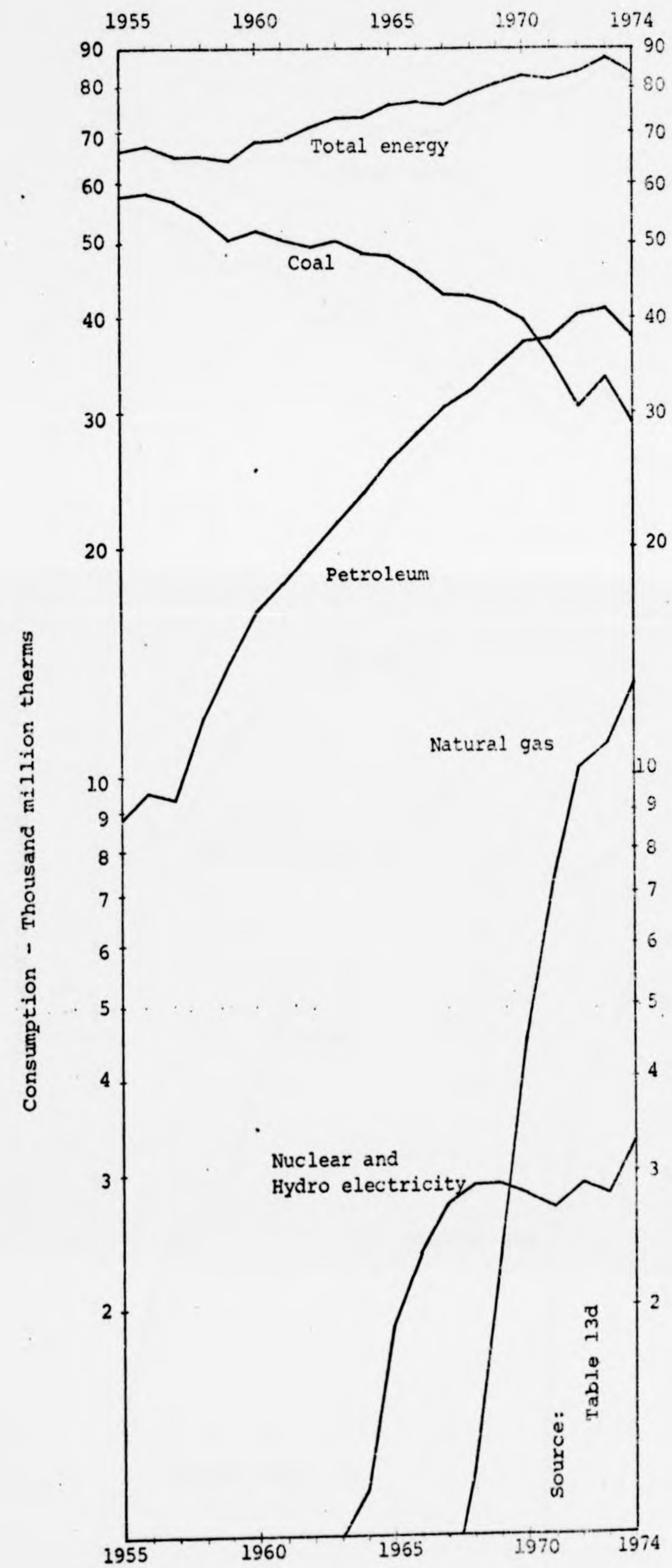


FIGURE No. 5.1 Primary energy consumption in the U.K.

FIGURE No. 5.2 Primary energy consumption in Scotland

Consumption - Hundred million therms

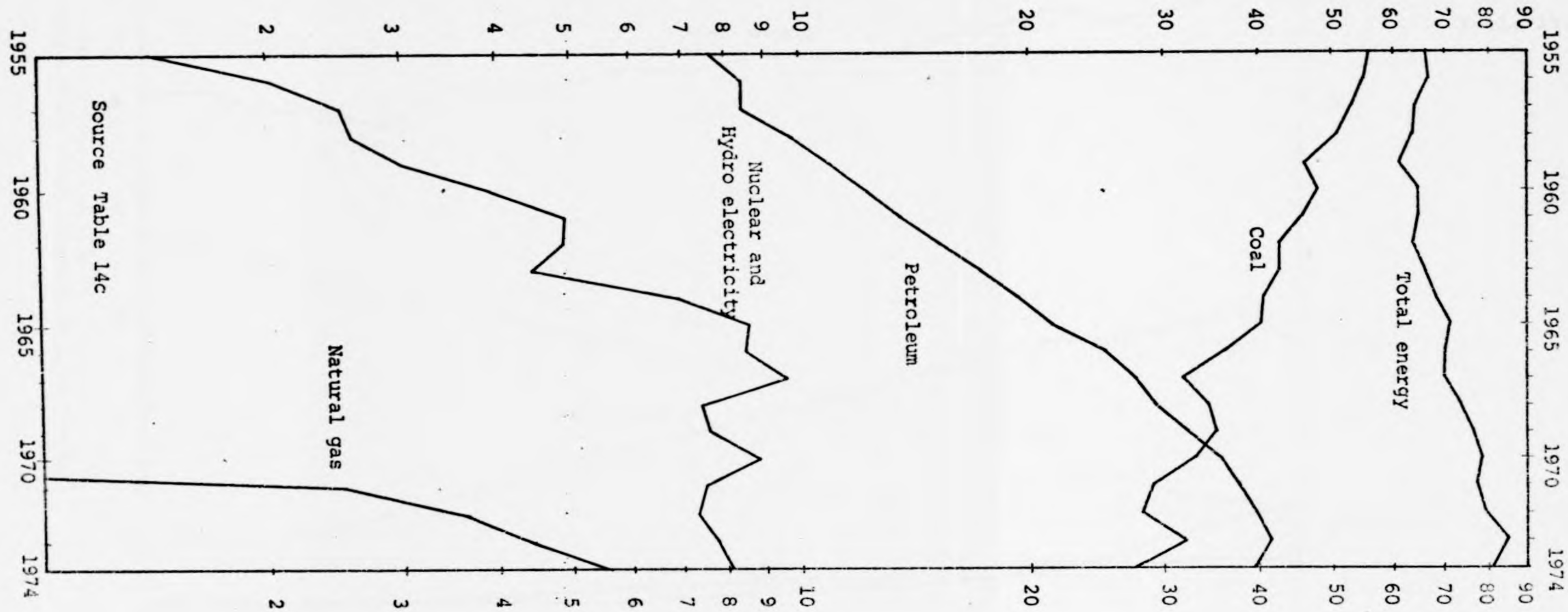


FIGURE No. 5.3 Final energy consumption in the U.K.

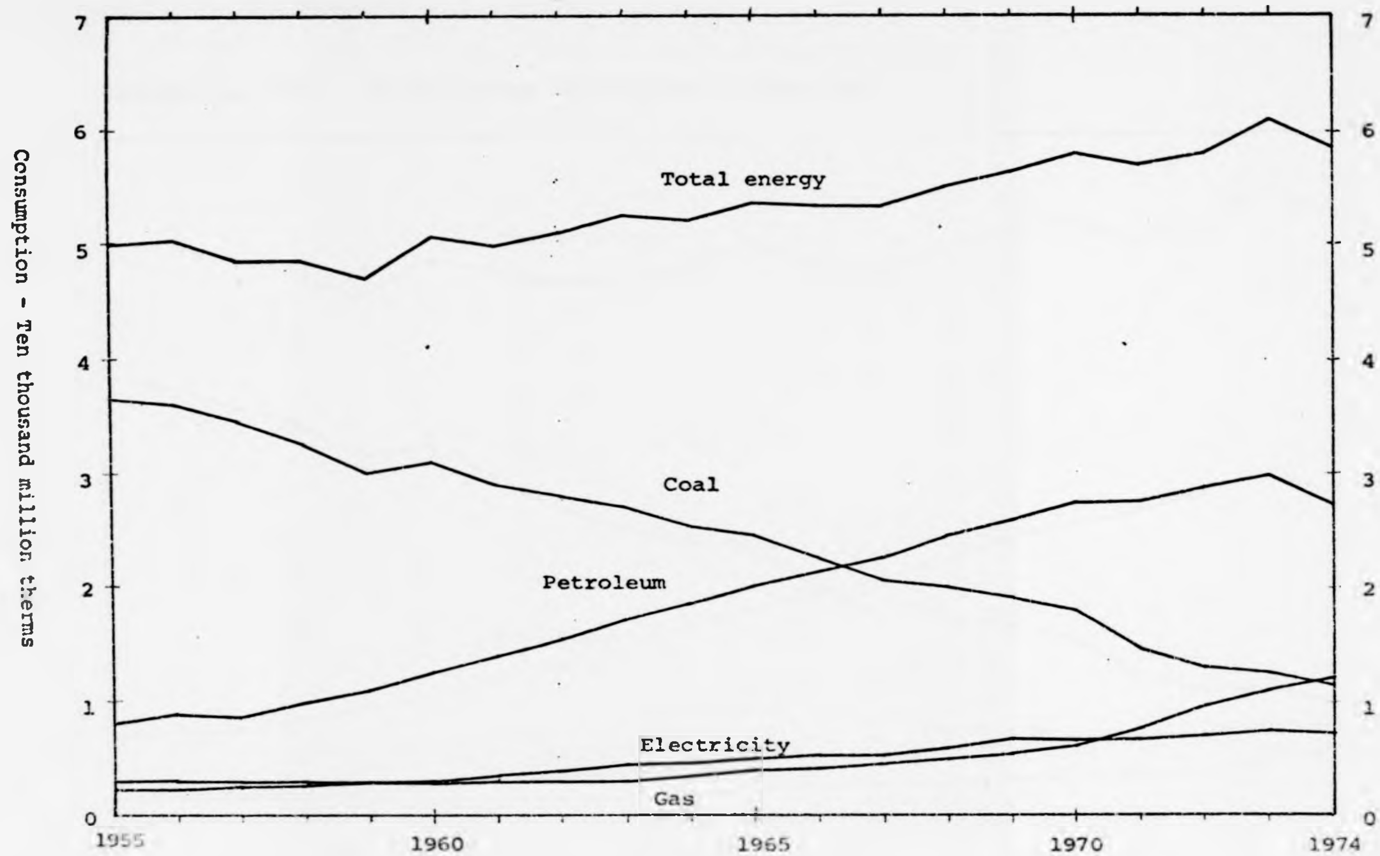


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Table 13e

FIGURE No. 5.3 Final energy consumption in the U.K.

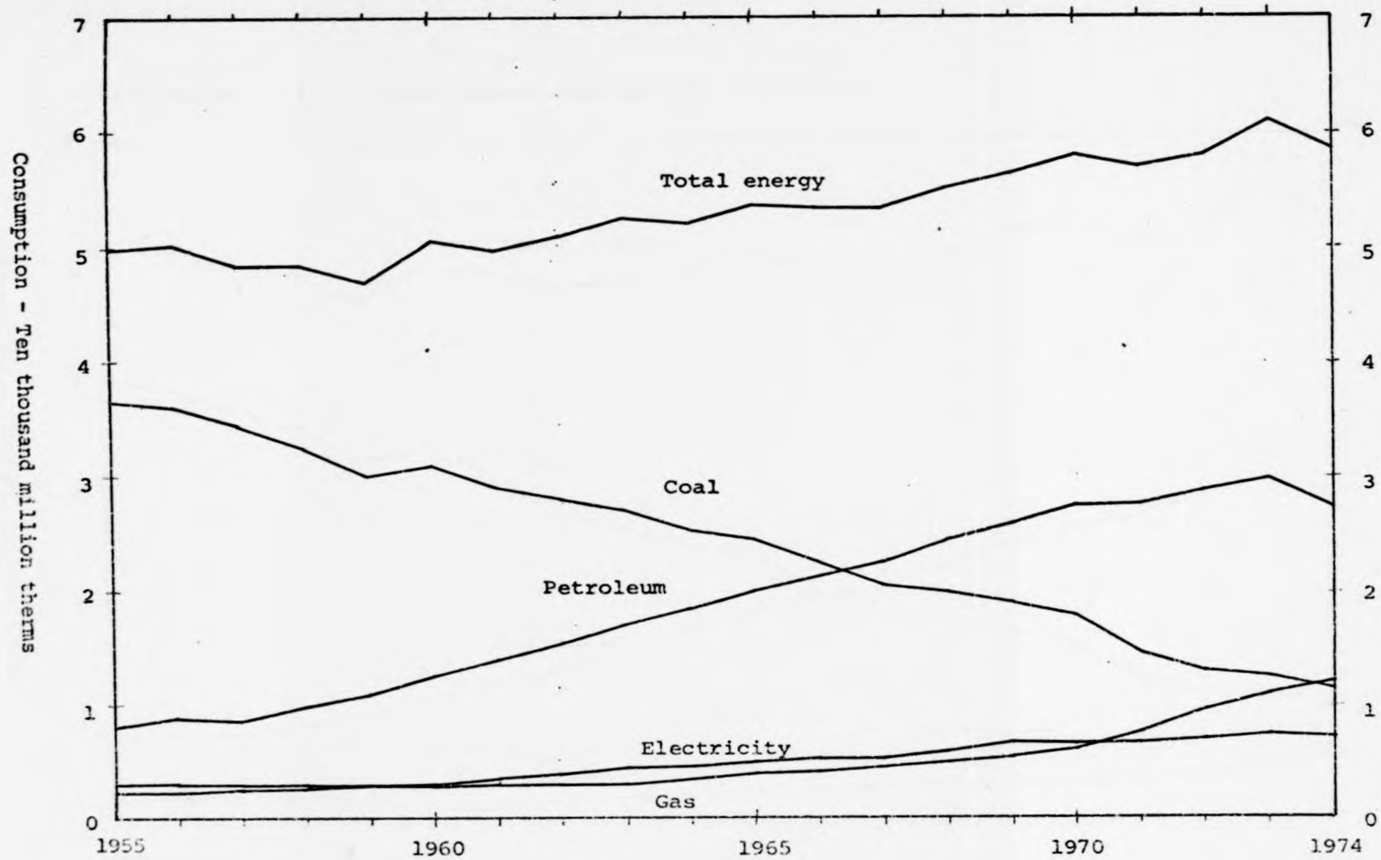

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FIGURE No. 5.4 Final energy consumption in Scotland

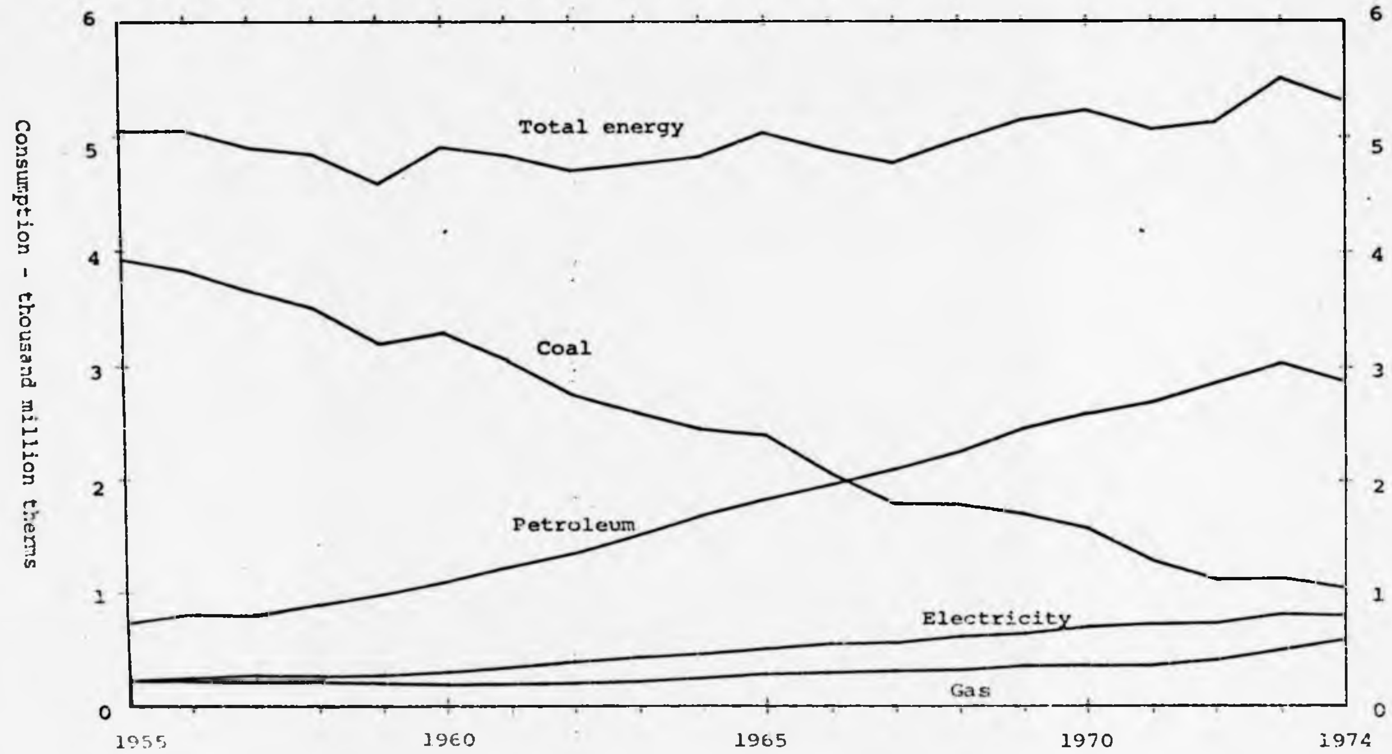

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FIGURE No. 5.4 Final energy consumption in Scotland

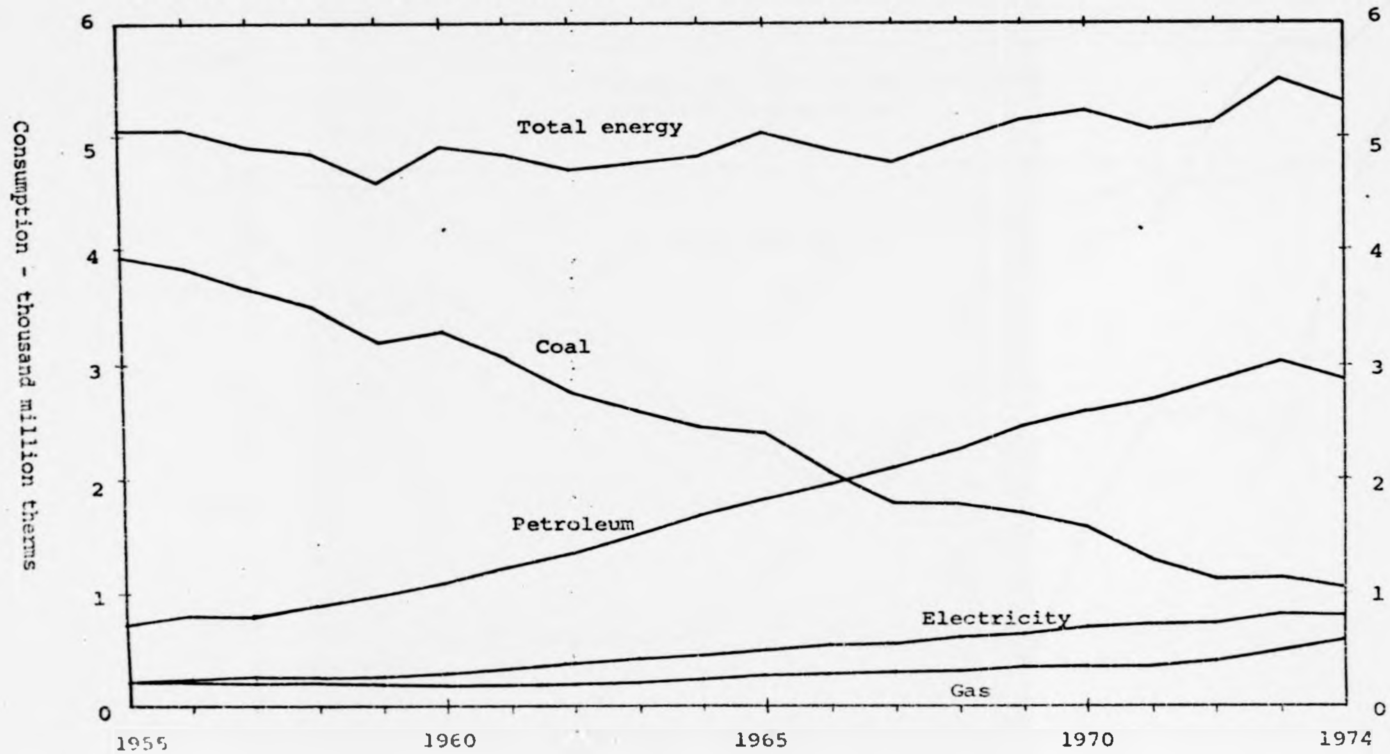

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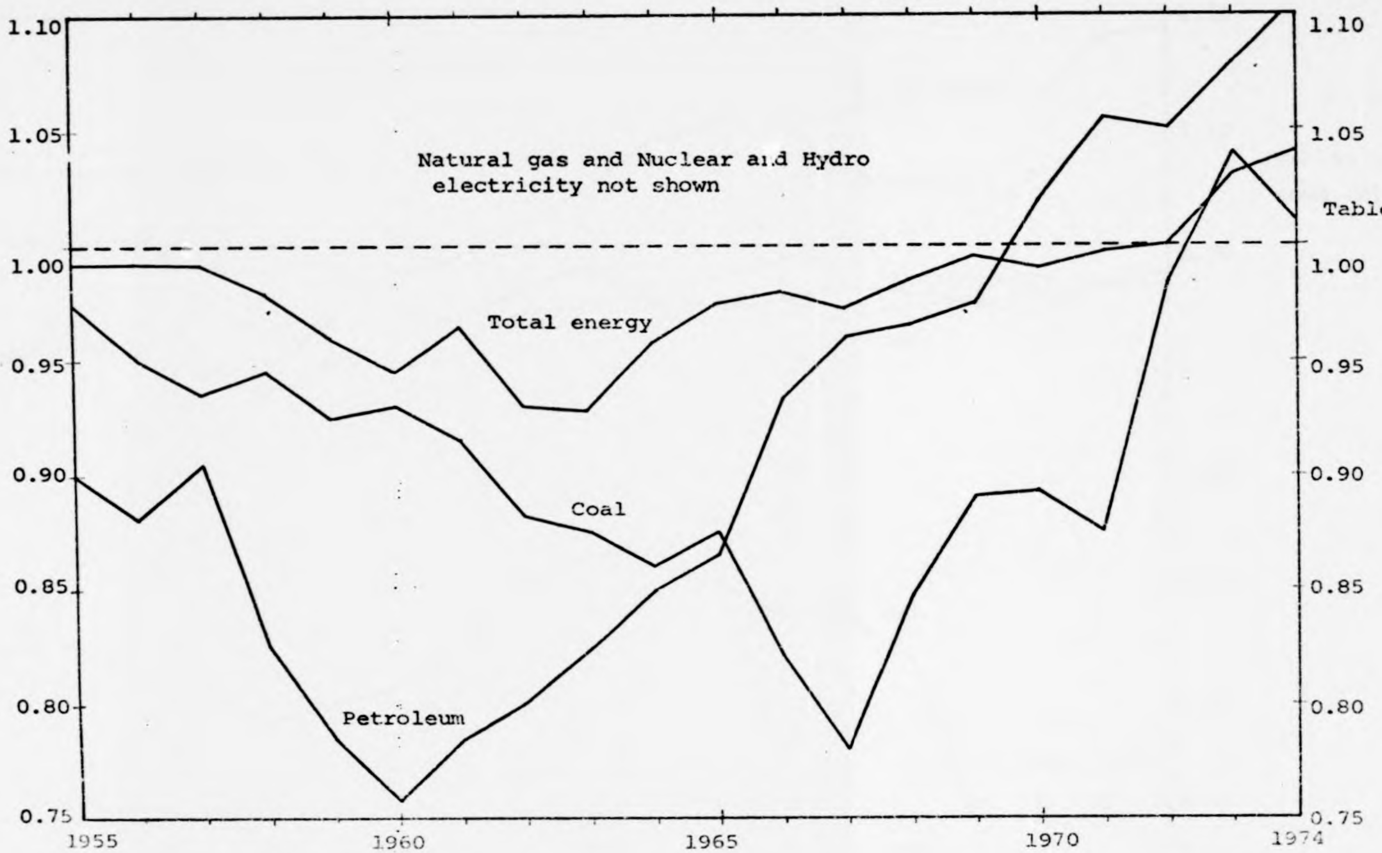
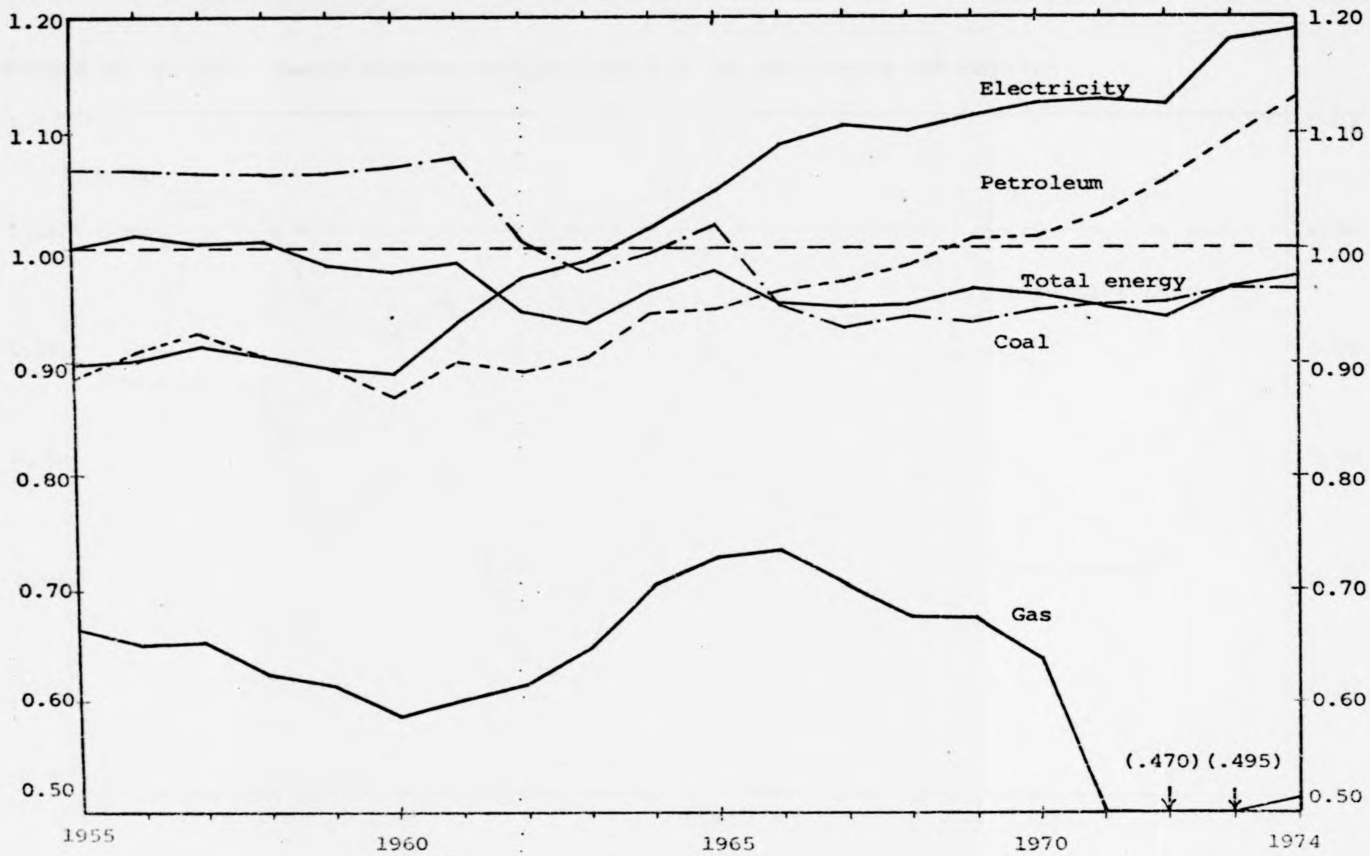
Table 14d

FIGURE No. 5.5 Ratio of per capita consumptions of primary energy; $\frac{\text{Scotland}}{\text{Total U.K.}}$



Sources:
Tables 13, 14 & 27

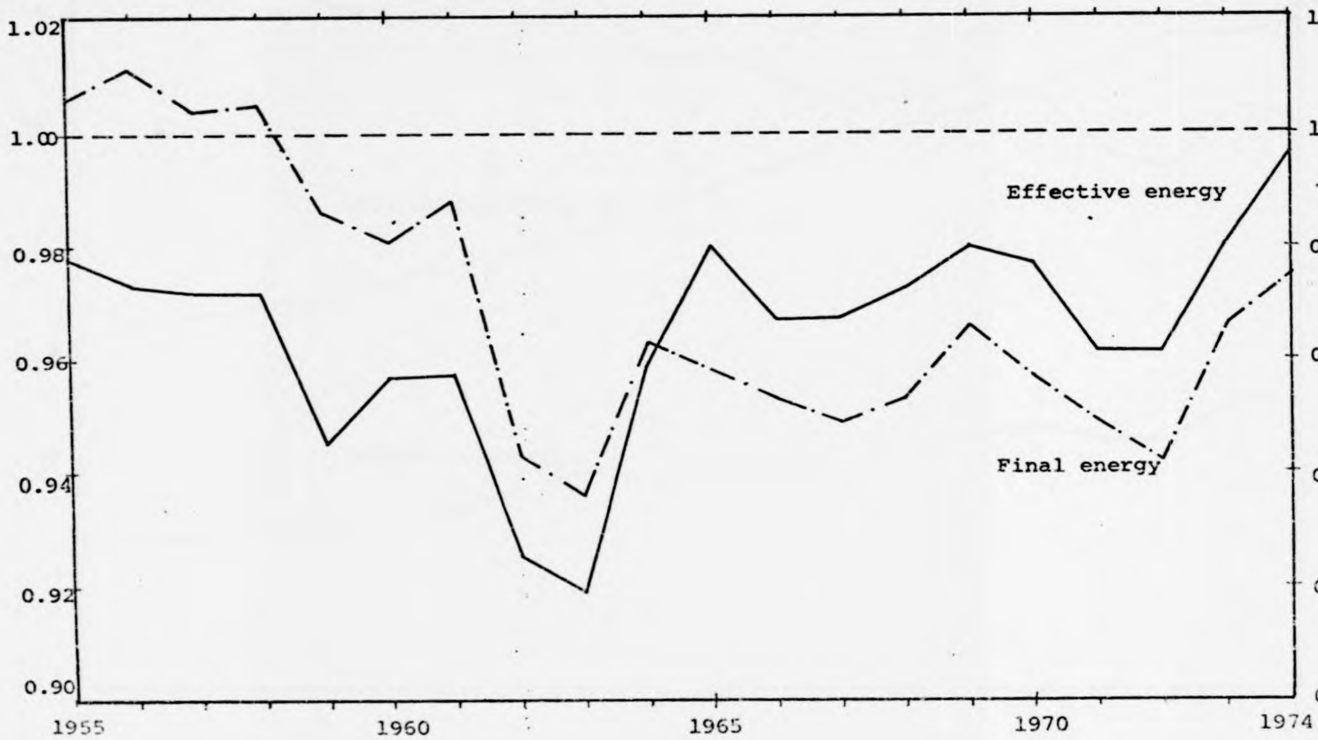
FIGURE No. 5.6(a) Ratio per capita consumptions of final energy: $\frac{\text{Scotland}}{\text{Total U.K.}}$



Sources:

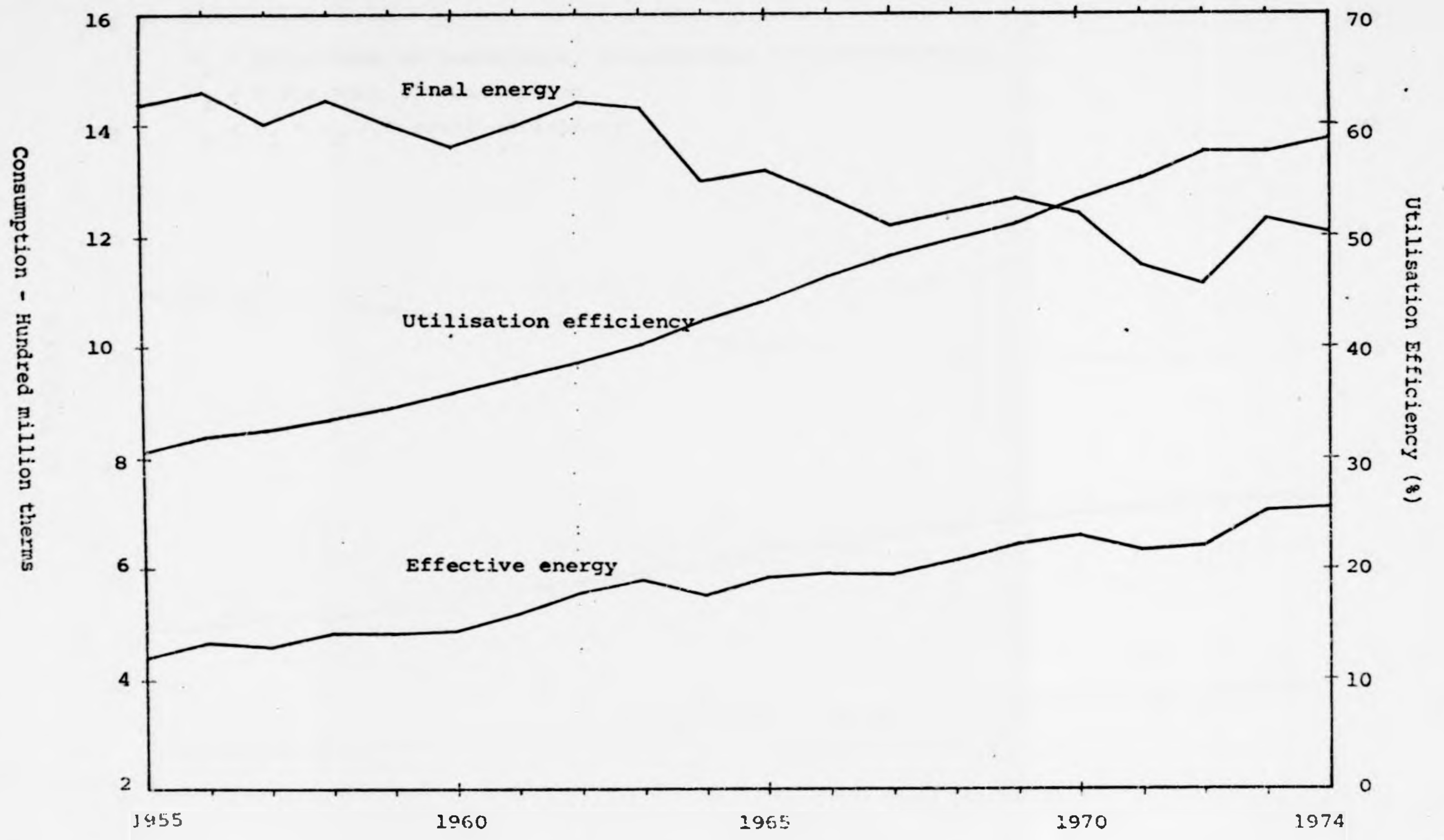
Tables 13, 14 & 27
rows (d) and (i)

FIGURE No. 5.6(b) Ratio between Scotland and U.K. of per capita consumption



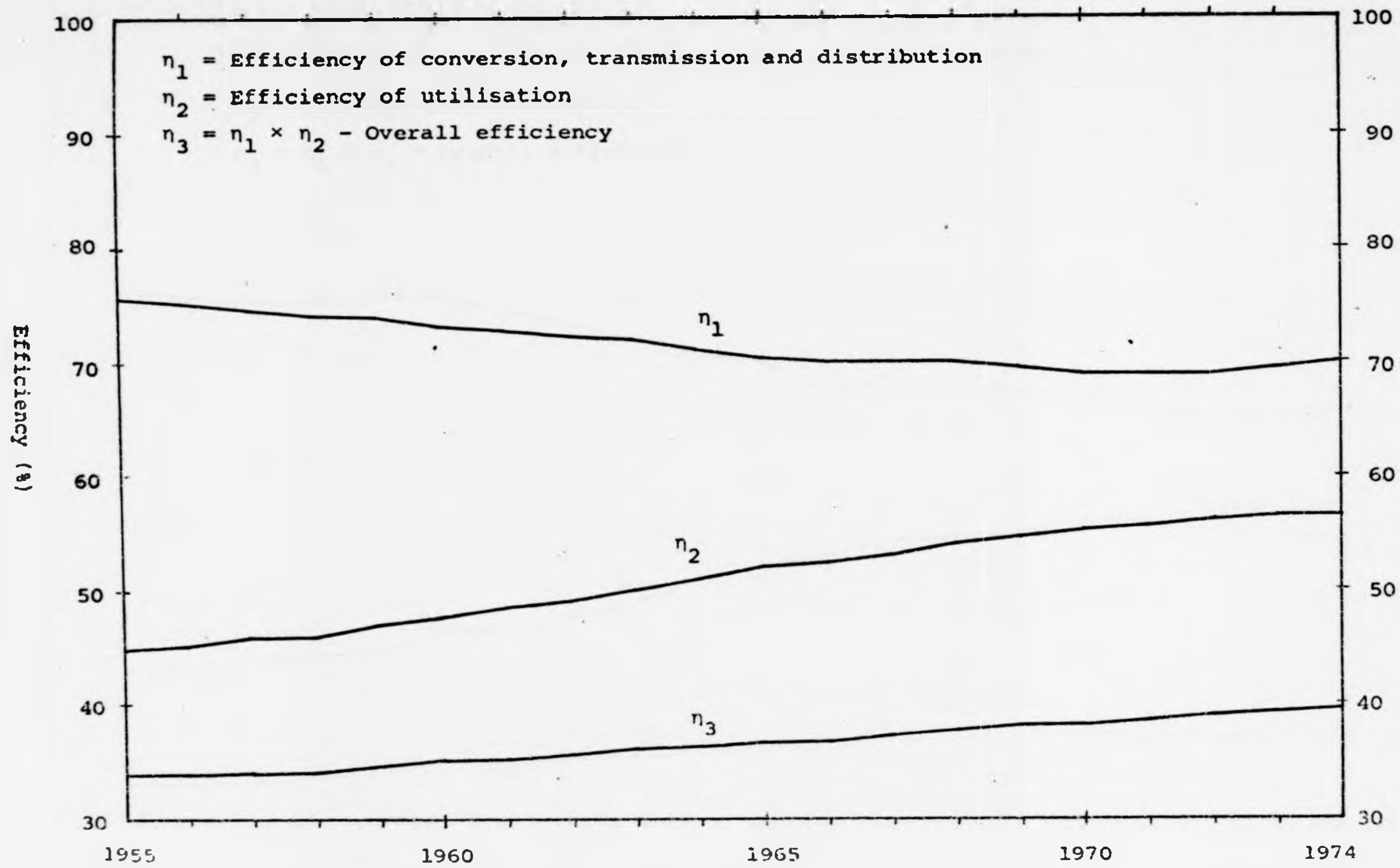
Sources:
Tables 15 & 16

FIGURE No. 5.7 Final energy v. effective energy consumption - Scotland Domestic Sector



Source: Table 16

FIGURE No. 5.8 η_1, η_2 and η_3 for the U.K.



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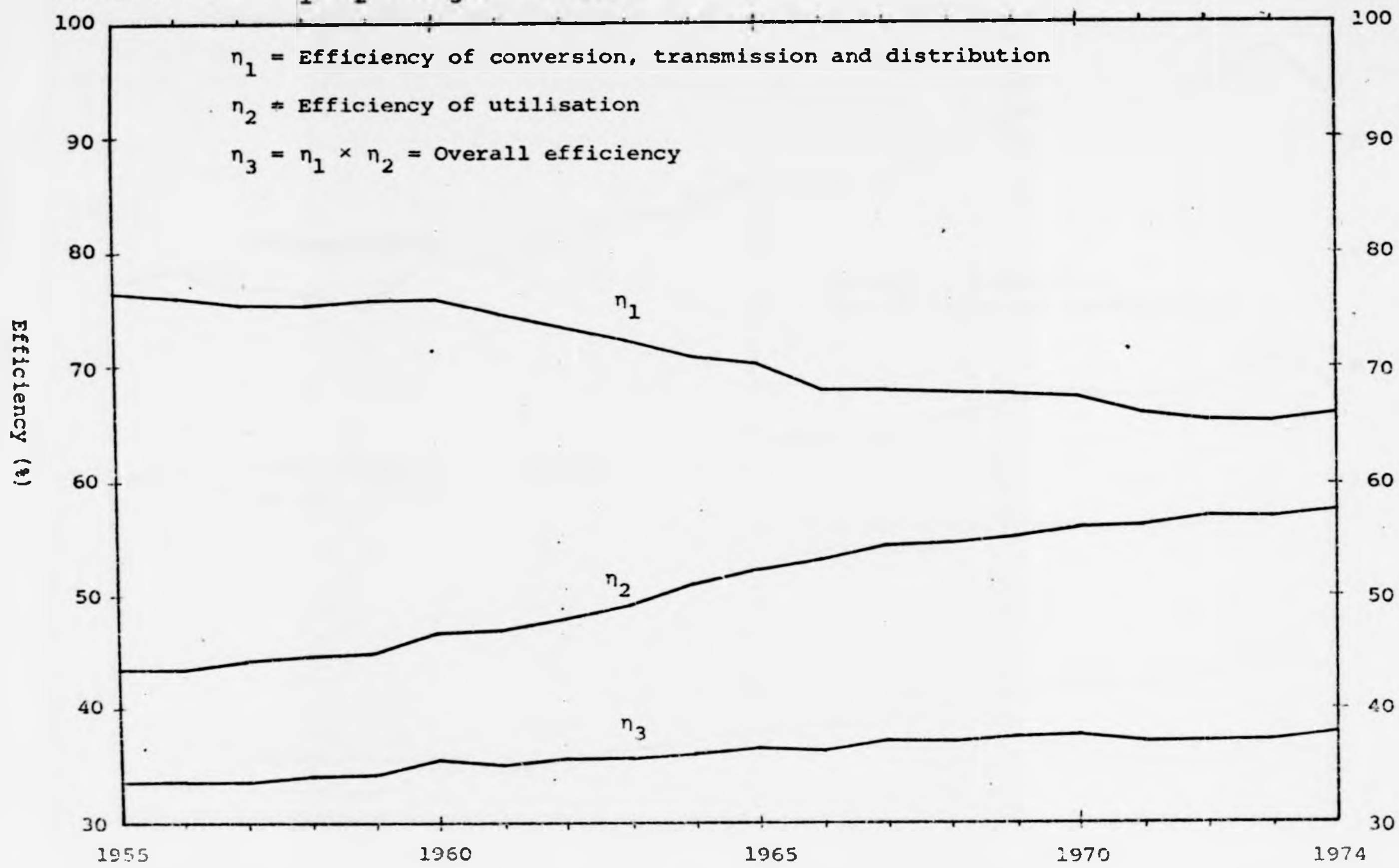
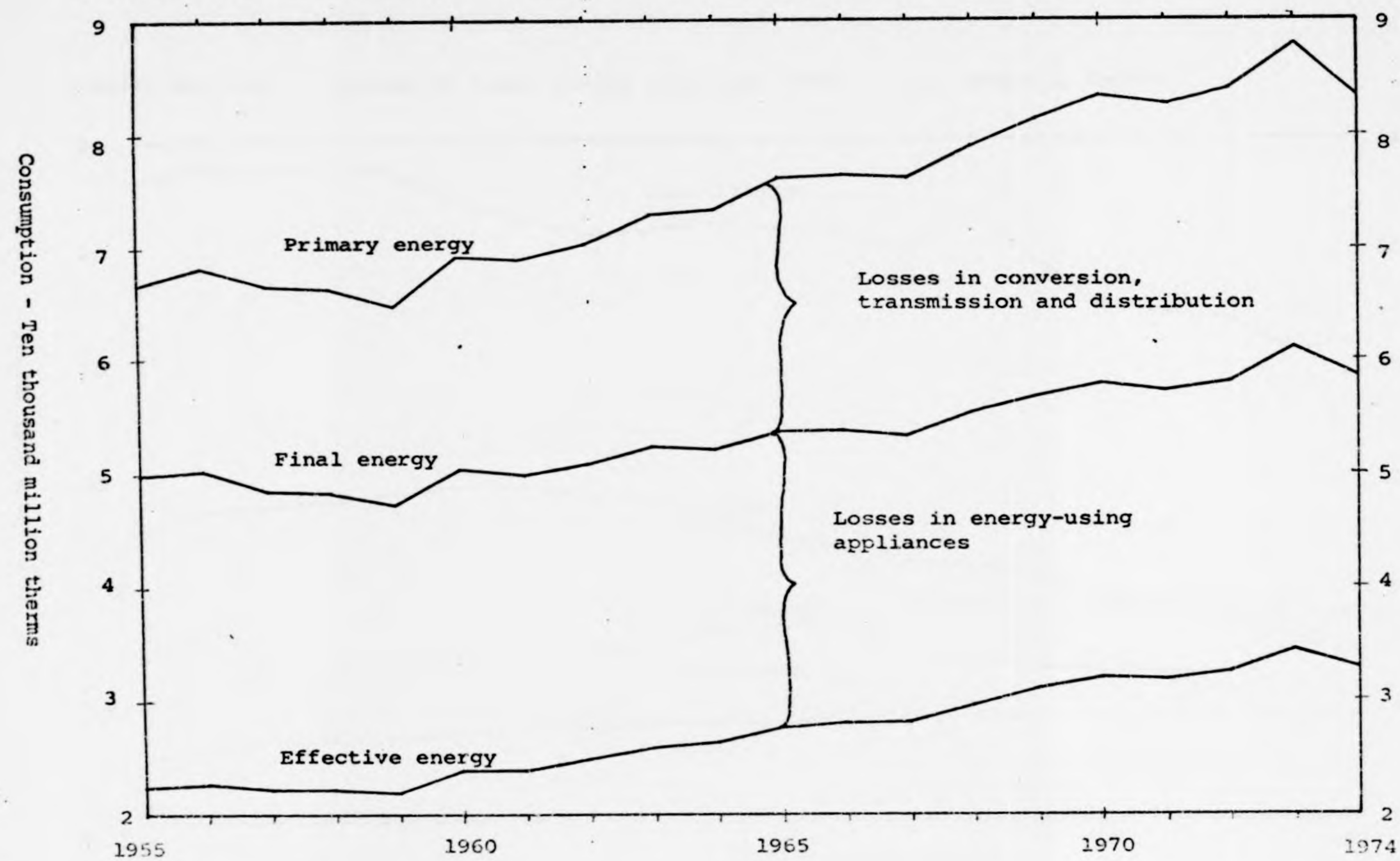
Tables 13 & 15

FIGURE No. 5.9 η_1, η_2 and η_3 for Scotland



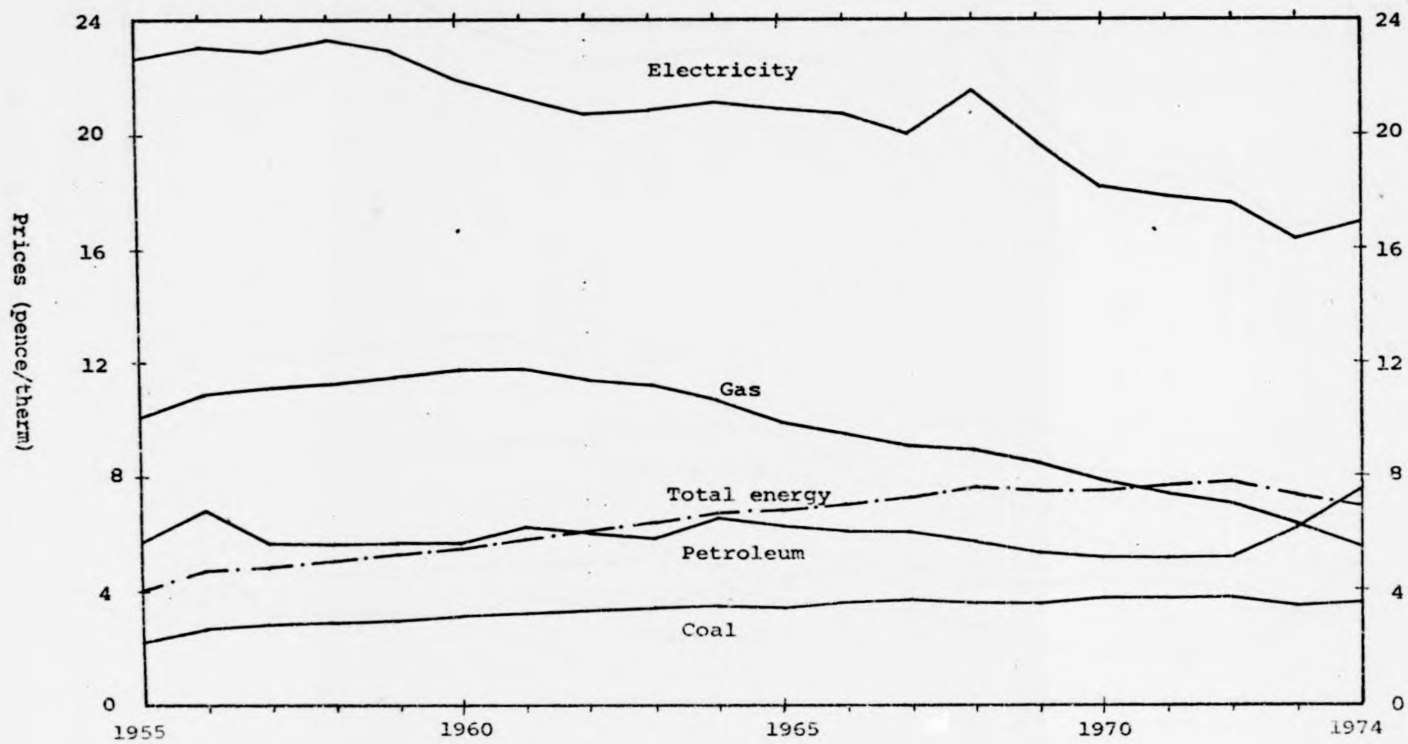
Sources:
Tables 14 & 16

FIGURE No. 5.10 Primary, Final and Effective energy consumptions in the U.K.



Sources:
Tables 13 & 15

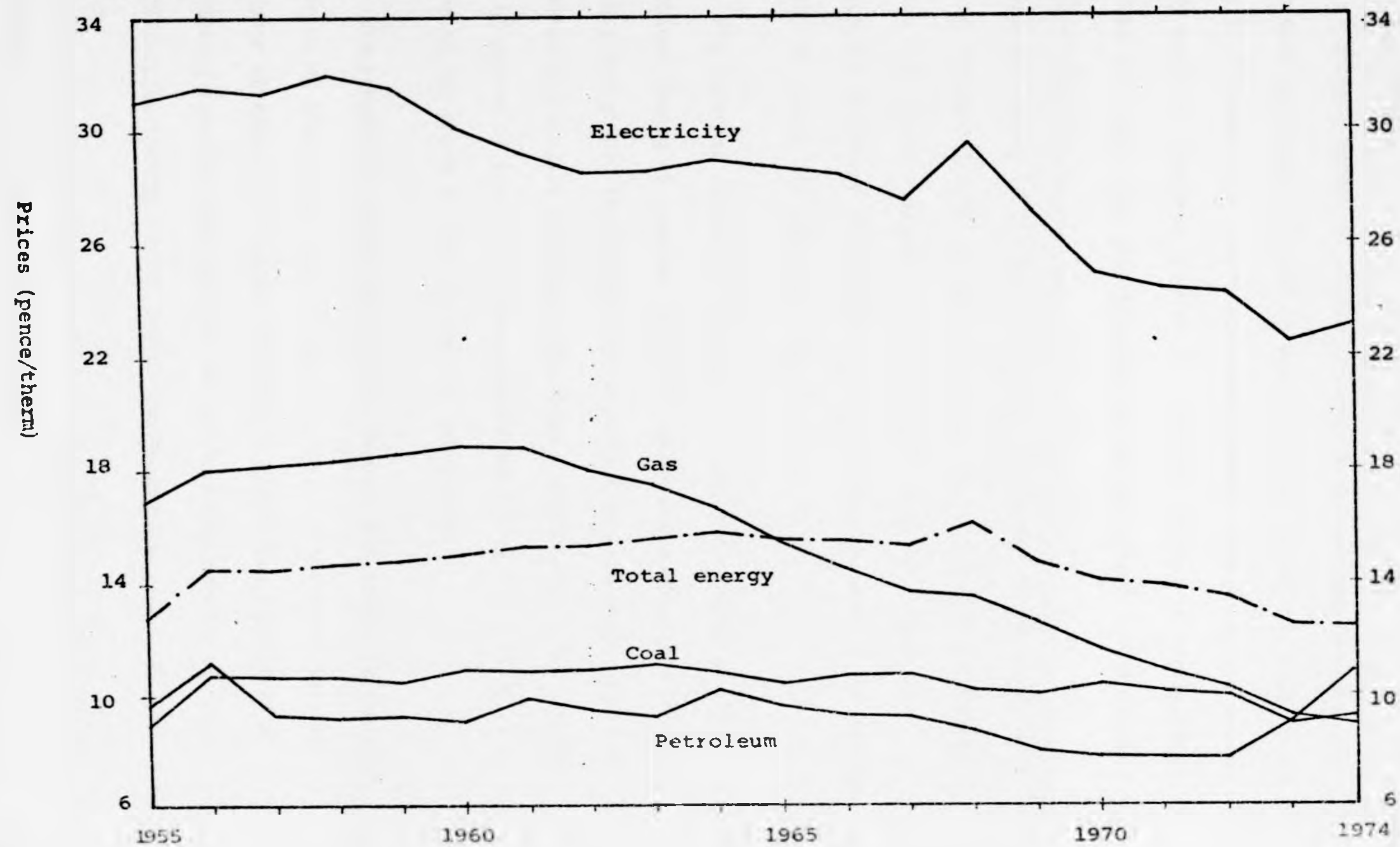
FIGURE No. 5.11 Prices of final energy (constant 1963) - U.K. Domestic Sector



Sources:

Table 21a

FIGURE No. 5.12 Prices of effective energy (constant 1963) - U.K. Domestic Sector



Sources:
Table 23

CHAPTER 6

A Review of Models of Energy Demand

6.1 Introduction

A general survey of studies concerned with energy has been presented in Chapter 4 where it was mentioned (in Section 4.1) that a detail discussion of the studies most closely related to our present study would be given in Chapter 6. Here we discuss in detail three studies concerned with the structure of energy demand. The first study is the one by Jorgenson (1974) which analyses the consumer demand for energy in the United States, the second is the study by Berndt and Wood (1975) concerned with the derived demand for energy in the U.S. manufacturing industry and the third is a study by Hudson and Jorgenson (1974) which analyses both the demand for and the supply of energy for the whole U.S. economy.

The consumer demand for energy is analysed according to the classical theory of consumer behaviour which states that the consumer chooses his goods, from among the range of available goods, so as to maximise his utility subject to his budget constraint. For a given set of prices of the goods, the consumer maximises his utility by choosing the goods in the appropriate quantities.

The industrial demand (or derived demand) for energy is analysed in terms of the theory of producer behaviour which assumes that the producer attempts to minimise his cost of production subject to a production function that defines the relationship between the level of production and the factor inputs (to production).

The three studies mentioned above do not estimate the structure of demand by using the direct utility function or the production function but employ the concept of the duality between quantity and price, and use indirect utility functions and minimum cost functions for estimating consumer demand and derived demand respectively.

In the rest of the chapter we discuss firstly the concept of duality between quantity and price, secondly the form of utility and production function and finally we discuss the methods of analysis and results from the three studies mentioned before.

6.2 The duality theory

6.2.1 The duality between the direct and the indirect utility functions

The utility maximising behaviour of the consumer may be expressed as

$$\text{Maximise } U(X) \text{ where } X = (X_1, X_2 \ldots Xn) \qquad (6.1)$$

$$\text{subject to } \sum^{n} p_i X_i = M \qquad (6.2)$$

where $X_1 \ldots Xn$ are the quantities of goods,

$p_1 \ldots p_n$ are the corresponding prices and

M is the total income (or expenditure)

If we assume that U(X) is well-behaved, i.e. it is continuous, monotonic, twice-differentiable and strictly quasi-concave - the first-order conditions of the above maximisation problem may be written as

$$\frac{\partial u}{\partial X_i} = \lambda p_i \qquad (6.3a)$$

and

$$\sum p_i X_i = M \qquad (6.3b)$$

(6.3a)

where λ may be considered to be the marginal utility of income and equation (6.3) means that the marginal utility of a good is proportional to its price. Our above assumption regarding the nature (well-behaved) of the function will guarantee that the set of equation (6.3) possess a unique solution.

It is helpful to eliminate λ which is done as follows.

Multiplying both side of equation (6.3a) by X_i, we get

$$\frac{\partial u}{\partial X_i} X_i = \lambda p_i X_i \tag{6.4}$$

which leads to

$$\sum^{n} \frac{\partial u}{\partial X_i} X_i = \sum^{n} \lambda p_i X_i = \lambda \sum^{n} p_i X_i \tag{6.5}$$

By substituting $\sum^{n} p_i X_i$ by M from equation (6.2) above, we get

$$\sum^{n} \frac{\partial u}{\partial X_i} X_i = \lambda M \tag{6.6}$$

which leads to

$$\lambda = \frac{\sum^{n} \frac{\partial u}{\partial X_i} X_i}{M} \tag{6.7}$$

Substituting equation (6.7) into equation (6.4), we get

$$\frac{\partial u}{\partial X_i} X_i = \frac{\sum^{n} \frac{\partial u}{X_i} X_i}{M} p_i X_i \tag{6.8}$$

which on transposition gives

$$\frac{\frac{\partial u}{\partial X_i} X_i}{\sum^{n} \frac{\partial u}{\partial X_i} X_i} = \frac{p_i X_i}{M} = \sigma_i \tag{6.9}$$

where σi is the share of expenditure by the ith good.

Equation (6.9) shows that if the utility function U had a functional form and if the quantities of goods bought and their share of expenditure could be observed, we could, in principle, estimate the utility function.

Equation (6.1) is called the direct utility function. The indirect utility function is defined on prices (instead of quantities) and income and it can be shown that the indirect utility function is the dual of the direct utility function. We begin by defining the indirect utility function as

$$V = V(p_1 \ldots p_n, M) \equiv \text{Max } U(X) \quad \text{subject to} \sum p_i X_i = M \qquad (6.10)$$

where V represents the maximum utility, for the given set of prices and income.

The first derivatives of the indirect utility function (6.10) can be shown to be (by Diewert (1974)),

$$\frac{\partial V}{\partial M} = \lambda \qquad \text{and} \qquad \frac{\partial V}{\partial p_i} = -\lambda X_i \qquad (6.11)$$

which gives

$$X_i = \frac{-\dfrac{\partial V}{\partial p_i}}{\dfrac{\partial V}{\partial M}} \qquad (6.12)$$

Now V is homogeneous of degree zero in prices and income and hence, by Euler's theorem,

$$\sum \frac{\partial V}{\partial p_i} p_i + \frac{\partial V}{\partial M} M = 0 \qquad (6.13)$$

Multiplying both sides of equation (6.12) by $\frac{p_i}{M}$ we get

$$\frac{p_i X_i}{M} = \frac{-\dfrac{\partial V}{\partial p_i} p_i}{M \dfrac{\partial V}{\partial M}} \qquad (6.14)$$

Equation (6.13) gives

$$\frac{\partial V}{\partial M} M = -\sum \frac{\partial V}{\partial p_i} p_i \qquad (6.15)$$

Substituting equation (6.15) into (6.14) we get

$$\sigma_i = \frac{p_i X_i}{M} = \frac{\dfrac{\partial V}{\partial p_i} p_i}{\sum \dfrac{\partial V}{\partial p_i} p_i} \qquad (6.16)$$

It can be seen that the equation (6.16) is equivalent to that of equation (6.9) for the direct utility function.

The important results due to the existence of duality between the direct and the indirect utility function may be summarised as follows:

(1) The equations (6.3) and (6.11) express the dual relationship between quantity and price.

(2) Equation (6.16) shows that if the form of the direct utility function is known, the indirect utility function can be estimated.

(3) Equation (6.12) shows that the demand functions can be obtained by simple differentiation of the indirect utility function.

(4) Equation (6.10) shows how the indirect utility function is derived from the direct utility function. It is also possible to derive the direct utility function from the indirect utility function.

(5) Knowledge of the direct utility function is exactly equivalent to the knowledge of the indirect utility function, since one can be derived from the other. Information such as elasticity of substitution can be obtained from both the direct and the indirect utility functions.

6.2.2 The duality between the production function and the cost function

The production function

$$Y = f\ (x) \quad \text{where} \quad X = (X_1,\ X_2\ \ldots\ X_n) \qquad (6.17)$$

means that y is the maximum output (i.e. y_{max}) that can be produced from factor inputs X_i where $i = 1 \ldots n$.

A profit maximising producer operating in perfect factor market, will wish to minimise cost of production for any given level of output i.e. he will seek to minimise

$$\sum^{n} p_i X_i = C, \text{ for } y = f(x) \qquad (6.18)$$

where p_i's are the cost of factor inputs and C is the total cost.

The first order conditions for (6.18) may be written as

$$p_i = \gamma \frac{\partial f}{\partial X_i} \qquad \text{and} \qquad y = f(x) \tag{6.19}$$

As in the case of direct utility function, γ can be eliminated to give,

$$\sigma_i = \frac{p_i X_i}{\sum p_i X_i} = \frac{f_i X_i}{\sum f_i X_i} \tag{6.20}$$

where σ_i is the share of the ith factor input in total cost,

and $f_i = \frac{\partial f}{\partial X_i}$.

If the production function represented by (6.17) is well behaved (which means monotonicity and quasi-concavity), the producer behaviour (6.18) may be expressed by the dual cost function. This cost function may be written as

$$C = C(y, p_1 \ldots p_n) \equiv \text{Min} \sum p_i X_i \quad \text{subject to} \quad y = f(x) \tag{6.21}$$

The set of first-order derivatives of (6.21) may be written as

$$\left.\begin{aligned} \frac{\partial C}{\partial p_i} &= X_i \\ \sum p_i X_i &= C \end{aligned}\right\} \tag{6.22}$$

As before it can be shown that

$$\sigma_i = \frac{p_i X_i}{C} = \frac{p_i X_i}{\sum p_i X_i} = \frac{\frac{\partial C}{\partial p_i} p_i}{\sum \frac{\partial C}{\partial p_i} p_i} \tag{6.23}$$

Equation (6.22) shows that the derived demand function can be obtained by simply differentiating the cost function. Equations (6.19) and (6.22) show the dual relationship between the production function and cost functions. As in the case of the utility function, the cost function can be obtained from the production function and vice versa.

In all cases, i.e. whether it is production, cost, utility or indirect utility function the objective is to estimate the parameters of a function f from a set of equations

$$\sigma_i = \frac{f_i X_i}{\sum f_i X_i}$$

The estimation is possible if and only if the function form is known. A number of functional forms have been used in economic analysis and we proceed to discuss the major features of the functional forms.

6.3 Principal Functional Forms

The functional form that probably has been used most widely is the one known as Cobb-Douglas function which may be written as

$$Y = A X_1^{\alpha} X_2^{\beta} \quad (6.24)$$

where Y is the output

X_1 and X_2 are factor inputs.

The properties of this function may be summarised as follows:

(1) α and β are the elasticities of production with respect to X_1 and X_2 respectively

(2) The production function is homogeneous of degree $\alpha + \beta$. If $\alpha + \beta > 1$, the function has an increasing returns to scale; if $\alpha + \beta = 1$, constant returns to scale (CRTS); $\alpha + \beta < 1$, decreasing returns to scale. The "returns to scale" is an indicator which shows whether, as X_1 and X_2 increase in proportion, Y increases in greater, equal or less proportion.

(3) Marginal productivity of any factor input decreases with increasing value of that input. Specifically

$$\frac{\partial^2 Y}{\partial X_1^2} = \frac{\alpha(\alpha-1)\, Y}{X_1^2}$$

and is negative if $\alpha > 1$. Similar condition holds for X_2 as well.

(4) The marginal rate of substitution is $\frac{\alpha X_1}{\beta X_2}$ and the elasticity of substitution is unity.

Two special properties of functions that are considered important for economic analysis are called additivity and homotheticity, which are explained below.

A function is additive if the inputs are independent of each other i.e. there is no interaction between the inputs. A function $f(X_1, X_2)$ is defined to be additive if there is a transformation h such that

$$g(X_1, X_2) = h[f(X_1, X_2)] \quad \text{and} \quad \frac{\partial^2 g}{\partial X_1 \, \partial X_2} \equiv 0 \qquad (6.25)$$

The Cobb-Douglas function (6.24) is additive.

A function is homothetic if the marginal rates of substitution between the inputs is same for a given ratio of the inputs i.e. for a function $y = f(X_1, X_2)$,

$$\text{if } \frac{\frac{\partial y}{\partial X_1}}{\frac{\partial y}{\partial X_2}} = \text{a constant for a given } \frac{X_1}{X_2} \qquad (6.26)$$

A more limiting form of homotheticity is that of homogeneity where the function not only satisfies equation (6.26) but also the equation

$$\lambda^K f(X_1, X_2) = f(\lambda^K X_1, \lambda^K X_2) \qquad (6.27)$$

The equation (6.27) represents a function f that is homogeneous of degree K. If K = 0, the equation (6.27) transforms to

$$\lambda f(X_1, X_2) = f(\lambda X_1, \lambda X_2) \qquad (6.28)$$

The function F of (6.28) is said to be homogeneous of degree 1 or that it is a function with constant return to scale.

The Cobb-Douglas function of (6.24) is homogeneous of degree $\alpha + \beta$.

The Leontief production function is based on the property of non-substitutability between factor inputs and may be written as

$$Y = \alpha X_1 = \beta X_2 \qquad (6.29)$$

or

$$Y = \min \text{ of } (\alpha X_1, \beta X_2) \qquad (6.30)$$

where Y is the output and X_1, X_2 are the factor inputs.

A more general form of production function is the one known as the CES (constant elasticity of substitution) which reduces both the Cobb-Douglas and the Leontief functions as special cases (with elasticity of substitution of 1 and 0 respectively). The CES function may be written as

$$Y = \gamma \left[\delta X_1^{-\rho} + (1 - \delta) X_2^{-\rho} \right]^{-\frac{\mu}{\rho}} \qquad (6.31)$$

where Y is output, X_1 and X_2 are factor inputs.

This function has a constant elasticity of substitution given by $\sigma = \frac{1}{1-\rho}$, so that when $\rho \to 0$, $\sigma \to 1$ and the CES function reduces to that of the Cobb-Douglas and when $\rho \to \infty$, $\sigma \to 0$ and the function becomes similar to that of the Leontief type. The parameter μ determines the return to scale, so that if $\mu > 1$ the function has an increasing returns to scale; if $\mu = 1$, a constant returns to scale; and if $\mu < 1$, a decreasing returns to scale.

The three functions discussed above, all of which are basically CES have properties of additivity and homotheticity. In fact, it may be shown that if any function is both additive and homothetic it is necessarily CES. The lack of generality of the CES function due to the underlying properties of additivity and homotheticity has led to the formulation of alternative function forms for the production, cost, utility and the indirect utility functions.

(1) The generalised Cobb-Douglas function may be written as

$$Y = \alpha_0 + \alpha_1 \log X_1 + \alpha_2 \log X_2 + \alpha_3 \log (1 + X_1) + \alpha_4 \log (1 + X_2) + \alpha_5 \log (X_1 + X_2) \qquad (6.32)$$

which is neither additive nor homothetic.

(2) Diewert (1971) has proposed a functional form called generalised Leontief which in a simplified form, may be written as

$$Y = \sum_i \sum_j a_{ij} X_1^{\frac{1}{2}} X_i^{\frac{1}{2}} \qquad (6.33)$$

(3) Christensen et al (1971) (1973) have proposed a functional form called transcendental logarithmic, which may be expressed as

$$\ln Y = \ln \alpha_0 + \sum_i \alpha_i \ln X_i + \sum_i \sum_j \alpha_{ij} \ln X_i \ln X_j \qquad (6.34)$$

Since the three studies under review in this section (i.e. Jorgenson (1974), Berndt and Wood (1975) and Hudson and Jorgenson (1974) use the transcendental logarithmic (or TRANSLOG for short) function, we examine more closely the form and properties of this function in the following section.

6.4 Transcendental logarithmic functions

If technical change is ignored, the translog production function may be written as in equation (6.34),

$$\ln Y = \ln \alpha_0 + \sum_i \alpha_i \ln X_i + \sum_i \sum_j \alpha_{ij} \ln X_i \ln X_j \qquad (6.34)$$

The translog function may be constructed either in the direct form or in the dual form as discussed earlier. It has certain special properties which makes it very convenient for demand studies and these properties may be summarised as follows:

(1) The function is not necessarily additive and whether the function is additive or not may be tested easily. For the function shown in (6.34), the additivity condition is satisfied if $\alpha_{ij} = 0$ for $i \neq j$.

(2) The function is not necessarily homothetic and can be easily tested for homotheticity. The function shown in (6.34) is homothetic if $\alpha_{ii} = 0$.

(3) The translog function is not well-behaved globally, but can be tested to see if it is well-behaved in the region under consideration. If the cost shares of all inputs are non-negative (i.e. $\sigma_i \geq 0$) then the translog (production) function satisfies the condition of monotonicity. The isoquants of the translog (production) function can be shown to be strictly convex if the corresponding bordered Hessian matrix of first and second partial derivatives is negative definite. This can be tested at each data point.

(4) The translog function provides a local second-order approximation to any general function. This means that given any function $f(\cdot)$ and any point $\bar{X}$, one can find values for the parameters of the translog function such that at the point $\bar{X}$ the value of the function $f(\cdot)$ and of its first- and second-order derivatives, equal the values of the translog function and its first- and second-order derivatives.

Since the elasticity of substitution depends only on the second-order terms, the elasticity can be estimated without having to estimate the utility function directly.

(5) If the translog function is additive and homothetic, it is Cobb-Douglas i.e. it has an elasticity of substitution of 1 between factor inputs. This limitation of the translog function will be discussed further in Chapter 9 while discussing our model.

We now proceed to discuss the three demand studies mentioned earlier.

6.5 Consumer demand for energy by Jorgenson (1974)

This study analyses consumer demand for energy in the U.S. during the period between 1947 and 1971, by a model that allocates personal consumption expenditure among three commodities: capital services (K), energy (E) and non-durables (N). Capital services includes housing services and services of consumers' durables; the stock of housing and consumers' durables corresponding to the stock of energy-using equipment and structure. Energy includes all types of energy - coal, gas, petroleum and electricity. Non-durables include all other items of personal consumption such as food, clothing etc.

The indirect utility function (explained in equation 6.10 earlier) is represented by a function which is quadratic in the logarithms of ratio of prices to total expenditure. Time is also introduced in the function as a variable to permit preferences to change over time. The resulting indirect utility function provides a local second-order approximation to any indirect utility function.

The indirect translog utility function is expressed as

$$\ln V = \alpha_o + \sum_i {}_i \log \frac{P_i}{M} + \alpha_t.t + \tfrac{1}{2} \sum_i \sum_j \beta_{ij} \log \frac{P_i}{M} \log \frac{P_j}{M} + \tfrac{1}{2} \beta_{tt}.t^2 \qquad (6.35)$$

where V is the utility

P_i . is the price of the ith good

M is the total expenditure, $M = P_K.K + P_E.E + P_N.N$ in this case.

The share of expenditure (budget share) by the three commodities may be expressed in general terms to be

$$\sigma i = \frac{\dfrac{\partial V}{\partial (P_i/M)} \dfrac{P_i}{M}}{\sum^n \dfrac{\partial V}{\partial (P_i/M)} \dfrac{P_i}{M}} \qquad (6.36)$$

which, in this case, give three equations which are

$$\frac{P_K.K}{M} = \frac{\alpha_K + \beta_{KK} \ln \frac{P_K}{M} + \beta_{KE} \ln \frac{P_E}{M} + \beta_{KN} \ln \frac{P_N}{M} + \beta_{Kt}.t}{\alpha_M + \beta_{MK} \ln \frac{P_K}{M} + \beta_{ME} \ln \frac{P_E}{M} + \beta_{MN} \ln \frac{P_N}{M} + \beta_{Mt}.t} \qquad (6.37)$$

$$\frac{P_E.E}{M} = \frac{\alpha_E + \beta_{EK} \ln \frac{P_K}{M} + \beta_{EE} \ln \frac{P_E}{M} + \beta_{EN} \ln \frac{P_E}{M} + \beta_{Et}.t}{\alpha_M + \beta_{MK} \ln \frac{P_K}{M} + \beta_{ME} \ln \frac{P_E}{M} + \beta_{MN} \ln \frac{P_N}{M} + \beta_{Mt}.t} \qquad (6.38)$$

$$\frac{P_N.N}{M} = \frac{\alpha_N + \beta_{NK} \ln \frac{P_K}{M} + \beta_{NE} \ln \frac{P_E}{M} + \beta_{NN} \ln \frac{P_N}{M} + \beta_{Nt}.t}{\alpha_M + \beta_{MK} \ln \frac{P_K}{M} + \beta_{ME} \ln \frac{P_E}{M} + \beta_{MN} \ln \frac{P_N}{M} + \beta_{Mt}.t} \qquad (6.39)$$

where

$$\left.\begin{aligned} \alpha_M &= \alpha_K + \alpha_E + \alpha_N \\ \beta_{MK} &= \beta_{KK} + \beta_{EK} + \beta_{NK} \\ \beta_{ME} &= \beta_{KE} + \beta_{EE} + \beta_{NE} \\ \beta_{MN} &= \beta_{KN} + \beta_{EN} + \beta_{NN} \\ \beta_{Mt} &= \beta_{Kt} + \beta_{Et} + \beta_{Nt} \end{aligned}\right\} \qquad (6.40)$$

The budget constraint implies that

$$\frac{P_K.K}{M} + \frac{P_E.E}{M} + \frac{P_N.N}{M} = 1 \qquad (6.41)$$

Since the equations 6.37, 6.38 and 6.39 are homogeneous of degree zero in the parameters, the parameters are conveniently normalised by

$$\alpha_M = \alpha_K + \alpha_E + \alpha_N = -1 \qquad (6.42)$$

The parameters of the model (equations 6.37, 6.38 and 6.39) are estimated first subject to the seven equality and symmetry restrictions (5 restrictions of equation 6.40, one each of 6.41 and 6.42) for estimating own-price and income elasticities of demand for energy and non-energy products and cross-price elasticities of demand among capital services (K), energy (E) and non-durables (N). Later, a series of restrictions are applied to test various separability and homotheticity criteria.

The important conclusions of Jorgenson may be summarised as follows:

(1) The income elasticity of demand for energy is negative throughout the period 1947 - 1971, implying that energy is an inferior good. At the beginning of the period the negative income elasticity is large in value, towards the end of the period this elasticity approaches zero.

(2) The own-price elasticity of demand for energy is small and positive at the beginning of the period, at the end of the period this own-price elasticity is negative and substantial in magnitude - but all throughout the demand for energy is inelastic with respect to price (i.e. elasticity < 1).

(3) Both capital services and non-durables have substantial income elasticity throughout the period.

(4) The cross-price elasticities of demand for energy with respect to the prices of capital services and non-durables are positive, very substantial in magnitude and decreasing throughout the period 1947-1971.

6.6 Technology, prices and the derived demand for energy - by Berndt and Wood (1975)

The purpose of this study is to analyse the structure of demand for energy in the U.S. manufacturing sector during 1947 to 1971. The concept behind the model is that there exists a twice-differentiable production function that relates the total cost of production (G) to the flow of output (Y) and four inputs which are capital (K), labour (L), energy (E) and all other intermediate materials (M).

Corresponding to such a production function, there must exist a cost function (which is its dual, as explained in equation 6.4). If constant returns to scale and Hicks-neutral technical change (Hicks-neutrality is obtained when technical progress is (1) disembodied and (2) the production function shifts over time by a uniform upward displacement of the whole function) is assumed then G may be expressed as:

$$G = G\,(Y,\ P_K,\ P_L,\ P_E,\ P_M) \qquad (6.43)$$

where P_K, P_L, P_E and P_M are the input prices of K, L, E and M respectively.

Berndt and Wood assume a translog functional form for (6.16) and imposing symmetry restruction, equation 6.16 is expressed as

$$\begin{aligned}\ln G = {} & \ln \alpha_0 + \ln Y + \alpha_K \ln P_K + \alpha_L \ln P_L + \alpha_E \ln P_E + \alpha_M \ln P_M \\ & + \tfrac{1}{2}\gamma_{KK} (\ln P_K)^2 + \gamma_{KL} \ln P_K \ln P_L + \gamma_{KE} \ln P_K \ln P_E \\ & + \gamma_{KM} \ln P_K \ln P_M + \tfrac{1}{2}\gamma_{LL} (\ln P_L)^2 + \gamma_{LE} \ln P_L \ln P_E + \gamma_{LM} \ln P_L \ln P_M \\ & + \tfrac{1}{2}\gamma_{EE} (\ln P_E)^2 + \gamma_{EM} \ln P_E \ln P_M + \tfrac{1}{2}\gamma_{MM} (\ln P_M)^2 \qquad (6.44)\end{aligned}$$

Linear homogeneity in prices impose the following restrictions:

$$\left.\begin{aligned} & \alpha_K + \alpha_L + \alpha_E + \alpha_M = 1 \\ & \gamma_{KK} + \gamma_{KL} + \gamma_{KE} + \gamma_{KM} = 0 \\ & \gamma_{KL} + \gamma_{LL} + \gamma_{LE} + \gamma_{LM} = 0 \\ & \gamma_{KE} + \gamma_{LE} + \gamma_{EE} + \gamma_{EM} = 0 \\ & \gamma_{KM} + \gamma_{LM} + \gamma_{EM} + \gamma_{MM} = 0 \end{aligned}\right\} \qquad (6.45)$$

The cost share for each of the inputs, (K, L, E and M) may be expressed in general terms as (in earlier equation 6.36)

$$\sigma_i = \frac{\frac{\partial G}{\partial P_i} P_i}{\sum_i \frac{\partial G}{\partial P_i} P_i} \qquad (6.46)$$

From 6.46, 4 equations of input cost shares are obtained as:

$$\frac{P_K.K}{G} = \alpha_K + \gamma_{KK} \ln P_K + \gamma_{KL} \ln P_L + \gamma_{KE} \ln P_E + \gamma_{KM} \ln P_M \qquad (6.47)$$

$$\frac{P_L.L}{G} = \alpha_L + \gamma_{KL} \ln P_K + \gamma_{LL} \ln P_L + \gamma_{LE} \ln P_E + \gamma_{LM} \ln P_M \qquad (6.48)$$

$$\frac{P_E.E}{G} = \alpha_E + \gamma_{KE} \ln P_K + \gamma_{LE} \ln P_L + \gamma_{EE} \ln P_E + \gamma_{EM} \ln P_M \qquad (6.49)$$

$$\frac{P_M.M}{G} = \alpha_M + \gamma_{KM} \ln P_K + \gamma_{LM} \ln P_L + \gamma_{EM} \ln P_E + \gamma_{MM} \ln P_M \qquad (6.50)$$

where the total cost is $G = P_K.K + P_L.L + P_E.E + P_M.M$ (6.51)

The elasticity of substitution of σ_{ij} may be written as

$$\sigma_{ij} = \frac{G\, G_{ij}}{G_i\, G_j} \text{ where } G_i = \frac{\partial G}{\partial P_i},\ G_j = \frac{\partial G}{\partial P_j} \text{ and } G_{ij} = \frac{\partial^2 G}{\partial P_i\, \partial P_j} \qquad (6.52)$$

The price elasticity of demand for factors of production E_{ij} is defined as

$$E_{ij} = \frac{\partial \ln X_i}{\partial \ln P_k} \text{ where } X_i = \frac{\partial G}{\partial P_i} \qquad (6.53)$$

This expression for E_{ij} has been alternatively defined by Allen (1972) as

$$E_{ij} = M_j\, \sigma_{ij} \qquad (6.54)$$

where M_j are the cost shares of the input.

By iterative three-stage least square (I3SLS) estimates, Berndt and Wood obtained price elasticities and partial elasticities of substitution between K, L, E, and M. The main conclusions from this study may be summarised as follows:

(1) The own price elasticity (E_{EE}) of energy is substantial, having an average value of approximately -0.47 which implies that the demand for energy is responsive to a change in price.

(2) Own price elasticities of capital and labour (E_{KK} and E_{LL}) which are 0.48 and -0.45 respectively are substantial.

(3) Energy and labour are slightly substitutable; the estimated value of σ_{LE} being 0.65.

(4) Capital and labour are substitutable; the estimated value of σ_{KL} being 1.00.

(5) Energy and capital are not substitutable but complementary; the estimated value of σ_{KE} being -3.2.

6.7 U.S. energy policy and economic growth, 1975-2000 by Hudson and Jorgenson (1974)

The purpose of this study is to assess the impact of economic policy on both the supply and demand of energy. The approach is based on an integration of econometric modelling (useful for studying demand) and input-output analysis (useful for detailed study of supply at a point of time). The model includes an inter-industry model for nine sectors of the U.S. economy (five of these sectors make up the energy sector of the economy), models for final demand and a growth model of the U.S. economy. This model is used for the Ford Foundation Energy Policy Project as discussed earlier in Section 4.3.4.

The inter-industry model includes models of producer behaviour for each of the nine industrial sectors. Four groups of aggregate inputs are defined which are

(1) Capital (K)

(2) Labour (L)

(3) Energy (E), which consists of inputs of (1) coal, (2) crude petroleum and natural gas, (3) refined petroleum products, (4) electricity and (5) town-gas.

(4) Materials (M), which consists of inputs of (1) agriculture, (2) manufacturing, (3) transport, (4) trade, communications and services and (5) competitive imports from non-energy sectors.

This model is estimated by using an indirect translog function which expresses the output as a function of the logarithms of the price of inputs. The form of the function is similar to that used by Bernd and Wood, as described earlier in Section 6.3.

In this producer behaviour model two other models in addition to that of the above are estimated, still using the translog functions. The first model gives the price of aggregate energy input in each industry as a function of the five energy types, (1) coal, (2) crude petroleum and natural gas, (3) refined petroleum products, (4) electricity and (5) town-gas. The second model gives the price of aggregate non-energy input in each industry as a function of the five non-energy inputs, (1) agriculture, (2) manufacturing, (3) transport, (4) communications, trade and services and (5) competitive imports.

The final demand includes four components: personal consumption expenditure, gross private domestic investment, government expenditure and exports. The personal consumer expenditure is analysed by a model of consumer behaviour. This model is based on an indirect translog utility function, as has been described earlier in Section 6.5, in connection with the study by Jorgenson.

The integrated model is used to project economic activity and consumption of energy up to the year 2000 and the effect of tax policy on conservation of energy is estimated for alternative assumptions.

The main strength of the models used by Jorgenson and Berndt and Wood is that, these models not only allow one to obtain all the relevant elasticities (the own-price, cross-price and income elasticities of demand and the elasticity of substitution) but they also provide information regarding the underlying utility function. The main weakness of these models is that it is difficult to include the effects of non-economic variables such as temperature in these models.

CHAPTER 7

The models used in the study

7.1 Introduction

The present demand analysis extends the analyses carried out by Jorgenson (1974) and Berndt and Wood (1975) described in the previous chapter, to the United Kingdom and Scotland. There are two main differences between the models used in this analysis and the models used by Jorgenson, Berndt and Wood and these are: (1) the models have a different functional form and (2) the models are estimated by using direct utility function and production function rather than the dual forms (i.e. indirect utility function and cost function respectively).

A major feature of this model is that the energy consumption is expressed in terms of effective energy; the majority of demand studies including the ones by Jorgenson, Berndt and Wood all express energy in terms of final energy.

It has been discussed earlier in Section 2.6.2.1 that a demand model should ideally take into account (1) the purposes for which energy is consumed (i.e. mainly for heat, light, power and transport), (2) the demand for energy-using appliances and (3) the cost of change-over from using one form of energy to using another form of energy, i.e. the cost of energy as well as the cost of appliances (the cost of appliances include cost of infrastructure such as storage facilities, pumps, meters etc). For reasons discussed earlier in Sections 2.6.1.2 and 2.6.2.1, the present model ignores these questions.

In the rest of this chapter, the models of consumer demand and derived demand are discussed in turn.

7.2 Consumer demand

7.2.1 The model

The assumption behind the model is that there are two homogeneous goods, (1) effective energy, E and (2) "non-energy" or consumption good, C. Given the price of effective energy, P_E, the price of consumption good, P_C and money income (or expenditure) M, the consumer maximises utility U(C, E) subject to the budget constraint $P_E.E + P_C.C = M$.

The particular form used for the utility function is a modification of the generalised constant elasticity of substitution (GCES) function,

$$U(C, E) = \frac{\alpha}{1-b} E^{1-b} + \frac{\beta}{1-b} C^{1-b} + \frac{\gamma}{1-b} (C + E)^{1-b} + \frac{\delta}{1-b} (1 + E)^{1-b} + \frac{\xi}{1-b} (1 + C)^{1-b} \quad (7.1)$$

proposed by Ulph and Ulph (1976).

The modified form used is

$$U(C, E) = \frac{\alpha}{1-b} E^{1-b} + \frac{\beta}{1-b} C^{1-b} + \frac{\gamma}{1-b} (C + E)^{1-b} + \frac{\delta}{1-b} (\lambda + E)^{1-b} + \frac{\xi}{1-b} (\mu + C)^{1-b} \quad (7.2)$$

The reason for this modification is discussed later in Section 7.2.3. Here we first explain briefly the reasons for choosing the GCES function rather than the translog function of Jorgenson, Berndt and Wood. There are two main reasons.

(1) Firstly, it is evident that the GCES function has all the properties of the translog function. It is additive if and only if $\gamma = 0$ and it is homothetic if and only if $\delta = \xi = 0$ in equation (7.1) or if and only if $\delta\lambda = \mu\xi = 0$ in the modified form of (7.2) and, for any value of $b > 0$ will provide a local second-order approximation to any underlying utility function.

(2) Secondly, it can be shown that the GCES function is more likely to identify accurately the underlying utility function than the translog function.

It has been discussed earlier in Section 6.4, clause 4, that if the translog function is additive and homothetic it is necessarily a Cobb-Douglas function with elasticity of substitution equal to 1. Consider a case where the true utility function is a CES function with elasticity not equal to 1 and where this CES function is fitted by a translog function. It has been pointed out earlier (in Section 6.4, clause 4) that the translog function gives a local second-order approximation at point $\bar{X}$ and that the elasticity of substitution depends only on second-order terms. The result is that, the elasticity of substitution computed for the fitted translog function at the point $\bar{X}$ must equal that of the underlying function, and so cannot be equal to one. Hence, the translog function which gives a local second-order approximation cannot be both additive and homothetic (since to be additive and homothetic the elasticity of substitution must be equal to 1) i.e. cannot be a CES function even though the underlying function is.

However, the GCES function can take on any value of the elasticity of substitution and be additive and homothetic, and so can identify any CES function accurately.

For the GCES function of equation (7.2), the first order conditions may be expressed as:

$$\left.\begin{aligned} \frac{\partial u(\cdot)}{\partial E} &= \lambda P_E \\ \frac{\partial u(\cdot)}{\partial C} &= \lambda P_C \\ P_E.E + P_C.C &= M \end{aligned}\right\} \qquad (7.3)$$

where λ is a parameter that reflects the marginal utility of income. Eliminating λ, the shares of energy and consumption to the total expenditure may be expressed as

$$\frac{P_E.E}{M} = \sigma E = \frac{\alpha E^{1-b} + \beta E(E + C)^{-b} + \delta E(\lambda + E)^{-b}}{\alpha E^{1-b} + \beta(E + C)^{1-b} + \gamma C^{1-b} + \delta E(\lambda + E)^{-b} + \xi C(\mu + C)^{-b}} \quad (7.4)$$

$$\frac{P_C.C}{M} = \sigma C = \frac{\beta C(E + C)^{-b} + \gamma C^{1-b} + \xi C(\mu + C)^{-b}}{\alpha E^{1-b} + \beta(E + C)^{1-b} + \gamma C^{1-b} + \delta E(\lambda + E)^{-b} + \xi C(\mu + C)^{-b}} \quad (7.5)$$

As explained in the previous chapter (Section 6.5, equations (6.37), (6.38) and (6.39)) the equations (7.4) and (7.5) can be used to estimate the parameters b, α, β, γ, δ, ξ, λ and μ.

7.2.2 Estimation

The estimates are obtained from time-series observations on σE, σC, E and C. The stochastic specification of the model is

$$\sigma E_i = \frac{\alpha E_i^{1-b} + \beta E_i\,(E_i + C_i)^{-b} + \delta E_i\,(\lambda + E_i)^{-b}}{\alpha E_i^{1-b} + \beta(E_i + C_i)^{1-b} + \gamma C_i^{1-b} + \delta E_i\,(\lambda + E_i)^{-b} + \xi C_i\,(\mu + C_i)^{-b}} + \xi E_i \quad (7.6)$$

$$\sigma C_i = \frac{\beta C_i(E_i + C_i)^{-b} + \gamma C_i^{1-b} + \xi C_i(\mu + C_i)^{-b}}{\alpha E_i^{1-b} + \beta(E_i + C_i)^{1-b} + \gamma C_i^{1-b} + \delta E_i(\lambda + E_i)^{-b} + \xi C_i(\mu + C_i)^{-b}} + \xi C_i \quad (7.7)$$

where ξE_i and ξC_i are error terms, and σE_i and σC_i are the per capita shares of energy and non-energy respectively.

Given the specification of the model $\xi E_i + \xi C_i = 0$, for i = 1 ... , therefore the error matrix is singular. Following other writers (e.g. Jorgenson) we drop one of the two equations and estimate equation (7.6). We assume that the errors are distributed normally with zero mean and constant variance and therefore obtaining maximum-likelihood estimates is equivalent to obtaining least-square estimates (Goldfeld and Quandt (1972)).

In performing the estimation we maintain the hypothesis that demand is generated from a utility function. Consequently, the tests for equivalence and symmetry conditions developed by Christenson (1971) are not required. Furthermore it will be noted that the right-hand sides of equations (7.4) and (7.5) are homogeneous of degree zero in the parameters α, β, γ, δ and ξ. So we estimate the parameters with normalisation $\alpha + \beta + \gamma + \delta + \xi = 1.0$

The hypotheses we wish to explore are

(1) The non-negativity of the parameters α, β, γ, δ and ξ. If these are all non-negative then the GCES function used in our case is well-behaved on all parts of the (non-negative) consumption space.

(2) The additivity condition $\gamma = 0$.

(3) The homotheticity conditions $\delta\lambda = \xi\mu = 0$.

7.2.3 The program used

The objective of the program is to minimise a sum of squares of m non-linear residuals (i.e. Left Hand Side - Right Hand Side) each of n variables. This may be expressed in general terms as

$$\text{Minimise } s(\underline{x}) = \sum_{i=1}^{m} f_i(\underline{x}) \text{ where } \underline{x} = x_1 \ldots x_n \qquad (7.8)$$

The conditions for minimisation are satisfied if

(1) the gradient $g(\underline{x}) = \frac{\partial f}{\partial x_j} = 0$ for all j (7.9)

and

(2) the hessian $hij = \left|\left| \frac{\partial f}{\partial x_i \, \partial x_j} \right|\right|$ is positive definite for all i and all j (7.10)

Various iterative routines are available for minimising non-linear function and a description of these routines will be found in the N.A.G. (Nottingham Algorithms Group) ICL 4100 Library Manual, Document Number 760 of January 1974.

In each of these routines the non-linear search is carried out from a starting point supplied by the user and the routine iterates between points that tend to the minimum. Most of the routines do not guarantee that the global minimum is reached but only the local minimum, so that unless some convergence criteria are easily satisfied, the procedure is to start the routine from different points to determine if a better minimum can be obtained.

Two routines were tried in this study. The first is the one developed by Nelder and Mead (1965), a description of which will be found in the NAG Library Manual, Document No. 187 of 30th September 1971. This routine was found to be unsatisfactory in terms of the desired convergence criteria which are (1) that the sum of squares value should be below a set minimum and (2) that at a point near the global minimum, the values of the parameters (such as b, α, β etc) should be similar, irrespective of the direction in which the search is made.

The second routine is the one developed by Powell (1968), a description of which will be found in the NAG Library Manual, Document No. 329 of 1st December 1972. This routine was found to be satisfactory, and was used.

Using the Powell's routine, two versions of the programme were run.

(1) In the first version, the variables i.e., b, α, β, γ, δ and ε

were allowed to take any value, either positive or negative.

(2) In the second version, these variables were constrained to take on only positive values. This was achieved by a combination of two procedures. Firstly, instead of searching for the variable itself, the routine searched for the square root of the variables (i.e. $\sqrt{b}$, $\sqrt{\alpha}$ ... etc) and the value of the variable was obtained by squaring the searched variable i.e. $(\sqrt{b})^2 = b$. Secondly, the normalisation criterion requires that $\alpha + \beta + \gamma + \delta + \xi = 1.0$ (Section 7.2.2) and hence one variable ξ was set so that $\xi = 1 - \alpha - \beta - \gamma - \delta$ and the routine did not search for $\sqrt{\xi}$ but used the final values of α, β, γ and δ to find ξ. Obviously, there was nothing to automatically prevent ξ to take a negative value. Hence, in this version of the programme a penalty function was used which raised the sum of squares value, if ξ was negative. While the use of a penalty function did not ensure that ξ was non-negative, it helped the routine both to avoid negative values for ξ and certainly to continue the search if ξ was found to be negative.

Three major features of the programme were

(1) Only one equation was estimated.

(2) The values of E and C (energy and consumption respectively) were scaled so that they took a value around unity, and

(3) For making the equation homogeneous in data, the terms $(1 + E)$ and $(1 + C)$ as expressed in equation (7.1) were modified to $(\lambda + E)$ and $(\mu + C)$ respectively. This means that two new variables (or strictly, floating-point constants), λ and μ, were introduced into the programme.

7.2.4 The data

Two sets of data were used, one for the entire U.K. and the other for only Scotland. The full set of data is given in Tables 8.1 and 8.2 at the end of Chapter 8.

As discussed in the previous Section (Section 7.2.3) the data was scaled, so that both E and C took on values around unity.

For the U.K. the scalings were:

$$E' = E/3000$$

$$C' = C/100$$

$$M' = M/100$$

$$PE' = PE \times 30$$

where E, C, M and PE are the original values of energy, "non-energy", money income and price of energy respectively and E', C', M' and PE' are the corresponding scaled values. M and PE were scaled so that the share of energy in the total expenditure (i.e. M) remained the same. This may be shown as below

$$\frac{PE'.E'}{M'} = \frac{(PE \times 30) \times (E/3000)}{M/100} = \frac{PE.E}{M}$$

For Scotland, the scalings were:

$$E' = E/300$$

$$C' = C/10$$

$$M' = M/10$$

$$PE' = PE \times 30$$

7.2.5 Calculation of elasticities

This section presents an outline of the procedure by which, from a knowledge of the utility function have been computed the own-price, cross-price and income elasticities of demand for both energy and "non-energy", and the elasticity of substitution, at each observation.

The direct procedure for computing the elasticities would be to derive demand functions from the utility function, substitute into these functions the observations on price and income for each of the years, compute an estimate of the quantity that would be consumed, and knowing the first-order derivatives of the demand function, compute all the elasticities.

The above procedure would be rather complex in our case since there is no way to solve equations (7.4) and (7.5) to obtain demand functions in a simple analytical form. Therefore, the following procedure is adopted which is perfectly general, and is theoretically equivalent.

Assuming that the consumer

Maximises $U(X_1 \ldots X_n)$ subject to $\sum P_i X_i = M$ (7.11)

the demand function may be written as

$$X_i = d_i \, (P_1 \ldots P_n, M) \tag{7.12}$$

which is homogeneous of degree zero in prices and income. Thus letting $q_i = P_i/M$ be the i-th normalised price, we have

$$X_i = d_i \, (P_1 \ldots P_n, M) \equiv d_i \, (q_1 \ldots q_n, 1) \equiv f_i \, (q_1 \ldots q_n) \tag{7.13}$$

which leads to

$$\frac{P_j}{X_i} \frac{\partial d_i}{\partial P_j} = \frac{P_j}{MX_i} \frac{\partial f_i}{\partial q_j} = \frac{q_j}{X_i} \frac{\partial f_i}{\partial q_j} \tag{7.14}$$

so that price elasticities can be calculated from the functions $f_i(q)$.

Moreover

$$\frac{M}{X_i} \frac{\partial d_i}{\partial M} = - \sum \frac{q_j}{X_i} \frac{\partial f_i}{\partial q_j} \tag{7.15}$$

which means that the income elasticities can also be calculated from the functions $f_i(q)$.

It has been discussed previously in Section 6 that the first-order conditions for utility maximisation may be written as

$$\frac{P_i X_i}{M} = q_i X_i = \frac{U_i X_i}{\sum U_j X_j}, \quad i = 1 \dots n \qquad (7.16)$$

These equations are implicit statements of the demand functions; that is, given any $q_1 \dots q_n$, then solving these equations for $X_1 \dots X_n$ will give us the demand functions

$$X_i = f_i (q_1 \dots q_n) \qquad (7.17)$$

We write

$$H_i (X_1 \dots X_n) \equiv \frac{U_i X_i}{\sum U_j X_j} \qquad (7.18)$$

and differentiate (7.16) with respect to q_j, j=1 ... n to obtain

$$D = (A - B)^{-1} C \qquad (7.19)$$

where

$$D = [d_{ij}]_{nxn}, \quad d_{ij} = \frac{\partial f_i}{\partial q_j}$$

$$A = [a_{ij}]_{nxn}, \quad a_{ij} = \frac{\partial H_i}{\partial q_j}$$

$$B = \begin{bmatrix} q_1 & & 0 \\ & \ddots & \\ 0 & & q_n \end{bmatrix}$$

$$C = \begin{bmatrix} X_1 & & 0 \\ & \ddots & \\ 0 & & X_n \end{bmatrix} \qquad (7.20)$$

a_{ij} in this case takes the form:

$$a_{ij} = \frac{\sum U_i X_i \left\{ X_i \frac{\partial U_i}{\partial X_j} + U_i\, a_{ij} \right\} - U_i X_i \left\{ \sum X_i \frac{\partial U_i}{\partial X_j} + U_j \right\}}{\left(\sum U_i X_i \right)^2}$$

where $a_{ij} = 0$ when $i \neq j$

$= j$ when $i = j$

It is to be noted that equation (7.16) can be regarded as a series of equations giving us the set of utility maximising prices associated with any particular point $(X_1 \dots X_n)$. It follows, therefore, that if the utility function $U(\cdot)$ is known, one can, by differentiating, find the functions $H_i\ (X_1 \dots X_n)$ such that for any point $(X_1 \dots X_n)$, the prices $q_i = \frac{H_i}{X_i}$ (which may also be written as

$$q_i = \frac{\partial u}{\partial X_i} / \left(\sum \frac{\partial u}{\partial X_i} X_i \right) \qquad (7.21)$$

and hence the matrices A, B and C can be found.

Knowing matrices A, b and C, matrix D (which is the matrix of the first-order derivates of the normalised demand functions) can be found, which allows us to compute all the price elasticities and hence the income elasticities of demand.

The elasticity of substitution is obtained directly from the utility function as explained below.

If the utility function is expressed as $U = f(X_1 \dots X_n)$, the partial elasticities of substitution may be defined as (Allen (1972)),

$$\sigma_{ij} = \frac{\sum f_i X_i}{X_i X_j} \; \frac{F_{ij}}{F} \qquad (7.22)$$

where $f_i = \frac{\partial u}{\partial X_i}$

and

$$F = \begin{vmatrix} 0 & f_1 \dots f_n \\ f_1 & f_{11} \dots f_{1n} \\ \vdots & \dots\dots\dots \\ f_n & f_{1n} \dots f_{nn} \end{vmatrix}$$

and F_{ij} is the co-factor of f_{ij} in F.

For a utility function having two variables X_1 and X_2 the elasticity of substitution may be shown to be

$$\sigma = \frac{f_1 f_2 (X_1 f_1 + X_2 f_2)}{X_1 X_2 \{f_{11} f_2^2 + f_{22} f_1^2 - 2 f_{12} f_1 f_2\}} \qquad (7.23)$$

which is the expression used for our calculation.

7.3 Derived demand

7.3.1 The model

The model is based on the assumption that output Q is generated by the combination of three aggregate factor inputs, (1) effective energy, (2) labour and (3) capital. Given the prices of energy P_E, of labour P_L and of capital P_K, the producer wishes to maximise the profit, so that the producer's behaviour (operating in a perfect factor market) may be represented as,

$$\text{Max } (Q - P_E E - P_L L - P_K K) \qquad (7.24)$$

It would be noted that the above representation of producer's behaviour ignores the question of technical progress except in so far as technical progresss with respect to energy has been included by expressing E in terms of effective energy.

The particular form of production function is a modification of the generalised constant elasticity of substitution (GCES) function, described earlier in Section 7.2.1. Assuming constant returns to scale, the modified GCES function may be expressed as

$$Q = \left[\alpha K^{-r} + \beta L^{-r} + \gamma E^{-r} + \delta (K + L)^{-r} + \varepsilon (L + E)^{-r} + \phi (K + E)^{-r} + \psi (1 + K)^{-r} + \pi (1 + L)^{-r} + \rho (1 + E)^{-r}\right]^{-\frac{1}{r}} \qquad (7.25)$$

As explained earlier in Section 7.2.3 (clause 3), the term (1 + K) is changed for $(\lambda + K)$, (1 + L) for $(\mu + L)$ and (1 + E) for $(\nu + E)$, so that the modified form of the production function used is

$$Q = \left[\alpha K^{-r} + \beta L^{-r} + \gamma E^{-r} + \delta(K + L)^{-r} + \varepsilon(L + E)^{-r} + \phi(K + E)^{-r} + \psi(\lambda + K)^{-r} + \pi(\mu + L)^{-r} + \rho(\nu + E)^{-r}\right]^{-\frac{1}{r}} \qquad (7.26)$$

The reasons for using the GCES function for derived demand are the same as those for consumer demand, discussed in Section 7.2.1.

The first order conditions, with respect to equation (7.26), may be expressed as

$$\left.\begin{aligned} \frac{\partial Q}{\partial K} &= P_K \\ \frac{\partial Q}{\partial L} &= P_L \\ \frac{\partial Q}{\partial E} &= P_E \\ Q &= P_E.E + P_K.K + P_L.L \end{aligned}\right\} \qquad (7.27)$$

By differentiating equation (7.26) and re-arranging the expressions, the shares of energy, labour and capital may be expressed as

$$\frac{P_E.E}{Q} = \sigma E = \frac{\gamma E^{1-b} + \varepsilon E(L + E)^{-b} + \phi E(K + E)^{-b} + \rho E(\nu + E)^{-b}}{D} \qquad (7.28)$$

$$\frac{P_L.L}{Q} = \sigma L = \frac{\beta L^{1-b} + \delta L(K + L)^{-b} + \varepsilon L(L + E)^{-b} + \pi L(\mu + L)^{-b}}{D} \qquad (7.29)$$

$$\frac{P_K.K}{Q} = \sigma K = \frac{\alpha K^{1-b} + \delta K(K + L)^{-b} + \phi K(K + E)^{-b} + \psi K(\ \ + K)^{-b}}{D} \qquad (7.30)$$

where $D = \alpha K^{1-b} + \beta L^{1-b} + \gamma E^{1-b} + \delta(K + L)^{1-b} + \varepsilon(L + E)^{1-b}$

$$+ \phi(K + E)^{1-b} + \psi K(\ \ + K)^{-b} + \pi L(\mu + L)^{-b} + \rho E(\nu + E)^{-b} \qquad (7.31)$$

and $1-b = -r$, where r is as expressed in equation (7.25).

Similar to the analysis discussed in the previous chapter (Section 6.5 for equations (6.37), (6.38) and 6.39)) the equations (7.28), (7.29) and (7.30) may be used to estimate the parameters $b, \alpha, \beta, \gamma, \delta, \varepsilon, \phi, \psi, \pi, \rho, \lambda, \mu$ and ν.

7.3.2 Estimation

The estimates are obtained from time-series observations on σE, σL, σK, E, L and K. The stochastic specification of the model is

$$\sigma E_i = \frac{\gamma E_i^{1-b} + \varepsilon E_i(L_i + E_i)^{-b} + \phi E_i(K_i + E_i)^{-b} + \rho E_i(\nu + E_i)^{-b}}{DD} + \varepsilon' E_i \quad (7.32)$$

$$\sigma L_i = \frac{\beta L_i^{1-b} + \delta L_i(K_i + L_i)^{-b} + \varepsilon L_i(L_i + E_i)^{-b} + \pi L_i(\mu + L_i)^{-b}}{DD} + \varepsilon' L_i \quad (7.33)$$

$$\sigma K_i = \frac{\alpha K_i^{1-b} + \delta K_i(K_i + L_i)^{-b} + \phi K_i(K_i + E_i)^{-b} + \psi K_i(\lambda + K_i)^{-b}}{DD} + \varepsilon' K_i \quad (7.34)$$

where
$$DD = \alpha K_i^{1-b} + \beta L_i^{1-b} + \gamma E_i^{1-b} + \delta(K_i + L_i)^{1-b} + \varepsilon(L_i + E_i)^{1-b}$$
$$+ \Phi(K_i + E_i)^{1-b} + \Psi K_i(\lambda + K_i)^{-b} + \pi L_i(\mu + L_i)^{-b}$$
$$+ \rho E_i(\nu + E_i)^{-b} \quad (7.35)$$

and $\varepsilon' E_i$, $\varepsilon' L_i$ and $\varepsilon' K_i$ are error terms.

Following the approach discussed in Section 7.2.2, only two equations out of the three are estimated on the basis of least squares.

It can be seen that the right-hand-sides of equations (7.32), (7.33) and (7.34) are homogeneous of degree zero in the parameters α, β, γ, δ, ε, ϕ, ψ, π and ρ. So the parameters are estimated with the normalisation $\alpha + \beta + \gamma + \delta + \varepsilon + \phi + \psi + \pi + \rho = 1.0$.

7.3.3 The program used

As mentioned earlier in Section 7.2.3 the objective of the program is to minimise a sum of squares. The routine used is the same one as that used for the consumer demand model, i.e. Powell's routine.

Since two equations need to be estimated in this case (compared to only one equation for the consumer demand model), the programme was arranged so as to minimise the sum of squares of $2 \times m$ residuals, m

7.3.2 Estimation

The estimates are obtained from time-series observations on σE, σL, σK, E, L and K. The stochastic specification of the model is

$$\sigma E_i = \frac{\gamma E_i^{1-b} + \varepsilon E_i(L_i + E_i)^{-b} + \phi E_i(K_i + E_i)^{-b} + \rho E_i(\nu + E_i)^{-b}}{DD} + \varepsilon' E_i \quad (7.32)$$

$$\sigma L_i = \frac{\beta L_i^{1-b} + \delta L_i(K_i + L_i)^{-b} + \varepsilon L_i(L_i + E_i)^{-b} + \pi L_i(\mu + L_i)^{-b}}{DD} + \varepsilon' L_i \quad (7.33)$$

$$\sigma K_i = \frac{\alpha K_i^{1-b} + \delta K_i(K_i + L_i)^{-b} + \phi K_i(K_i + E_i)^{-b} + \psi K_i(\lambda + K_i)^{-b}}{DD} + \varepsilon' K_i \quad (7.34)$$

where
$$DD = \alpha K_i^{1-b} + \beta L_i^{1-b} + \gamma E_i^{1-b} + \delta(K_i + L_i)^{1-b} + \varepsilon(L_i + E_i)^{1-b} + \Phi(K_i + E_i)^{1-b} + \Psi K_i(\lambda + K_i)^{-b} + \pi L_i(\mu + L_i)^{-b} + \rho E_i(\nu + E_i)^{-b} \quad (7.35)$$

and $\varepsilon' E_i$, $\varepsilon' L_i$ and $\varepsilon' K_i$ are error terms.

Following the approach discussed in Section 7.2.2, only two equations out of the three are estimated on the basis of least squares.

It can be seen that the right-hand-sides of equations (7.32), (7.33) and (7.34) are homogeneous of degree zero in the parameters α, β, γ, δ, ε, ϕ, ψ, π and ρ. So the parameters are estimated with the normalisation $\alpha + \beta + \gamma + \delta + \varepsilon + \phi + \psi + \pi + \rho = 1.0$.

7.3.3 The program used

As mentioned earlier in Section 7.2.3 the objective of the program is to minimise a sum of squares. The routine used is the same one as that used for the consumer demand model, i.e. Powell's routine.

Since two equations need to be estimated in this case (compared to only one equation for the consumer demand model), the programme was arranged so as to minimise the sum of squares of 2 × m residuals, m residuals for the first equation and m residuals for the second equation - m being the number of observations. The equations corresponding to energy and labour were estimated and the equation for capital was not used.

For this model, the unconstrained version was not estimated and the equations were estimated by constraining all the variables to take positive values. Furthermore, the variables were normalised so that ρ was equal to $1.0 - (\alpha + \beta + \gamma + \delta + \varepsilon + \phi + \psi + \pi)$ and ρ was induced to take on a positive value by using a penalty function that raised the total sum of squares value if ρ became negative. Fuller discussion of the procedure is presented earlier in Section 7.2.3.

7.3.4 The data

The derived demand model was estimated only for the U.K. since as discussed later in Section 8.1.1, data for Scotland was not available. The data for the U.K. is shown in Table 8.3, at the end of Chapter 8.

Similar to the procedure discussed earlier in Section 7.2.3, the data was scaled, so that E, K and L took on values around unity. The scalings were

$$E' = E/20{,}000$$

$$K' = K/500$$

$$L' = L/50$$

$$P_E' = P_E \times 10$$

$$P_L' = P_L \times 25$$

$$Q' = Q \times 2000$$

7.3.5 Calculation of the elasticities

The own and cross-price elasticities of capital, labour and energy, and the elasticities of substitution between capital labour and energy were derived in the following way.

Assuming that the producer maximises his profit, the producer behaviour can be expressed as

$$\left.\begin{array}{ll} & \text{Max } p\,Q - \sum q_i X_i \\ \text{or} & \text{Max } Q - \sum w_i X_i \\ \text{subject to} & Q = f(X_1 \ldots X_n) \end{array}\right\} \quad (7.36)$$

where p is the price of output Q

Q is the quantity of output

X_i's are the quantities of factor inputs

q_i's are the corresponding prices of factor inputs

$w_i = \frac{q_i}{p}$ = "real" price of factor inputs

The demand for factor input may be written as

$$X_i = \phi_i\ (p, q_1 \ldots q_n) \quad (7.37)$$

Since the demand X_i is homogeneous of degree zero in prices, we have,

$$X_i = \phi_i(p, q_1 \ldots q_n) = \phi_i(1, \frac{q_1}{p} \ldots \frac{q_n}{p}) = g_i(w_1 \ldots w_n) \quad (7.38)$$

which leads to

$$\frac{q_j}{X_i}\ \frac{\partial X_i}{\partial q_j} = \frac{w_j}{X_i}\ \frac{\partial X_i}{\partial w_j} \quad (7.39)$$

The maximising behaviour Max $Q - \sum w_j X_j$ subject to $Q = f(X_1 \ldots X_n)$ as expressed in equation (7.36) may be written as

$$\text{Max } f(X_1 \ldots X_n) - \sum W_j \cdot X_j \tag{7.40}$$

where X_i's are functions of w_j's.

The first order condition for (7.40) may be shown to be

$$f_i = w_i \tag{7.41}$$

Differentiating f_i with respect to $w_1 \ldots w_n$, we have

$$\left[f_{ij}\right]\left[\frac{X_i}{w_j}\right] = I .$$

Hence the matrix of the price elasticity may be written as

E = ACD where

$$\left.\begin{aligned}
E &= \left[e_{ij}\right]_{n\times n}, \quad e_{ij} = \frac{q_j}{X_i} \frac{\partial X_i}{\partial q_j} \\
A &= \begin{bmatrix} \frac{1}{X_1} & & 0 \\ & \ddots & \\ 0 & & \frac{1}{X_n} \end{bmatrix} \\
B &= \left[\frac{\partial f}{\partial X_i \, \partial X_j}\right]_{n\times n} \quad \text{and } C = B^{-1} \\
D &= \begin{bmatrix} w_1 & & 0 \\ & \ddots & \\ 0 & & w_n \end{bmatrix} = \begin{bmatrix} \frac{\partial f}{\partial X_1} & & 0 \\ & \ddots & \\ 0 & & \frac{\partial f}{\partial X_n} \end{bmatrix}
\end{aligned}\right\} \tag{7.42}$$

The elasticities of substitution are obtained, according to the definitions used by Allen (1972), as

$$\sigma_{ij} = \frac{\sum f_i X_i}{X_i X_j} \cdot \frac{F_{ij}}{F} \tag{7.43}$$

where $\quad f_i = \frac{\partial f}{\partial X_i}$

$$F = \begin{bmatrix} 0 & f_1 \cdots f_n \\ f_1 & f_{11} \cdots f_{1n} \\ \cdot & \\ \cdot & \\ \cdot & \\ \cdot & \\ f_n & f_{1n} \cdots f_{nn} \end{bmatrix}$$

and F_{ij} is the co-factor of f_{ij} in F.

CHAPTER 8

The data

8.1 Introduction

The validity of the analysis depends as much on the reliability of the data as on the correct specification of the model. The data that could be obtained from published sources did not meet the requirement in full and a major part of the research effort was spent to recompile data from the various sources and, in a few cases, to construct the data. This chapter is therefore devoted to describing the nature and sources of data, its problems and limitations and the method used for extending the data to suit the needs of our analysis.

8.1.1 An outline of the model and the required data

The analysis is based upon the assumption that the total demand for energy can be divided into two components. The first component represents the consumer energy demand which consists of domestic demand and private transport demand. The second component represents the derived energy demand i.e. demand for production and distribution and it is equal to the total demand minus consumer demand.

The model for the consumer demand is based on the hypothesis of utility maximisation and the consumer is assumed to maximise his utility by choosing appropriate quantities of two goods namely, energy and "non-energy", subject to his budget constraint. The form of the utility function is generalised constant elasticity of substitution (GCES) and the first order conditions generate two equations that are expressed in share forms, as discussed in the previous chapter. Only one equation needs to be estimated and the data required for this model are (1) quantity of energy (2) quantity of "non-energy" (3) price of either energy or "non-energy" and (4) total consumer expenditure. Since the equation expressing the share of energy is estimated the data required for (3) above is the price of energy. Quantities of energy and non-energy and expenditure are expressed in per capita terms.

The model for the derived demand is based on the hypothesis of producer behaviour according to which the producer wishes to minimise the total cost of production given the set of prices of the factor inputs. In this case only three aggregated factor inputs are considered: (1) capital (2) labour and (3) energy. The form of the cost function is generalised CES and three equations are expressed in share forms, as discussed in the previous chapter. Only two equations need be estimated and hence the data required for this model are (1) quantity of capital, (2) quantity of labour, (3) quantity of energy, (4) price of energy, (5) price of labour and (6) total expenditure. Since the two equations estimated correspond to labour and energy, the two price data required for (4) and (5) above are the prices of labour and of energy. Full set of data could be obtained for the U.K. but not for Scotland and hence the derived demand model is estimated only for the U.K.

The data for the two consumer demand models (one for the U.K. and the other for Scotland) and the derived demand model are shown in Tables 8.1, 8.2 and 8.3 at the end of this chapter. A further table, Table 8.4 is also attached which gives the consumer demand for energy and "non-energy" in the U.K. - but energy measured in final units.

8.1.2 <u>Nature of the model</u>

The main purpose of the present study is to analyse the changes in the pattern of energy demand during the period between 1955 and 1974 and hence the nature of the model is one of time-series. Since the analysis is carried out at the level of the aggregate economy no cross-sectional data is involved. The data used are annual averages i.e. the data on consumption represents average annual consumption, the data on price represents average annual price, and so on.

Although the data presented in the Appendix cover the period between 1955 and 1974, the models were actually estimated using data only up to and including the year 1973. The reason for excluding the data for 1974 for estimating the models was that the data was obtained too late to be used. This data has, however, been used in Chapter 5 for comparing the trends of consumption between the whole of the U.K. and Scotland.

8.1.3 Sources of data other than energy

Four principal sets of data, other than those for energy, were required for the analysis and they are (1) quantity and price of "non-energy" in the consumer sector (2) total consumers' expenditure, (3) quantity and price of labour and (4) quantity and price of capital. These data were obtained in the following way.

(1) Quantity and price of "non-energy"

Total quantity of energy and the average price of energy gave total expenditure on energy and this was subtracted from consumers' expenditure to give total expenditure on "non-energy". The expenditure figure was corrected for inflation by using the Retail Price Index with 1963 as the base year. An index of prices for "non-energy" was devised to give a price of 100 for the year 1963 and from this a surrogate quantity of non-energy was obtained by dividing the expenditure on non-energy by this price index. A more detailed account is to be found later in Section 8.4.1.

(2) Total consumers' expenditure

For the United Kingdom this information was obtained from the National Income and Expenditure statistics. Consumers' expenditure in Scotland was not available from official sources and was compiled from various sources, one of the main sources being the study by Begg (1975). The construction of data is discussed in detail later in Section 8.4.2

(3) Quantity and price of labour

Quantity of labour in man-hour was obtained, for the U.K. from published statistics such as Annual Abstract of Statistics, Department of Employment Gazette etc. The cost of labour (in £/man-hour) was not directly available but was constructed on the basis of information provided by official statistics. Details of the way the data was constructed are to be found later in Section 8.4.3.2.

(4) Quantity and price of capital

The available official statistics such as Annual Abstract of Statistics, National Income and Expenditure statistics and Financial Statistics give the total gross and the total net value of capital. The price of capital services was constructed, using the approach of Mizon (1974) and the quantity of capital by deflating the value of capital by the price index of capital services. Details of the calculation are to be found later in Section 8.4.3.3.

For labour and capital, the quantity and price figures were obtained in two stages. In the first stage the data was constructed for the whole industrial and distributive sector. In the second stage, the above data was modified to exclude the capital and labour in the energy sector, since energy consumption in this study excludes energy consumption in the energy sector itself. Further details of these calculations are to be found later in Sections 8.4.3.2 and 8.4.3.3.

8.1.4 Problem of energy data - conversion to effective energy

The estimation of effective energy is dependent both on the definition of effective energy and its measurement. For our purposes effective energy is defined as the amount of energy available after accounting for the losses occurring in the energy-using appliances. The measurement of this effective energy present a host of problems and the major ones are as follows.

(1) Information is required on the distribution of energy-using appliances in the country and the average loading of these appliances.

(2) Information is required on the average site efficiency of these appliances. This efficiency may be quite different from the tested efficiency at the laboratory, the size of the difference depending on the age-structure of the set of all appliances and the changes in performance over time.

(3) How to account for the lag between the time an appliance is switched on and the time when the energy is required. For example, the night storage electric heater takes a long time to store energy and may give out some heat when it is not required.

(4) How to define the effective energy for transport. The appliance in this case may be the petrol engine of the motor car which is used in an entirely different way than (say) the central heating equipment at home.

(5) In the case of transport, as in the case of domestic sector, the efficiency of the appliances on the site may be quite different from the tested efficiency. For example, the efficiency of a motor car will depend on road and weather conditions and also on driving habits. Reliable data on the operational efficiency of the various transport equipment is scarce.

Although the above problems are difficult, estimations of average utilisation efficiencies had to be made and use was made of all the available information on equipment and system efficiencies. Details of these calculations are to be found later in Section 8.3.15.

8.1.5 Problem of the breakdown of energy data between the consumer demand and the derived demand

The problem has been mentioned earlier in Section 2 and detailed calculation of the breakdown of the data are to be found later in Sections 8.3.22 and 8.3.23. Here the problem is mentioned again for completeness of argument.

Consumers' expenditure on energy consists of expenditure in the domestic sector and expenditure on private transport i.e. transport used solely for leisure and recreational purposes. Domestic consumption of energy and domestic expenditure on energy are readily available but energy consumption (and expenditure) in private transport had to be estimated.

8.1.6 An outline of the rest of the chapter

The rest of this chapter is organised in the following way.

In Section 8.2 some of the important problems associated with the use of energy data are discussed.

Section 8.3 is concerned with the compilation of energy data. Each individual series on energy is discussed, in terms of the nature, sources and problems of data and in terms of the method of construction of the data, if such construction has been necessary.

Finally in Section 8.4 a discussion, of the individual series on data other than energy, is presented.

8.2 Problems of using energy data

8.2.1 Unit of energy

The available data on energy express the consumption of energy in various units such as ton, ton coal-equivalent, kilowatt-hour, B.T.U., million cubic feet (in the case of gas), therms, joule etc. A majority of the recent energy studies, however, use either the therm or the Joule which are units for available heat. Since most of the energy statistics in the U.K., particularly those of recent years, express the consumption in therms, this is the unit used in the present study.

In the official statistics, for recent years, the consumption figures are provided in both the original units of measurement (such as ton, kwh) as well as in therm. But figures for energy consumption before 1960 were given either in original units or coal equivalents, but not in therm. These figures had to be transformed using therm-equivalents, and the therm-equivalents used for these transformation are listed in Table 1 of the Appendix.

In the data for Scotland, the use of original units was more prevalent than in the data for the U.K. In this study, the same therm-equivalents were used for both Scotland and the U.K. data. In so far as the average quality of coal in Scotland is slightly lower compared to that in the rest of the U.K., the consumption of coal in therms in Scotland has been slightly overestimated. For other forms of energy such as gas and petroleum products, the quality does not differ between different geographical regions and hence no errors have been introduced.

8.2.2 Energy generation by private industry

Certain industries buy particular forms of fuels and convert them to another form for their own use. For example, iron and steel industry and the railways buy coal and oil and convert them in their own power stations into electricity. Other examples are: the coke-oven industry which buys coal and then convert it to coke and coke-oven gas; iron and steel industry which buys (and also produces) coke and uses the by-product of coke-oven gas; the chemical industry which generates electricity for its own use, etc.

The majority of private generation is from coal to electricity by certain industries and this private electricity generation in the U.K. in 1974 accounts for around 9 per cent of the total electricity consumption and around 1 per cent of the total energy consumption. For the present study, this small amount of private generation of energy has been ignored (treated as though energy generated by industry is consumed direct) so that strictly speaking the energy data used in the study reflects the energy supplied by the energy sector rather than the overall total energy actually consumed.

8.2.3 Treatment of feedstock

Some fuels are used not only for providing energy but also as feedstocks in the industrial process. For example, a number of petroleum products such as naphtha, industrial spirits and bitumen are used by industry as feedstocks. The available statistics on petroleum separates this feedstock category from the rest of the petroleum products and hence the data on petroleum used in this study excludes feedstocks.

Another potential problem arises because of the difficulty of treating industrial coke. Coke is mainly consumed in the iron and steel industry and clearly coke is used both as a feedstock (reducing agent) and as a fuel for the production of iron. No effort has been made either in any of the published statistics or in this study to estimate the relative contributions of coke as a feedstock and as a fuel. Coke is treated herein solely as a fuel (as it is also in the digest of U.K. energy statistics) and hence a slight overestimation has been made of the energy consumption in the industry sector.

8.2.4 The difference between units consumed and units delivered

Electricity and gas share a common feature in that they are not usually stored at the consumer's premises; some large industries may have provisions for storing gas but the amount is usually negligible compared to the annual demand. Hence, both for electricity and for gas, consumption may be assumed to be equal to the delivery.

However, in the cases of solid fuels and petroleum the situation is quite different. These fuels are delivered at single points of time and are usually stored at the consumer's premises and the consumption is spread over sizeable time intervals. Data on petroleum refer to delivery only and most data on solid fuels refer to disposals from the collieries or from the fuel manufacturing plants. An error will be introduced if consumption is assumed to be the same as delivery when the levels of stock change significantly from year to year.

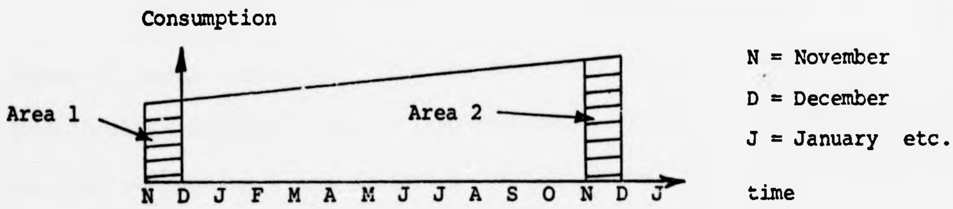
Fluctuations in the stock level can have important bearing if the study is a short-term one and if the data-points are close with respect to time (i.e. monthly data - instead of annual data). But unless there is a definite trend of either a build-up or run-down of stock over the years, the level of stock may be assumed to be constant for long-term studies. Since the present study covers a time period of about 20 years and uses annual data, and since there has not been significant changes in the stocking policy by the energy consumer, the effect of stock changes has been considered to be small, for this study.

8.2.5 Units consumed and units billed (or recorded)

The consumption of energy is not recorded continuously but instead at specific points in time. For solid fuels and petroleum the recording takes place at the time of delivery (i.e. before consumption has taken place) and so long as the delivery is recorded to cover the full year, the difference between the units consumed and units delivered (or billed) depends only on stock changes, as discussed in Section 2.4.

The problem for gas and electricity is, however, different. In this case, there are no stock changes, but a different problem arises because the recording of consumption takes place after consumption has occurred. If there are consistent trends in the consumption, then this difference between the time of consumption and recording would lead to certain errors. This can be illustrated by a simple example. Let us consider that electricity is metered all throughout the year, but on average there is a time lag of one month between consumption and recording, and also that there is an upward trend in the consumption. The consumption may be shown as:

Fig. 8.1 Units consumed and units billed



In the case shown above, the units billed for a particular year will cover the period between November of the previous year to November of that year i.e. the error between consumption and recording will be equivalent to the difference between Area 2 and Area 1. The difference will depend on two factors (a) the average lag between consumption and recording and (b) the trend of consumption i.e. consumption will be underestimated if the trend is an increasing one and vice versa.

The problem discussed above is not a new one in economic analysis. In fact, any averaging over time in the presence of a time-trend will lead to certain errors. Owing to the nature of our analysis (i.e. use of discrete models instead of continuous ones), this problem has been ignored.

8.3 Individual series on energy

In this section, the individual series on energy are discussed in detail. The tables are attached in the Appendix and copious footnotes are provided under each table.

8.3.1 Average gross calorific value of fuels used (Tables 1a, 1b, 1c, 1d, 1e and 1f)

The unit of energy consumption used in this study is the therm. Since the consumption figures are sometimes provided, particularly for the years before 1960, not in therms but in the original units of measurement (such as ton, kilo watt-hour), figures on thermal equivalents are necessary to convert the consumptions from original units to therms.

The main source of information on thermal equivalents is the U.K. Digest of Energy Statistics. For the five years before 1960 (i.e. 1955 to 1959 inclusive), however, the figures on thermal equivalents were not available and were assumed to be (a) the same for all the five years and (b) the same as that for the year 1960.

In this study, the same heating value was used for both Scotland and the U.K. data. In so far as the average quality of coal in Scotland is slightly lower compared to that in the rest of the U.K., some slight errors may have been introduced in converting the Scottish data on coal. For other forms of energy, such as gas and petroleum products, there are no distinguishable differences in the qualities of fuel used between Scotland and the rest of the U.K. and hence it may be assumed that no errors were introduced in these cases.

The procedure for converting the original units of measurement to the therm, as adopted in the U.K. D.E.S. is as follows. For coal and petroleum (and gas, which in the earlier years was expressed in million cubic feet) the average heating values were used. The thermal equivalent of secondary fuels (such as coke) represented the quantities of primary fuels required to produce them and included losses incurred in the processes of manufacture and distribution. Nuclear and hydro electricity were first converted to coal equivalents according to the amount of coal needed to produce electricity at the efficiency of the contemporary power station and then converted to therm from coal-equivalent. A more detailed discussion on the method of calculating thermal equivalents will be found in the 1967 U.K. D.E.S., pp.27-28.

8.3.2 Fuel consumption in the U.K. on heat supplied basis (Table 2)

As mentioned in Section 8.3.1, the available data on energy consumption for the year 1955 to 1959, express consumption in the original units of measurement. By using the thermal equivalents of Table 1, consumptions expressed in the original units were converted to therm.

8.3.3 Coal consumption in the U.K. (Table 3)

Figures for the years 1960 to 1974 inclusive were obtained from the U.K. D.E.S. and figures for the years 1955 to 1959 inclusive were obtained from Table 2.

For the period between 1955 to 1967 (both inclusive), consumption by establishments consuming less than 1000 tons/annum (which included many small industries) were included under the "miscellaneous" category in the U.K. D.E.S.. Moreover, consumption by establishments consuming more than 1000 tons/annum (which includes some large public service establishments such as schools and hospitals) were included under the "other industry" category. Since 1968, however, these anomalies have been corrected so that consumption in the "industry" category includes the consumption by small industries and excludes the consumption by public service establishments.

No attempt was made, while compiling Table 3 to remove these anomalies before 1968 since the magnitude of errors resulting from these anomalies in the classification was relatively small as borne out by the fact that the consumption under "non-manufacturing" sector amounted to only 5 per cent within the total "industrial" sector.

Since 1973, coal consumption under the "domestic" and "other industry" categories refer to colliery disposals instead of merchant sales.

8.3.4 Coal consumption in Scotland (Table 4)

The main sources of data for this table are (1) the Digest of Scottish Statistics (DSS) for the years before 1961 and (2) the Scottish Abstract of Statistics (SAS) for the years since 1961.

Data on consumption in the thermal units is available only for the recent years and even then this data does not provide breakdown into appropriate categories of consumption. Hence the thermal-basis data, that was available, was not used and instead the consumption figures in the units of tons were taken and then converted using thermal equivalents given in Table 1a (for the U.K.).

The problems of data on coal with respect to the various anomalies of classification (as discussed in Section 8.3.3) are the same in the case of Scotland as in the case of the U.K.

8.3.5 Coke, breeze and other solid fuel consumption in the U.K. (Table 5)

The main source of data is the U.K. D.E.S. For the years 1955 to 1959 inclusive, the figures in thermal units are obtained from Table 2.

8.3.6 Coke, breeze and other solid fuel consumption in Scotland
Tables 6a/1, 6a/2. 6a/3. 6a/4, and 6b

For Scotland, the necessary data was not available for certain years, particularly for breeze and manufactured fuels, and was compiled as follows.

(a) Coke and Breeze.

Figures on the production of breeze were not available for the years 1965 to 1974 inclusive and were estimated from the (known) production of coke by assuming that both coke-ovens and gas-works in Scotland produced the same proportion of breeze to coke as in the U.K. For example, if on average, the coke-ovens in the U.K. produced 7 per cent breeze and 93 per cent coke - it was assumed that the coke-ovens in Scotland produced the same ratio of breeze to coke, and knowing the production of coke, the production of breeze could be estimated. The same type of argument was also used to estimate the production of breeze by the gas-works. The total production of breeze was then obtained by adding the estimates of production by coke-ovens and gas-works. The necessary ratios for the U.K. were calculated in Table 6a/1 and the production figures for Scotland were estimated in Table 6a/2.

For certain years, the consumption of coke and breeze were not broken down into the appropriate categories and were estimated as follows.

(i) For the domestic sector, the figures on consumption were not available for the years 1955 to 1958 inclusive. But figures were available for the two years 1951 and 1959 and linear extrapolations were used to obtain the figures for the intermediate years, as shown in Table 6a/3a.

(ii) For the railways, the consumption by railways as a proportion of the total consumption was assumed to be the same in Scotland as in the U.K. and since this proportion for the U.K. is known, the consumption in Scotland could be estimated. The calculations are shown in Table 6a/3b.

(iii) For the "other industry" and the public and miscellaneous sector, the consumption in Scotland were constructed using the U.K. Data as the basis. For the U.K., for which data was available, the proportion was obtained of "other industry" consumption in the total sector of "other industry" and "public and miscellaneous". Using this proportion for Scotland as well, the "other industry" consumption in Scotland was estimated from the known consumption in the total sector comprising of "other industry" and "public and miscellaneous" sectors. Details of these calculations are shown on Table 6a/3c and a summary of coke and breeze consumption in Scotland is presented in Table 6a/4.

(b) Manufactured fuel.

Production figures for manufactured fuel were not available and were estimated by assuming that the ratio of output of manufactured fuel to the input of coal was the same in Scotland as in the U.K., and knowing the input of coal to the manufactured fuel plants, the output could be estimated. For example, if the ratio of output to input in the manufactured fuel plant was 0.8 in the U.K., then the output of manufactured fuel in Scotland was assumed to be 0.8 times the input of coal to these plants. The calculations are shown in Table 6b.

8.3.7 Petroleum consumption in the U.K. (Tables 7a and 7b)

For the years 1955 to 1959 inclusive, the consumption figures for the U.K. were not available on the same basis as that for later years. For example, since 1960, the U.K. statistics provide the breakdown of the total consumption by sector and by product such as consumption of gas/diesel oil in agriculture or consumption of fuel oil in industry. Before 1960, however, the consumption is broken down into applications and sectors such as consumptions of gas/diesel oil in agricultural heaters and driers, gas/diesel oil in the open-hearth process in steel-making, fuel oil for marine craft, vaporising oil for fishing, fuel oil for central heating etc. These consumption figures were recompiled in Table 7a, for the years 1955 to 1959 and the consumption was disaggregated into four sectors of (1) domestic, (2) industry, (3) transport and (4) public and miscellaneous - so that the table for 1955 to 1959 was compatible with the table for 1960 to 1974.

Due to the fact that the data on petroleum consumption in Scotland was not broken down into the appropriate sectors, Table 7b was prepared - so that a product-to-product transformation could be used (explained later in Section 8.3.8) to derive the sectoral consumption of petroleum in Scotland, using the U.K. as the basis. Table 7b provides a series which expresses the ratio of consumption of a particular fuel in a particular sector to the total consumption of that fuel. For example, row (a) expresses the consumption of a product (say, butane and propane) in the domestic sector, row (b) expresses the total consumption of butane and propane and row (c) expresses the ratio of row (a) to row (b) - this is the figure which is used later for compiling the Scottish table. Row (d) simply expresses the consumption of row (a) in the units of therm.

8.3.8 Petroleum consumption in Scotland (Tables 8a and 8b)

The purpose of Table 8a is to provide the consumption figures, in tons, of various petroleum products. The available statistics on petroleum consumption includes the consumption by the energy sector and the latter had to be subtracted from the former to obtain the consumption by final consumers.

Consumption in the energy sector consists of three categories, (1) consumption of butane and propane (sometimes referred to as petroleum gases) in the gas works, (2) consumption of gas/diesel oil in the power stations and (3) consumption of fuel oil in the power stations. Consumption in each of the above three categories are available from the D.S.S. and S.A.S., but these figures are provided in terms of financial years (which cover the period between the beginning of April of one year to the end of March of the following year) rather than calendar years and the calendar year figures were constructed by adding the figures of 1/4 of one financial year to 3/4 of the next financial year. For example the figure for the year 1965 was obtained by adding 1/4 of the consumption in the year 1964 - 1965 to 3/4 of the consumption in the year 1965 - 1966.

For Scotland, the only information that was available for the whole period was the total delivery of each petroleum product and this information was used to construct the Table 8a as discussed above. What was needed for the present study was a further breakdown of the total consumption of each product into the sectors of (1) domestic, (2) industrial, (3) transport and (4) public and miscellaneous. A limited amount of information regarding sector consumption was available in the S.A.S. which provided consumption under such categories as "road and air transport", "refinery fuel", "gas works", "power stations" and "other inland deliveries" for the years since 1964 (see Table 104 of 1974 S.A.S.). But this information is not adequate for our purposes and consequently the data for Scotland was constructed using the U.K. as the basis. The constructed data was checked against the information given in the S.A.S. and was found to be satisfactory. The method used for constructing the Scottish Table is explained below.

The method used rested on the assumption that for a given fuel, and for a given year, the ratio of consumption in a given sector to the total delivery, is the same in Scotland as in the U.K. For example consider the case of burning oil in 1955. It was assumed that the ratio of domestic delivery to the total delivery of burning oil in Scotland was

0.533, a figure which was obtained from the known domestic delivery in the U.K. and the known total delivery in the U.K. Hence if the ratio for the U.K. was known for all the years, the series for the burning oil delivery in the domestic sector in Scotland could be computed from the known total delivery of burning oil in Scotland. The above assumption was not unjustifiable since certain products are used mainly in one particular sector in the U.K. and the situation could not be very different in Scotland. For example, motor spirits, avaiation fuels and derv fuels are used almost exclusively in the transport sector; burning oil is used mainly in thé domestic sector; gas/diesel and fuel oil are used mainly in the industrial sector.

Table 8b was constructed using Tables 8a and 7b. Table 8c gives a summary of petroleum consumption in Scotland.

8.3.9 Gas consumption in the U.K. (Table 9)

For both the town and the natural gas consumption in the U.K. (and also for the small consumption of colliery methane in the earlier years), the U.K. D.E.S. covered the full period between 1955 and 1974. For the coke-oven gas, the unit of consumption, as published in the U.K. D.E.S., was in million cubic feet for the years 1955 to 1959 and this unit was converted to the therm using equivalent given in Table 1c. The consumption of blast-furnace gas was ignored, since this is produced by the iron and steel industry mainly for their own internal consumption.

8.3.10 Gas consumption in Scotland (Table 10)

The data was supplied by the Scottish Gas Board. For the years up to 1964 the calendar year figures were obtained from the financial year figures by taking 1/4 and 3/4 proportion of the successive years; from 1965 to 1972 the figures were compiled from monthly data and since 1972, from quarterly data.

8.3.11 Electricity consumption in the U.K. (11a and 11b)

As mentioned earlier in Section 8.2.2, a certain amount (which was around 10 per cent of the total) of electricity is generated by industrial producers. A major portion of this private generation (around 80 per cent) is used by the industry itself while the rest is made available to the public supply authorities. In general, the electricity produced by using solid fuel and petroleum is used for own purposes while that produced by nuclear and hydro generation is connected to the public supply. Consumption figures that appear in Table 11b relate to the electricity made available by the power supply industry, railway and transport power stations and industrial hydro-electric and nuclear power stations.

For the U.K. the data was available from the U.K. D.E.S., for the whole period and is shown in Table 11b.

Nucelar and hydro electricity present certain problems of aggregation while computing the primary energy consumption figures. These problems are basically due to the fact that electricity is a secondary energy if produced from coal, petroleum or gas but can be considered as either primary or secondary energy when produced as nuclear and hydro electricity. Basically there are two conventions: (a) using the output of electricity as primary energy and (b) using the output of electricity as secondary energy and converting it to the equivalent primary energy according to the amount of coal that would have been needed to produce the same amount of electricity, at the efficiency of the contemporary steam power stations.

The U.K. D.E.S. follow the convention (b) for calculating the primary energy equivalent for the nucelar and hydro electricity. The available data cover the period 1965 to 1974 and hence Table 11a was prepared to complete the series back to 1955, following the same convention as the U.K. D.E.S.

8.3.12 Electricity consumption in Scotland (Tables 12a, 12b and 12c)

Consumption figures for Scotland were computed from quarterly data supplied by the North of Scotland Hydro Board and South of Scotland Electricity Board. Consumptions within the N.S.H.E.B. and S.S.E.B. are shown in Tables 12a and 12b respectively and the total consumption is computed by adding the consumptions of the two Boards, as shown in Table 12c. The comments regarding private generation of electricity in the U.K. (discussed in Section 6.3.11 above) apply to Scotland as well.

8.3.13 Primary and final energy consumption in the U.K. - Summary Tables (Tables 13a, 13b, 13c, 13d and 13e)

The figures for primary energy consumption in the U.K. were not available in the thermal units for the years 1955 to 1959. The necessary tables were constructed by converting the energy used in the energy sector from original units to thermal units and then adding this consumption to the final energy consumption. Tables 13a and 13b show the computation of primary energy for the years 1955 to 1959, for coal and petroleum respectively. Table 13c gives a summary of final energy consumption, Table 13d gives a summary of primary energy consumption and Table 13e shows both the primary and final energy consumption in a single table.

8.3.14 Primary and final energy consumption in Scotland (Tables 14a, 14b, 14c and 14d)

For Scotland, the primary energy consumption in million therm was calculated from original units of measurement by using thermal equivalents given in Table 1. Tables 14a and 14b give the final energy consumption by sector and by type of energy, respectively. Table 14c shows the primary energy consumption and Table 14d gives a summary of final and primary energy consumption in a single table.

8.3.15 Effective energy consumption in the U.K. and in Scotland (Tables 15 and 16 respectively)

The general problems regarding the measurement of effective energy have already been discussed in Section 8.1.4. The effective energy was estimated by using an average efficiency of each type of energy in each sector and multiplying the final energy consumption with this average efficiency to obtain the effective energy. The efficiency figures were assumed to be the same in Scotland and in the U.K. The methods by which the average efficiency figures were estimated are discussed below.

The efficiency figures below are taken from many different sources which may well be inconsistent with each other. There is also the additional difficulty of defining what efficiency is.

8.3.15.1 Efficiency of coal and other solid fuels

Domestic sector: In 1973, approximately 6.1 per cent of the 19 million households in Great Britain had coal-fired central heating (Source: Audits of Great Britain). Assuming an average consumption of 3 tons of coal per household for central heating, (figures used by the Coal Board), this amounts to 0.061 × 19 × 3 = 3.477 million tons or 3.477 × 300 = 1043 million therms which is equivalent to 1043/5328 = 20 per cent of total coal consumption. The average efficiency of an open coal fire was around 30 per cent in 1970 (NEDO (1974b)) and it may be assumed that gradual improvement in the efficiency of open coal fires had resulted in an average efficiency of around 32 per cent in 1973. The average efficiency of coal-fired central heating is estimated (Barton (1974)) to be 55 and 65 per cent depending on whether the operation is manual or automatic.

If average efficiencies of 32 per cent for open coal fire and 60 per cent for coal-fire central heating are assumed, then the weighted average efficiency appears as 37.6 per cent for the year 1973. This figure compares favourably with the figures published by NEDO (1974a)) which gives an estimated overall efficiency of 37 per cent for 1970. In order to make adjustments for the change in efficiency over time, a linear trend was assumed with a starting efficiency of 25 per cent for the year 1955.

<u>Industrial sector</u>: Solid fuel consumed in the industrial sector is of lower quality compared to that in the domestic sector but most of the solid fuel in industry is burned in automatic boilers. Hence the average efficiency of coal in the industrial sector was assumed to be the same as that coal-fired central heating in the domestic sector, i.e. 60 per cent.

<u>Transport sector</u>: The efficiency of energy in transport depends on the definition and for the present study, this efficiency was assumed to be the same as that of the energy-using appliance. Efficiency of coal in this sector, then, is assumed to be the same as the efficiency of steam locomotive which is between 5 and 10 per cent (Adams and Miovic (1968b)). An average efficiency of 8 per cent is used for this study.

<u>Public and miscellaneous sector</u>: The efficiency in this combined sector is influenced by two factors. Firstly, the efficiency is much higher in the public sector than in the miscellaneous sector. This is due to the fact that consumption in the public sector is mainly achieved by a few large consumers who tend to use coal in the boiler while the consumption in the miscellaneous sector is achieved by a large number of small consumers who use both boiler and open-fire system. Secondly, the relative weight of the public sector has been increasing over time, for example in the U.K., the weight increased from 45 per cent in 1955 to 82 per cent in 1973.

Assuming that the efficiency in the public sector was 60 per cent throughout the period and that the efficiency in the miscellaneous sector rose from 40 per cent in 1955 to 50 per cent in 1974, the average weighted efficiency in the combined sector was estimated to increase linearly from 50 per cent in 1955 to 59.5 per cent in 1974.

8.3.15.2 Efficiency of petroleum

Domestic sector: Petroleum has a relatively high efficiency whether it is burned locally or centrally; the efficiency being approximately 60 per cent and 70 per cent in the two cases (NEDO (1974a)). There has been a gradual shift from local to central heating and hence the efficiency was estimated to have increased linearly from 60 per cent in 1955 to 69.5 per cent in 1974.

Industrial sector: Petroleum in industry is mainly burned in the boiler and hence the efficiency in this sector is assumed to be the same as the boiler efficiency which is approximately 70 per cent (NEDO (1974a)). This figure is used throughout the entire period.

Transport sector: Four main fuels are used in this sector; gasolene, gas/diesel oil, derv fuel and aviation turbine fuel. Average efficiency of a petrol engine is assumed to be 25 per cent (Hammond (1973)) and the average efficiency of transmission is assumed to be 80 per cent (Chapman (1975)), thus giving an overall efficiency for the petrol engine as 20 per cent. The diesel engine has an efficiency of about 35 per cent (Hammond (1973)) and again assuming an efficiency of 80 per cent for transmission, the overall efficiency achieved is about 28 per cent. Aviation turbine has an efficiency similar to that of a diesel engine (Hammond (1973)) and hence an overall efficiency of 28 per cent is assumed. The above efficiency figures are used for the whole period between 1955 to 1974.

Public and miscellaneous sector: The pattern of consumption in this sector is similar to that in the domestic sector and hence the efficiency in this sector is assumed to be the same as that in the domestic sector.

8.3.15.3 Efficiency of gas

The efficiency of gas for most applications such as central heating, other space heating, steam raising etc. is very similar to that of petroleum, as reported by NEDO (1974a), Barton (1974) and S.R.I. (1972). Hence the efficiency of gas is assumed to be the same as petroleum, for all sectors.

8.3.15.4 Efficiency of electricity

Domestic sector: Average efficiency calculations for this sector were based mainly on the information published in the NEDO (1974a) report on energy conservation in the U.K., Table 11. This table made no provision for the somewhat lower efficiency of the off peak storage central heating (compared to ordinary central heating systems) and hence the NEDO figures were adjusted in the following way.

Majority of the electric central heating systems use off-peak storage system. In 1973, the off-peak electricity consumption averaged around 25 per cent of all electricity consumed in the domestic sector for Scotland around 20 per cent in the U.K. (Source: Audits of Great Britain). This situation has developed from 1963 when these figures were 8 per cent and 2 per cent respectively. If one takes an average efficiency of 70 per cent for off-peak heating (B.R.E. (1975)) instead of 94 per cent used in Table 11 of the NEDO report, this would reduce the average efficiency of 76 per cent quoted in the NEDO report (the figure actually appears as 82 in Table 11 but ought to read 76) to about 73 per cent. This is the figure used for the U.K. throughout the period between 1955 to 1974. For Scotland, the higher off-peak electricity consumption reduced this figure to 71 per cent.

Since the consumption of off-peak electricity as a proportion of the total consumption of electricity was smaller in the earlier years, the use of a single efficiency figure throughout the period 1955 to 1974, would result in underestimating the effective energy consumption for the earlier years. In the earlier years, however, the share of electricity in total consumption was smaller than that for the later years and hence the magnitude of the errors would be small (less than 1 per cent).

Industrial sector: The efficiency is assumed to be 80 per cent throughout the period 1955 to 1974 (Adams and Miovic (1968b)).

Transport sector: The average efficiency of large electric motors is taken to be 75 per cent (Hammond (1973)) and the transmission efficiency to be 80 per cent (Chapman (1975)). This gives the overall efficiency of 60 per cent, which is used for the entire period from 1955 to 1973.

Public and miscellaneous sector: Table 14 of the B.R.E. report (1975) gives a breakdown of the commercial consumption of electricity in 1972. The following set of efficiency was assumed for the uses of electricity: (a) central heating 90 per cent, (b) other heating 99 per cent, (c) water heating 99 per cent, (d) cooking 80 per cent, (e) lighting 15 per cent (assuming all fluorescent lamps), (f) power drives 90 per cent and (g) sundries 50 per cent. The above set of efficiency used in conjunction with Table 14 (mentioned above) gives an overall efficiency of 62 per cent, for the U.K., a figure that is used throughout the period.

The off-peak consumption in Scotland amounts to about 22 per cent of the total consumption of electricity as against 12 per cent for the U.K. The U.K. figure was adjusted and this gives an efficiency figure of 60 per cent for Scotland.

8.3.16 Price of coal and other solid fuels in the U.K. and in Scotland (Tables 17a, 17b, 17c, 17d, 17e, 17f, 17g, 17h, 17j and 17k)

Domestic sector: (U.K., Table 17b and Scotland, Table 17a)

For the U.K., the prices of coal and coke were calculated from figures published in the N.I.E. statistics under expenditure on coal and coke.

For Scotland, this series was compiled by using the U.K. as the basis. U.K. D.E.S. provides information regarding the results of sample survey on the prices of certain grades of coal in certain large towns in the U.K. and in Scotland. These prices usually refer to the end-of-year prices. Consumption of coke is relatively small in Scotland (approximately 5 per cent of the total) and hence "house coal group C" was assumed to represent the quality of coal consumed in Scotland. A weighted average price of coal and coke was constructed by using a weight of 1 for Aberdeen price and 3 for Edinburgh price (the rationale being the approximate population ratio surrounding the two centres) for the years 1964 to 1974, for which data was available. A series that gave the ratio of coal and coke prices in Scotland to coal and coke prices in the U.K. was constructed and this ratio was used to obtain the price of coal and coke in Scotland for the years between 1955 to 1963, from the known prices in the U.K.

Industrial sector (U.K. Table 17c and Scotland, Table 17d):

For the U.K. the average prices of industrial coal was obtained from the U.K. D.E.S. and the average prices of coke were obtained from the annual reports of the National Coal Board. The combined average price for coal and coke was obtained by weighting the price by the relative consumption of coal and coke.

For Scotland, the average price of coal was estimated from the average price of coal in the U.K. by using the ratio of the proceeds per saleable ton of coal in Scotland to that in the U.K., as given in the annual reports of the N.C.B. The price of coke in Scotland was determined in a similar manner from the price of coke in the U.K. and from the ratio of the proceeds per saleable ton of coke. A weighted average price for coal and coke was obtained using the relative consumption figures.

Transport sector (U.K. Table 17e and Scotland, Table 17f)

Coal is consumed mainly in the railways. Some information is available from the annual reports of the British Railways Board regarding expenditure on fuel, up to the year 1966. It was found that the price of coal and coke as obtained from the B.R.B. reports does not differ greatly from the price of industrial coal. Hence the price of industrial coal was used for the price of coal and coke in the transport sector.

Public and commercial sector (U.K., Table 17g and Scotland, Table 17h)

For both the U.K. and Scotland, the price of coal and the price of coke was taken to be the same as the price of industrial coal and industrial coke respectively. The combined price of coal and coke was obtained by weighting the prices by the relative consumptions.

8.3.17 Prices of petroleum in the U.K. and in Scotland (Tables 18a, 18b and 18c)

Domestic sector

Consumption in the domestic sector consists mainly of burning oil which represented approximately 70 per cent of the total domestic consumption of petroleum in 1974. Moreover, 80 per cent of the total burning oil was consumed in the domestic sector in 1974. Hence the price of burning oil was used to represent the price of petroleum in the domestic sector.

Prices of burning oil, as indeed the prices of all petroleum products, depend on the geographical location of the consumer. There are three delivery zones, (1) inner, (2) outer and (3) general and the price in the outer zone is higher than in the inner zone and the price in the general zone is higher than in the outer zone. Burning oil has also two different grades, (1) standard and (2) premium. The information on the prices of different grades of burning oils in the different zones were supplied by the Institute of Petroleum and these are shown on Table 18a.

Prices for the U.K. and for Scotland were obtained by taking weighted average prices. For the U.K. the weightings were 1 for the inner zone and 1 for the general zone; for Scotland, the weightings were 3 for the inner zone and 1 for the general zone. The reason for the above weightings is the consumption ratio in each zone. Details of the prices are given on Table 18b.

Industrial sector

Consumption in this sector consists mainly of fuel oil. Data on fuel prices were obtained from the U.K. D.E.S. as shown on Table 18b. These prices are slightly lower than the prices of the heavy grade fuel oil as shown on Table 18a. According to the U.K. D.E.S., this difference is due to the fact that the consumer is usually able to negotiate a price lower than the quoted price.

Prices were taken to be the same for both the U.K. and Scotland.

Transport sector

Consumption in this sector consists mainly of motor spirits, derv fuel and aviation turbine fuel. For example, in the U.K. in 1974, motor spirits consisted about 60 per cent, derv fuel about 20 per cent and aviation turbine fuel about 13 per cent, of the total consumption of petroleum in the transport sector. The price of derv fuel is approximately 4 per cent cheaper than motor spirits and the price of aviation turbine fuels is approximately 30 per cent cheaper than motor spirits.

The determination of an accurate price for the transport sector would have involved much computation and therefore the price of the 3-star gasolene (or standard grade motor oil, as it was called in the earlier years) for the inner-zone was taken to represent the price of petroleum in the transport sector. Using this price means that the actual price may have been over-estimated by about 4 per cent (30 per cent of 13 per cent) due to the lower price of the aviation turbine fuel. The prices were assumed to be the same for both the U.K. and Scotland and are shown on Table 18b.

Public and miscellaneous sector

Consumption in this sector consists mainly of gas/diesel oil and fuel oil. For example, in the U.K. in 1974, these two fuels constituted about 99 per cent of total consumption. For fuel oil, the inner-zone price of the heavy grade, and for the gas/diesel oil, the inner-zone price were taken. The price in the sector was computed by weighting these two prices by the respective consumption of the two fuels.

The prices in the U.K. and in Scotland were assumed to be the same and these figures are shown on Table 18b.

8.3.18 Prices of gas in the U.K. and in Scotland (Tables 19a, 19b, 19c, 19d and 19e)

Domestic sector

Prices of gas in the domestic sector for the U.K. were calculated by using quarterly data supplied by the British Gas Board. Since consumption of gas in Northern Ireland is small (less than 5 per cent of the total for the U.K.), the use of average gas price in Britain as the price for the whole of the U.K. would involve very little error. The figures are shown on Table 19a.

For Scotland, prices for the earlier years were computed from financial year statistics and prices for the recent years were computed from the monthly and quarterly data supplied by the Scottish Gas Board. Figures are shown on Table 19b.

Industrial sector

The quarterly data supplied by the British Gas Board gave information on the prices to industrial consumers, excluding certain bulk consumers. Since the bulk consumers, who are supplied with gas at a cheaper rate than that for the small consumers, consume a significant amount of gas, the use of data supplied by the B.G.B. would have resulted in considerable overestimation of the price. For this reason, the calendar year prices for the industrial sector were computed from the financial year figures quoted in the U.K. D.E.S. Figures are shown on Table 19a.

For Scotland, the prices were computed in the same way as that for the domestic sector. The figures are shown on Table 19b.

Public and commercial sector

The data was constructed, both for the U.K. and for Scotland, in the same way as that for the domestic sector described above as shown on Tables 19a and 19b.

8.3.19 Prices of electricity in the U.K. and in Scotland (Tables 20a, 20b, 20c and 20d)

For the U.K., the price of electricity was taken to be the same as the price charged by the public supply authority. The data on prices were obtained from the U.K. D.E.S. The prices are shown on Table 20a.

For Scotland, the price was computed from the quarterly data supplied by the N.S.H.E.B. and the S.S.E.B. Figures are shown on Tables 20b, 20c and 20d.

8.3.20 Prices of final energy in the U.K. and in Scotland (U.K. Tables 21a and 21b; Scotland, Tables 22a and 22b)

These two sets of tables provide the summary of final energy prices and expenditure for the U.K. and Scotland.

8.3.21 Prices of effective energy in the U.K. (Table 23)

The present study requires effective prices of the entity called "energy" but does not require the effective prices for each type of energy in each sector. For this reason, the table on effective energy prices was compiled only for the U.K. and this table was used in Chapter 5 to illustrate the differences between final energy prices and effective energy prices.

This table is compiled on the basis of two tables, (1) Table 15, which gives effective energy consumption in the U.K. and (2) Table 21b, which gives expenditure on energy in the U.K.

8.3.22 Consumers' expenditure on energy in the U.K. (Tables 24a, 24b, 24c, 24d, 24e and 24f)

Consumers' expenditure on energy consists of (1) expenditure in the domestic sector and (2) expenditure on personal transport i.e. transport for leisure and recreation. Domestic consumption of and expenditure on energy, as shown on Table 24a, was available from earlier tables (summary Table 21b), but an estimate had to be made for energy consumption in transport. Consumption of energy in transport is the sum of consumption in four transport types: (1) private cars and motor cycles, (2) public service vehicles and taxis, (3) railways and (4) aviation. Consumption in water transport is small and was ignored. Consumption of energy in each of the above four categories is discussed in turn.

8.3.22.1 Private cars and motor cycles (Table 24b)

Expenditure on petrol and oil is available from the N.I.E. statistics, for the years 1964 to 1974. Prior to 1964 the data is available not on "expenditure on petrol and oil" but on the "running cost of motor vehicles". It was found that for the years between 1964 and 1974 the "expenditure on petrol and oil" was approximately 50 per cent of the "running cost of motor vehicles". Hence the expenditures on petrol and oil for the years 1955 to 1963 were estimated to be 50 per cent of the running cost of motor vehicles.

The final energy consumption corresponding to this expenditure was obtained by dividing the expenditure by the price of gasolene. The corresponding effective energy consumption was obtained by assuming a 20 per cent conversion factor from final to effective energy.

The effective energy consumption estimated by the above procedure represents the energy consumption of cars which are owned and used privately. But private cars are not only used for the purposes of leisure and recreation but also for other purposes such as travelling to work. The use of cars, purely for recreational purposes, was estimated as follows.

In view of the fact that the total energy consumption in the transport sector is small compared to the energy consumption in the domestic sector (in effective energy terms it was 24 per cent in 1973), a precise estimation of private transport consumption that would involve much computation, was not considered worthwhile. For this reason, the survey by Gray (1969) on private motoring in England and Wales was used as the basis of estimation. Since consumption by private cars constitutes about 60 per cent (1973 figure) of the total transport energy consumption, the maximum error in the estimate of total consumer energy demand is unlikely to be more than 1 per cent.

According to Gray, the proportion of all journeys for entirely private purposes was between 50 to 47 per cent in 1962 and 49 to 47 per cent in 1963; the higher figures in the set correspond to the month of July and the lower figures in the set correspond to the month of October. An average figure of 50 per cent was taken for our calculation since the average length of journey for recreational purposes was slightly higher than that for non-recreational purposes (for example, travelling to and from work). This figure of 50 per cent was taken as the proportion of recreational consumption for not only (1) cars but also for (2) buses and taxis, (3) rail and (4) aviation.

Full-scale surveys have been carried out by the Department of Environment (1974) in the U.K. in 1965 and 1972-73 and these surveys contain information, on magnetic tapes, on the purpose of journeys by private cars, buses, rail etc. (except air travel). This information had not been used in the present study, since the potential improvement in the overall figure was not considered worthwhile in view of the considerable computation that would have been necessary.

8.3.22.2 Public service vehicles and taxis (Table 24c)

The source of information on consumption in this category was the U.K. D.E.S. Consumption consists mainly of derv fuel and motor spirits, motor spirits constituting a small proportion of the total consumption. The total consumption of final energy was estimated by adding the consumptions of derv fuel and motor spirits and the expenditure was estimated by using the price series for derv fuel. A conversion efficiency of 28 per cent was used for converting final energy consumption to effective energy consumption.

Consumption of energy for leisure and recreational purposes was assumed to be 50 per cent of the total consumption, as discussed above in Section 8.3.22.1.

8.3.22.3 Railways (Table 24d)

Consumptions of solid fuels, gas/diesel oil and electricity were obtained from the U.K. D.E.S. and the consumption figures were multiplied by the respective prices to give the total expenditure. Consumption of effective energy was obtained by using efficiency figures for each type of energy.

Unlike the previous two categories of "private cars and motor cycles" and "public service vehicles and taxis", in which the private consumption represented 50 per cent of the total, the private consumption of rail transport was estimated to be 25 per cent. The reason for this was that energy consumption by the passenger transport was assumed to be 50 per cent of the energy consumption by railways (which consist of both passenger transport and freight transport). The basis for this assumption were the figures published in the annual report (for 1966) of the British Railways Board which showed that for 1968 (Tables 2A and 2B) the receipts from passenger and freight transport were respectively £185 million and £262 million. Assuming a slightly higher load factor for the freight transport, the energy consumption in passenger transport was estimated to be approximately 50 per cent of the total energy consumption.

Out of this total passenger transport only 50 per cent is used for private purposes and hence 50 per cent of 50 per cent, i.e. 25 per cent, was used as the proportion for private consumption.

8.3.22.4 Aviation (Table 24e)

Consumption of final energy was obtained from the U.K. D.E.S. The total expenditure on energy and the total consumption of energy were obtained by using the price of aviation turbine fuel and an efficiency of conversion of 28 per cent respectively. Consumption of energy for private purposes was assumed to be 50 per cent of the total consumption.

8.3.23 Consumers' expenditure on energy in Scotland (Tables 25a, 25b, 25c, 25d, 25e and 25f)

Domestic consumption of energy and domestic expenditure on energy were available from the earlier Scottish tables and are shown on Table 25a.

The general philosophy behind the breakdown of transport energy consumption into (1) recreational purposes and (2) non-recreational purposes, as discussed earlier in Section 8.3.22.1, holds for Scotland as well.

Expenditures on the categories of (1) "private cars and motor vehicles", and (2) "public service vehicles and taxis" were not available and were estimated using the U.K. as the basis. For example, the ratio between (a) consumption of motor spirits for private purposes to (b) the total consumption of motor spirits in the U.K. was known. This ratio was used to find out the consumption of motor spirits for private purposes in Scotland, since the total consumption of motor spirits in Scotland was known. Calculations are shown in Table 25b. A similar procedure was adopted to find out the private consumption of "public service vehicles and taxis", and this time the ratio for derv rather than motor spirits was used. Details of these calculations appear in Table 25c.

Apart from the consumption of gas/diesel oil in the railways, consumptions were available of all other forms of energy for both the railways and aviation. The consumption of gas/diesel oil in the railway in Scotland was assumed to be 10 per cent of the consumption of gas/diesel oil in the railways in the U.K. The rationale behind this assumption was that the delivery of gas/diesel oil in Scotland was approximately 10 per cent of the U.K. figure. Detailed calculations for the railway and aviation are shown respectively on Tables 25e and 25f.

8.4 Discussion of data other than energy

8.4.1 Consumption of energy and non-energy in the U.K. (Tables 26a and 26b)

Four sets of data were required for our analysis, (1) total consumers' expenditure, (2) price of energy, (3) quantity of energy and (4) quantity of non-energy.

Total consumers' expenditure was obtained from the N.I.E. statistics. Price and quantity of energy were available from earlier tables. What was not known was the quantity of non-energy and it was estimated in the following way.

The retail price index may be defined as

$$RPI(t) = 100 \left[\alpha(0) \frac{PE(t)}{PE(0)} + [1 - \alpha(0)] \frac{PC(t)}{PC(0)} \right] \qquad (8.1)$$

where RPI(t) is the retail price index in year t

α(0) is the share of energy expenditure to total consumers' expenditure

PE(t) is the price of energy in year t

PE(0) is the price of energy in a base year, which is taken as 1963

PC(t) is the price of "non-energy" in year t and

PC(0) is the price of "non-energy" in the year 1963

The equation (8.1) can be re-written as

$$RPI(t) = \alpha(0) \frac{PE(t)}{PE(0)} 100 + [1 - \alpha(0)] \frac{PC(t)}{PC(0)} 100 \qquad (8.2)$$

which on transposition gives

$$RPI(t) - \alpha(0) \frac{PE(t)}{PE(0)} 100 = [1 - \alpha(0)] \frac{PC(t)}{PC(0)} 100 \qquad (8.3)$$

so that

$$\frac{PC(t)}{PC(0)} 100 = \frac{RPI(t) - \alpha(0) \frac{PE(t)}{PE(C)} 100}{1 - \alpha(0)} \qquad (8.4)$$

If the price of "non-energy" is measured as an index with 1963 = 100, then PC(0) = 100, so that equation (8.4) becomes

$$PC(t) = \frac{RPI(t) - \alpha(0) \frac{PE(t)}{PE(0)} 100}{1 - \alpha(0)} \qquad (8.5)$$

or

$$\tilde{PC}(t) = \frac{PC(t)}{RPI(t)} = \frac{RPI(t) - \alpha(0) \frac{PE(t)}{PE(0)} 100}{[1 - \alpha(0)]\ RPI(t)} \qquad (8.6)$$

where $\tilde{PC}(t)$ is the price of "non-energy" deflated by the retail price index.

Since $\alpha(0)$, RPI(t), PE(t) and PE(0) are known, $\tilde{PC}(t)$ can be found.

The corresponding quantity of "non-energy" may be found from the expression

$$X(t) = XE(t) + XC(t) = PE(t)\ QE(t) + PC(t)\ QC(t) \qquad (8.7)$$

where X(t) is the consumers' expenditure

QE(t) is the quantity of energy

QC(t) is the quantity of "non-energy"

Dividing both sides of the equation (8.7) by the retail price index,

$$\tilde{X}(t) = \frac{X(t)}{RPI(t)} = \frac{PE(t)\ QE(t)}{RPI(t)} + \frac{PC(t)\ QC(t)}{RPI(t)} = \tilde{PE}(t)\ QE(t) + \tilde{PC}(t)\ QC(t) \qquad (8.8)$$

where $\tilde{X}(t)$, $\tilde{PE}(t)$ and $\tilde{PC}(t)$ are respectively the consumers' expenditure, price of energy and the price of "non-energy", all deflated by the retail price index.

It can be seen from equation (8.8) that if $\tilde{X}(t)$, $\tilde{PE}(t)$, QE(t) and $\tilde{PC}(t)$ are known, QC(t) can be found.

Based on the above method, Tables 26a and 26b show the calculations for energy and "non-energy" when energy is measured respectively in effective units and final units.

8.4.2 Consumption of energy and non-energy in Scotland
Tables 27 and 28

Consumers' expenditure in the U.K. was obtained readily from the N.I.E. statistics but this data for Scotland was not available from official sources. A recent work by Begg (1975) provides estimates of consumers' expenditure in Scotland for the years 1961 to 1971 and these figures were used. The rest of the series was constructed in the following manner.

The consumers' expenditure in Scotland as estimated by Begg and the consumers' expenditure in the U.K. as supplied by the N.I.E. statistics, were both compared with the information on weekly household expenditure as supplied by the Family Expenditure Survey. It was found that, both for Scotland and for the U.K., the Family Expenditure Survey included about 88 per cent of the total consumers' expenditure as estimated by Begg for Scotland and as given by the N.I.E. statistics for the U.K. This suggested that the estimates by Begg for Scotland are comparable to the N.I.E. data for the U.K. The ratios of per capita expenditure in Scotland to the per capita expenditure in the U.K., during 1961 to 1971 were calculated from the above two series (i.e. Begg for Scotland and N.I.E. for the U.K.), and the trend was extrapolated to cover the years 1955 to 1960 and 1972 to 1974. For example, it was found that the ratio increased gradually from 0.91 in 1961 to 0.93 in 1971. The ratio for 1955 was assumed to by 0.90, hence by taking the population ratio between U.K. and Scotland, the total consumers' expenditure in Scotland in 1955 was $(0.90 \times 13088 \times 5.113) \div 50.946$, where 13088 is the consumers' expenditure (in £m) in the U.K. in 1955, 5.113 is the population (in millions) in Scotland in 1955 and 50.946 is the population (in millions) in the U.K.

Details of these calculations are shown on Table 27.

The price and quantity of "non-energy" for Scotland were calculated precisely in the same way as for the U.K., as discussed in Section 8.4.1. The figures for Scotland are given on Table 28.

8.4.3 Consumption of energy, labour and capital in the production and distribution sectors in the U.K. (Tables 29 and 30)

8.4.3.1 Energy (Table 29)

This table could have been discussed earlier while discussing the individual series on energy, but it was thought to be more convenient to discuss the data on energy, labour and capital together.

Consumption of energy in this sector consists of (a) industrial consumption, (b) consumption in the public and miscellaneous sector (including agriculture) and (c) consumption of transport for industrial and commercial purposes. The data for (a) and (b) were available from earlier tables and the data for (c) was computed by deducting private consumption of transport from total transport. Calculations are shown in Table 29.

8.4.3.2 Labour (Tables 30a, 30b and 30c)

The data correspond to the total labour employed (demand) rather than total available labour (supply).

Quantity of labour is measured by the number of man-hours worked. This is obtained by multiplying the total number of employed persons in the U.K. by the average annual hours worked. The price of labour is represented by the average hourly earnings (which is higher than the average basic wages due to higher rates for overtime work) of the manual workers. Data on labour appears on Table 30a.

The data shown on Table 30a refers to the total labour in the economy, including the energy sector. Since the data on energy consumption excludes consumption by the energy sector, the labour data of Table 30a had to be transformed to exclude the energy sector. The total employment in the energy sector was computed in Table 30b and the corrected data appears in Table 30c.

8.4.3.3 Capital (Tables 30d, 3oe/1, 30e/2, 30e/3, 30e/4, 30e/5, 30f and 30g)

The value of capital is obtained from the N.I.E. statistics, from the series of net capital stock (excluding capital for personal sector). The quantity of capital and the price of capital services were calculated, by following the approach of Mizon (1974).

The price of capital is defined as

$$q(t) = \frac{\text{G.D.F.C.F. at current prices}}{\text{G.D.F.C.F. at 1970 prices}} \times 100 \qquad (8.9)$$

where GDFCF stands for Gross Domestic Fixed Capital Formation.

The quantity of capital Q(t) is obtained by

$$Q(t) = \frac{\text{Net Capital Stock at time t}}{q(t)} \qquad (8.10)$$

The price that is necessary is not the price of capital q(t) but the price of capital services R(t), which is obtained from

$$R(t) = q(t) \, . \, r(t) \qquad (8.11)$$

where r(t) is the dividend yield of ordinary industrial shares.

The computed figures for the quantity of capital and the price of capital services are shown on Table 30(d).

The data given on Table 30(d) refers to the total capital in the economy, including the energy sector. As explained in Section 8.4.3.2, the data on energy consumption excludes consumption by the energy sector and hence the data on capital had to be corrected, so that the energy sector was excluded.

Tables 30e/1, 30e/2. 30e/3 and 30e/4 respectively show the computations of capital for the coal mining, petroleum refining, gas industry and electricity industry. Where the capital employed in a particular sector (say petroleum refining) was not available separately but in combination with another sector, the proportions of capital employed were assumed to be the same as the proportion of respective outputs. For example, the capital employed in petroleum refining was not available; what was available was the capital employed in the chemical and allied sector which includes petroleum refining. The output (in money terms) of petroleum refining and the total output in the chemical and allied sector were known and the share of capital employed was taken to be the same as the share of output. (See Table 30e/2).

The revised figures for the quantity of capital and the price of capital services are shown in Table 30(g).

TABLE 8.1

Consumer demand for energy in the U.K.
(Energy consumption measured in effective energy units)

Year	Quantity of energy Million Therm	Price of energy Pence/ Therm*	Quantity of non-energy Million units	Consumers' expenditure £m	Population Million
1955	4940	14.82	152.1	16093	50.946
1956	5133	16.75	155.3	16433	51.184
1957	5073	16.40	158.3	16723	51.430
1958	5452	16.58	161.4	17113	51.652
1959	5376	16.87	169.8	17933	51.956
1960	5800	17.07	176.2	18644	52.372
1961	5937	17.37	179.1	18961	52.807
1962	6468	17.38	181.5	19295	53.273
1963	6894	17.61	189.0	20118	53.552
1964	6620	18.19	196.0	20795	53.866
1965	7054	18.00	198.8	21132	54.219
1966	7238	18.31	202.8	21562	54.503
1967	7438	18.28	207.2	22041	54.802
1968	7880	18.62	213.1	22688	55.048
1969	8302	18.07	213.6	22821	55.262
1970	8564	17.34	217.5	23256	55.418
1971	8671	16.98	221.7	23688	55.610
1972	9218	16.76	233.8	24992	55.793
1973	9673	16.02	243.7	26068	55.933

* Effective energy unit deflated by the Retail Price Index

Source: Table 26a

TABLE 8.2

Consumer demand for energy in Scotland
(Energy consumption measured in effective energy units)

Year	Quantity of energy Million Therm	Price of energy Pence Therm*	Quantity of non-energy Million units	Consumers' expenditure £m	Population Million
1955	479.3	15.29	13.62	1453	5.1130
1956	510.6	17.35	13.83	1478	5.1190
1957	496.7	17.05	14.08	1500	5.1247
1958	524.8	17.17	14.36	1533	5.1420
1959	531.0	17.53	15.04	1603	5.1626
1960	535.5	18.19	15.60	1659	5.1770
1961	573.4	17.88	15.81	1686	5.1838
1962	610.3	17.97	15.57	1670	5.1975
1963	636.5	18.43	16.01	1718	5.2051
1964	609.4	18.43	17.23	1835	5.2085
1965	641.8	17.95	17.58	1877	5.2099
1966	650.7	18.58	17.81	1900	5.2066
1967	654.9	18.71	18.18	1938	5.1983
1968	686.1	18.95	18.43	1969	5.2002
1969	722.4	18.16	18.35	1968	5.2085
1970	738.0	17.82	18.96	2031	5.2137
1971	718.5	18.33	19.26	2058	5.2174
1972	728.0	18.41	20.83	2217	5.2104
1973	797.2	17.71	21.47	2186	5.2117

* Effective energy unit deflated by the Retail Price Index

Source: Table 28

TABLE 8.3

Derived demand for energy in the U.K.
(Energy consumption measured in effective energy units)

Year	Quantity of energy Million Therm	Price of energy * £/therm	Quantity of Labour 1000 million man-hours	Price of Labour £/ man-hours	Quantity of Capital Index Number	Total Expenditure £m
1955	17488	0.0773	49.43	0.238	451.2	14572.0
1956	17646	0.0970	49.75	0.258	429.4	16364.0
1957	17266	0.0876	49.68	0.271	450.6	16955.0
1958	16879	0.0937	48.87	0.283	461.9	17480.0
1959	16813	0.0952	49.71	0.293	473.3	17795.0
1960	18384	0.0962	50.63	0.315	504.6	19381.0
1961	18199	0.1053	50.92	0.338	525.0	21100.0
1962	18573	0.1062	51.00	0.353	546.3	22276.0
1963	19329	0.1080	51.25	0.367	572.2	22835.0
1964	20019	0.1175	52.46	0.395	611.1	25342.0
1965	20813	0.1178	52.58	0.432	647.7	28120.0
1966	20908	0.1252	51.87	0.467	668.3	30080.0
1967	20902	0.1339	50.77	0.486	711.6	30620.0
1968	21780	0.1490	50.77	0.523	752.8	32275.0
1969	22613	0.1507	50.78	0.563	798.8	34900.0
1970	23341	0.1613	49.76	0.638	843.0	39322.0
1971	22990	0.1756	48.07	0.718	884.3	42358.0
1972	23411	0.1799	47.85	0.834	948.7	47873.0
1973	24756	0.2070	49.95	0.936	1011.9	57602.0

* Effective energy units, not deflated by the Retail Price Index

Source: Table 30(g)

TABLE 8.4

Consumer demand for energy in the U.K.
(Energy consumption measured in final energy units)

Year	Quantity of energy Million therm	Price of energy Pound Therm*	Quantity of non-energy Million units	Consumers' expenditure £m	Population Million
1955	17376.0	0.0421	150.1	16093.0	50.946
1956	17467.0	0.0492	153.2	16433.0	51.184
1957	16858.0	0.0492	156.3	16723.0	51.430
1958	17379.0	0.0520	159.8	17113.0	51.652
1959	16569.0	0.0547	167.9	17933.0	51.956
1960	17439.0	0.0571	174.9	18644.0	52.372
1961	17037.0	0.0605	178.2	18961.0	52.807
1962	17808.0	0.0631	181.1	19295.0	53.273
1963	18181.0	0.0668	189.0	20118.0	53.552
1964	16909.0	0.0712	196.5	20795.0	53.866
1965	17413.0	0.0729	199.8	21132.0	54.219
1966	17315.0	0.0765	204.3	21562.0	54.503
1967	17132.0	0.0794	209.4	22041.0	54.802
1968	17546.0	0.0836	215.7	22688.0	55.048
1969	17946.0	0.0836	216.7	22821.0	55.262
1970	17904.0	0.0829	221.2	23256.0	55.418
1971	17640.0	0.0834	225.8	23688.0	55.610
1972	18187.0	0.0850	238.7	24992.0	55.793
1973	18653.0	0.0831	249.1	26068.0	55.933

* Final energy units deflated by the Retail Price Index

Source: Table 20b

CHAPTER 9

Results

9.1 Introduction

The results from the analysis of the consumer demand and the derived demand models are presented in this chapter.

As explained earlier in Section 7.2.3, the models are estimated by using non-linear programming routines that minimise the sum of squares of the residuals (i.e. Left-hand-side minus Right-hand-side of an equation). Since non-linear routines cannot guarantee the global minimum, the estimating procedure involves searches starting from given initial grid points. The global minimum is assumed to have been achieved when searches starting from different directions tend to converge towards a minimum.

The estimation of the consumer demand model involves searches in eight dimensions since the utility function has eight parameters and the estimation of the derived demand model involves searches in thirteen dimensions since the production function has thirteen parameters. The estimations, for both the consumer and the derived demand models, are highly time-consuming, using routines that are presently available. The estimation of the derived demand model is more time-consuming than the consumer demand model since (a) the derived demand model has a larger number of parameters and (b) two equations (instead of one) need to be estimated, as explained earlier in Section 7.3.3. In view of the above time-constraint and the fact that more extensive data was available for the consumer demand, a much greater part of the research effort was devoted to a careful estimation of the consumer demand models.

In all six models were estimated, five on the consumer demand and

and only one on the derived demand. A summary of the estimated models is given on the following table.

TABLE 9.1 Description of the models

Model No.	Description
1	Consumer demand, U.K., effective energy, unconstrained parameters*
2	" " final energy, unconstrained parameters*
3	" " effective energy, constrained parameters*
4	" " final energy, constrained parameters*
5	" Scotland, effective energy, constrained parameters*
6	Derived demand, U.K., effective energy, constrained parameters*

* Unconstrained parameters refer to the situation where all the parameters were allowed to take either positive or negative values. The constrained parameter version allowed the paramcters to have only positive values.

The results from the consumer demand models are discussed first followed by a discussion of the results from the derived demand model.

9.2 The consumer demand

Two programmes were used for estimating the consumer demand models. The values for the set of eight parameters (b, α, β, γ, δ, ε, λ and μ) corresponding to the maximum likelihood were obtained from the first program (estimating program) that minimised the sum of squares of the residuals. The values of these parameters were then used in the second programme (elasticity program) to obtain the income and price elasticities and the elasticities of substitution.

The final values of the eight parameters and the corresponding values of the sum of squares for each model are given in the following table. To facilitate comparison of the relative magnitude of the parameters in different models, the parameter values for the five parameters α, β, γ, δ and ε presented here are their normalised values i.e. α has been shown as $\alpha/\sum |\alpha| + |\beta| + |\gamma| + |\delta| + |\varepsilon|$ and so on for β, γ, δ and ε.

TABLE 9.2 Final values of the parameters from the estimating programme

Parameters	Model 1	Model 2	Model 3	Model 4	Model 5
b	2.089	2.099	1.614	3.786	1.323
α	-0.16×10^{-5}	-0.24×10^{-5}	0.4×10^{-10}	0.8×10^{-8}	0.4×10^{-9}
β	0.13×10^{-5}	1.00×10^{-4}	0.1×10^{-10}	0.15×10^{-7}	0.5×10^{-8}
γ	0.06×10^{-4}	-0.12×10^{-3}	0.1×10^{-3}	0.8×10^{-6}	0.5×10^{-2}
δ	0.25×10^{-4}	-0.36×10^{-3}	0.5×10^{-2}	0.036	0.043
ε	0.999	-0.971	0.993	0.963	0.951
λ	0.441	0.052	0.238	0.967	4.087
μ	0.059	1.527	1.454	1.318	5.848
Sum of squares	0.431×10^{-4}	0.974×10^{-4}	0.117×10^{-3}	0.101×10^{-3}	0.832×10^{-4}

Note: For a description of the models, see Table 9.1

The complete set of elasticities is presented in Table 9.4. Tables 9.4(a), 9.4(b), 9.4(c), 9.4(d) and 9.4(e) correspond respectively to the model 1, model 2, model 3, model 4 and model 5. The meaning of terms used in the tables are shown on a separate Table 9.3.

The utility function used in the study (a modified GCES) gives a local second-order approximation to any utility function, only when the estimated parameters (i.e. α, β etc) are allowed to take any values, positive or negative. Since the elasticities depend only on the second-order terms, the true elasticities of the underlying utility function are approximated only in the unconstrained models. The unconstrained model was estimated both for effective energy and for final energy and the results are discussed below in Section 9.2.1.

The unconstrained models provide estimates of the elasticity of the underlying utility function, but estimating the elasticities is not the sole objective of our analysis. A second objective is to test whether the utility function is well-behaved over a wide area.

The utility function is well-behaved if all the estimated parameters (α, β etc) are positive. Consequently a second set of programmes were run in which the parameters were constrained to take only positive values. The results from the constrained models, both for effective energy and for final energy are discussed in Section 9.2.2.

The models mentioned above, all refer to the United Kingdom. For Scotland, one model was estimated and the results are discussed in Section 9.2.3.

9.2.1 United Kingdom, unconstrained models (Tables 9.4(a) and 9.4(b))

The results for the effective energy model are shown in Table 9.4(a) which shows that the own-price elasticities of energy and non-energy are negative throughout the period 1955 to 1973, the elasticity of non-energy remaining 1.0 throughout the period while that of energy increases slightly from 0.40 to 0.34 over the same period. The elasticity of substitution between energy and non-energy is low (average 0.39) and this is reflected in the low values of the cross-price effects.

The income elasticity of energy is positive, less than unity and remains virtually constant throughout the period. The income elasticity of non-energy is nearly 1.0 and also remains constant throughout the period.

When energy is measured in terms of final energy instead of effective energy, the values of the elasticities become markedly different. A comparison between Tables 9.4(a) and 9.4(b) leads to the following observations.

(a) The own-price elasticity becomes higher when energy is measured in final energy units. Over the period 1955 to 1973, the elasticity increases from 1.16 to 2.60 in the case of final energy whereas it decreases from 0.40 to 0.34 in the case of effective energy.

(b) The elasticity of substitution between energy and non-energy is much higher when energy is measured in final energy units (for example an average value of 1.45 instead of 0.39) and this is reflected in the cross-price effect e_{12} which is higher in the case of final energy.

(c) The income elasticity of energy becomes negative, implying that energy is an inferior good, when energy is measured in terms of final energy whereas the income elasticity is positive when energy is measured in effective energy units. Moreover the income elasticity decreases from -0.73 to -3.38 over the period 1955 to 1973 in contrast to the corresponding values in the case of effective energy which increases slightly from 0.38 to 0.41.

The above results can be compared to those obtained by Jorgenson from his study of consumer demand in the U.S.A. as mentioned in Section 6.5. Jorgenson obtained positive income elasticities for both K (durable goods) and N (non-durable goods). Between the period 1947 to 1971, the income elasticities of K and N changed respectively from 2.80 to 0.97 and from 0.51 to 1.13. In the present study, the income elasticity of non-energy is estimated to be nearly unity in the case of effective energy and around 0.86 in the case of final energy. Hence it can be concluded that, with regard to non-energy, the results from the present study are in reasonable agreement with the results from Jorgenson's analysis.

With respect to energy, the results obtained by Jorgenson showed a negative income elasticity for most of the period between 1947 to 1971. This is indeed the case, when in the present study, energy is measured in terms of final energy. However, when energy is measured in terms of effective energy, the income elasticity becomes positive, although less than unity. Since there are no a priori reasons to consider energy as an inferior good (in fact this particular result of negative income elasticity was described as "surprising" by Jorgenson), analysis in terms of effective energy may be considered to be more appropriate than analysis in terms of final energy.

The own-price elasticity of energy was found to move from (+)0.47 to 0.76 during the period 1947 to 1971, in the Jorgenson study. This elasticity is found to move from 0.40 to 0.34 for effective energy and from 1.60 to 2.60 for final energy, in the present study.

9.2.2 United Kingdom, constrained models (Tables 9.4(c) and 9.4(d))

The underlying assumption behind the constrained model is that the utility function is well-behaved over the whole of the non-negative orthant. Consequently, the results presented in Tables 9.4(c) and 9.4(d) show the elasticities, when the utility function is assumed to be well-behaved.

A comparison between Tables 9.4(a) and 9.4(c), which show the results (when energy is measured in effective energy units) corresponding to the unconstrained and constrained models, leads to the following observations. With the exceptions of income elasticity and own-price elasticity of non-energy which are virtually the same in both the constrained and the unconstrained models, all other elasticities appear sharper (i.e. more positive or more negative) in the constrained model. The income elasticity of energy is particularly high (an average of 2.1 instead of 0.40 in the unconstrained model) and the elasticity of substitution is also significantly higher (3.8 instead of 0.39).

A comparison between Tables 9.4(b) and 9.4(d) show that the income elasticity of energy is higher in the constrained model, also when energy is measured in terms of final energy. The average value for the constrained version is 1.68 as compared to 1.30 for the unconstrained version.

Since the likelihood function is proportional to the logarithm of the sum of squares, the hypothesis that the utility function is well-behaved can be tested by the Chi-Square tests. The test statistic is the differences in the likelihood function between the unconstrained and the constrained models and the degrees of freedom is equal to the number of negative paramaters in the unconstrained version.

In the case of effective energy the test statistic is 382 - 343 = 39 which is higher than both $\chi^2_{0.95,1}$ (= 3.84) and $\chi^2_{0.99,1}$ (= 6.63). Hence, in the case of effective energy the hypothesis that the utility function is well-behaved can be rejected at both 95% and 99% significance level.

In the case of final energy the test statistic is 351 - 349 = 2 which is lower than $\chi^2_{0.95,4}$ = 9.48 and $\chi^2_{0.99,4}$ = 13.27 and hence the hypothesis can not be rejected even at the 95% significance level.

9.2.3 Scotland, effective energy, constrained model (Table 9.4(e))

For Scotland, estimations were attempted for both the unconstrained and the constrained versions. But the results from the unconstrained version could not be obtained in time for them to be presented in this study and consequently the results of the constrained version are presented here.

A comparison with the corresponding results from the U.K. model (Table 9.4(c)) show that, with regard to the movement over the period 1955 to 1973, all the elasticities for Scotland show trends that are similar to that of the U.K. But in terms of absolute values of these elasticities, with the exception of own-price elasticity and income elasticity of non-energy, the elasticities are higher in Scotland than in the U.K. For example, the income elasticity of energy, over the period 1955 to 1973, decreases both in Scotland and in the whole of the U.K. but the corresponding figures are 3.6 and 1.9 for Scotland as compared to 3.0 and 1.4 for the U.K.

9.3 The derived demand

Before discussing the results from the derived demand model, the following points may be noted.

(a) A fully-articulated model must take technical progress into account. The present model, however, ignores this question except in so far as energy is measured in effective energy units and consequently the technical progress is incorporated in the energy term. In a sense, this is equivalent to assuming that technical progress is energy-augmenting.

(b) The study by Berndt and Wood (discussed earlier in Section 6.6), which form the basis of the present study, does take technical progress into account by measuring capital, energy, labour and material with respect to the Division Index. In the present study, however, measurement of capital, labour and energy, using a Division Index, was not attempted since that would have involved a major exercise in itself.

(c) A trend variable t can be used to reflect technical progress. However, this was not used in the present model since the chosen unit of energy already reflects technical progress and further introduction of t would have resulted in strong correlation.

As in the case of the consumer demand models, the estimation of the derived demand model involved using two separate progremmes, the estimation programme and the elasticity programme. A strict convergence was not obtained in the estimating programme and two programmes gave very similar sum of squares and yet quite different values for the estimated parameters. The results from the estimating program are shown in Table 9.5 below.

TABLE 9.5 Final values of the parameters

Parameters	Programme 1	Programme 2
b	2.986	1.649
α	0.60×10^{-3}	0.015
β	0.21×10^{-8}	0.48×10^{-2}
γ	0.27×10^{-7}	0.21×10^{-5}
δ	0.54×10^{-7}	0.11×10^{-4}
ε	0.33×10^{-2}	0.026
φ	0.20×10^{-2}	0.028
ψ	0.206	0.073
π	0.186	0.651
ρ	0.600	0.199
λ	4.464	3.684
μ	1.227	0.853
ν	6.667	4.422
Sum of Squares	0.213×10^{-2}	0.222×10^{-2}

The results from Programme 1 and Programme 2 are shown on Tables 9.6/1 and 9.6/2 respectively.

Both the programmes give price elasticity figures (Tables 9.6/1(a), 9.6/1(b), 9.6/2(a) and 9.6/2(b)) which are not implausible a priori, in general the elasticities values obtained from Programme 2 are higher than those obtained from Programme 1. Both the programmes show the same relative order for the own-price elasticities, which are highest for energy and lowest for capital. The own-price elasticity is much higher for energy compared to those for capital and labour; in contrast the relative magnitude of these own-price elasticities are found to be the same by Berndt and Wood.

The elasticities of substitution are shown on Tables 9.6/1(c) and

9.2/2(c) for programmes 1 and 2 respectively. All the partial elasticities of substitution are positive and in terms of ranking, that between capital and energy is highest and that between capital and labour is lowest. These results do not seem reasonable a priori, and indeed are in contradiction with those obtained by Berndt and Wood who found a negative elasticity of substitution between capital and energy meaning that energy and capital are complementary and are not substitutes. This somewhat surprising result from the present model may have been caused either by the fact that (a) convergence has not been achieved in our estimation programme or that (b) the ignoring of technical progress (except in the term for energy) may have caused a mis-specification of the model, or (c) the fact that the parameters are constrained.

TABLE 9.3

Meaning of terms used in the later tables

For Tables 9.4

Good 1	is energy
Good 2	is "non-energy"
e_{11}	is the price elasticity of good 1 with respect to good 1 (i.e. own-price elasticity) i.e. the change in the demand for good 1 for a unit change in the price of good 1
e_{12}	is the price elasticity of good 1 with respect to good 2 (i.e. cross-price elasticity), $e_{12} \neq e_{21}$
e_{21}	is the price elasticity of good 2 with respect to good 1, $e_{21} \neq e_{12}$
e_{22}	is the own-price elasticity of good 2
m_1	is the income elasticity of good 1
m_2	is the income elasticity of good 2
es_{12}	is the elasticity of substitution of good 1 with respect to good 2, $es_{12} = es_{21}$

es_{11} and es_{22} are equal to zero

For Tables 9.6

Good 1	is capital
Good 2	is labour
Good 3	is energy

e_{11}, e_{12}, e_{13}, e_{21}, e_{22} and e_{23}. etc. are the price elasticities;

e_{11}	is the price elasticity of good 1 with respect to good 1,
e_{12}	is the price elasticity of good 1 with respect to good 2 and so on

es_{12}, es_{13} etc. are the elasticities of substitution

$es_{12} = es_{21}$, $es_{23} = es_{32}$, and so on

TABLE 9.4(a)

Consumer demand elasticities
(U.K., effective energy, unconstrained parameters)

Year	e_{11}	e_{21}	e_{12}	e_{22}	m_1	m_2	$es_{12} = es_{21}$
1955	-0.40	0.020	6×10^{-6}	-1.00	0.38	0.99	0.40
1956	-0.40	0.018	6×10^{-6}	-1.00	0.38	0.99	0.40
1957	-0.40	0.018	6×10^{-6}	-1.00	0.38	0.99	0.40
1958	-0.39	0.010	6×10^{-6}	-1.00	0.38	0.99	0.40
1959	-0.40	0.007	6×10^{-6}	-1.00	0.39	0.99	0.40
1960	-0.39	-0.002	5×10^{-6}	-1.00	0.39	0.99	0.39
1961	-0.39	-0.004	5×10^{-6}	-1.00	0.40	0.99	0.39
1962	-0.38	-0.010	5×10^{-6}	-1.00	0.40	0.99	0.38
1963	-0.38	-0.020	4×10^{-6}	-1.00	0.40	0.99	0.38
1964	-0.39	-0.020	5×10^{-6}	-1.00	0.41	0.99	0.39
1965	-0.38	-0.020	4×10^{-6}	-1.00	0.41	0.99	0.38
1966	-0.38	-0.030	4×10^{-6}	-1.00	0.41	0.99	0.38
1967	-0.37	-0.030	4×10^{-6}	-1.00	0.41	0.99	0.38
1968	-0.37	-0.040	4×10^{-6}	-1.00	0.41	0.99	0.37
1969	-0.36	-0.040	3×10^{-6}	-1.00	0.41	0.99	0.36
1970	-0.36	-0.050	3×10^{-6}	-1.00	0.41	0.99	0.36
1971	-0.36	-0.050	3×10^{-6}	-1.00	0.41	0.99	0.36
1972	-0.35	-0.060	3×10^{-6}	-1.00	0.41	0.99	0.35
1973	-0.34	-0.070	3×10^{-6}	-1.00	0.40	0.99	0.39
Average for 1955 to 1973	-0.38	-0.020	4×10^{-6}	-1.00	0.40	0.99	0.39

Note: For meaning of the terms e_{11} etc., see Table 9.3

TABLE 9.4(b)

Consumer demand elasticities
(U.K., final energy, unconstrained parameters)

Year	e_{11}	e_{21}	e_{12}	e_{22}	m_1	m_2	$es_{12} = es_{21}$
1955	-1.16	-0.011	1.89	-0.87	-0.73	0.88	1.02
1956	-1.18	-0.012	1.95	-0.86	-0.78	0.88	1.04
1957	-1.24	-0.016	2.14	-0.86	-0.90	0.87	1.10
1958	-1.24	-0.015	2.14	-0.86	-0.90	0.88	1.10
1959	-1.39	-0.023	2.58	-0.85	-1.19	0.87	1.24
1960	-1.39	-0.022	2.61	-0.85	-1.23	0.87	1.24
1961	-1.46	-0.025	2.81	-0.85	-1.35	0.87	1.30
1962	-1.41	-0.021	2.68	-0.86	-1.28	0.88	1.26
1963	-1.45	-0.023	2.86	-0.86	-1.40	0.88	1.31
1964	-1.74	-0.034	3.67	-0.83	-1.93	0.86	1.58
1965	-1.71	-0.032	3.60	-0.84	-1.88	0.87	1.55
1966	-1.81	-0.034	3.88	-0.83	-2.08	0.87	1.64
1967	-1.95	-0.039	4.31	-0.82	-2.36	0.86	1.78
1968	-1.99	-0.038	4.45	-0.83	-2.46	0.87	1.81
1969	-1.91	-0.036	4.24	-0.83	-2.33	0.87	1.75
1970	-2.02	-0.038	4.57	-0.83	-2.54	0.86	1.85
1971	-2.22	-0.044	5.15	-0.82	-2.93	0.86	2.04
1972	-2.42	-0.045	5.81	-0.82	-3.38	0.86	2.24
1973	-2.60	-0.047	6.37	-0.81	-3.38	0.86	2.41
Average for 1955 to 1973	-1.60	-0.028	3.28	-0.84	-1.68	0.87	1.45

Note: For meaning of the terms e_{11} etc, see Table 9.3

TABLE 9.4(c)

Consumer demand elasticities
(U.K., effective energy, constrained parameters)

Year	e_{11}	e_{21}	e_{12}	e_{22}	m_1	m_2	$es_{12} = es_{21}$
1955	-4.5	1.4	0.18	-1.08	3.0	0.89	4.6
1956	-4.4	1.4	0.18	-1.08	2.9	0.89	4.5
1957	-4.4	1.5	0.18	-1.08	2.9	0.89	4.5
1958	-4.2	1.4	0.18	-1.08	2.7	0.90	4.3
1959	-4.3	1.6	0.18	-1.09	2.7	0.90	4.4
1960	-4.1	1.6	0.17	-1.09	2.5	0.91	4.2
1961	-4.1	1.6	0.17	-1.09	2.4	0.92	4.1
1962	-3.8	1.5	0.17	-1.09	2.3	0.92	3.9
1963	-3.6	1.5	0.16	-1.09	2.1	0.92	3.7
1964	-3.8	1.6	0.16	-1.10	2.1	0.92	3.9
1965	-3.6	1.5	0.16	-1.10	2.0	0.93	3.7
1966	-3.6	1.5	0.16	-1.10	2.0	0.93	3.7
1967	-3.5	1.5	0.16	-1.10	1.9	0.93	3.6
1968	-3.4	1.5	0.15	-1.10	1.8	0.94	3.5
1969	-3.2	1.5	0.15	-1.10	1.7	0.94	3.3
1970	-3.2	1.4	0.15	-1.10	1.7	0.95	3.3
1971	-3.1	1.5	0.14	-1.10	1.6	0.95	3.3
1972	-3.0	1.5	0.14	-1.11	1.5	0.96	3.1
1973	-2.9	1.5	0.13	-1.11	1.4	0.96	3.0
Average for 1955 to 1973	-3.7	1.6	0.16	-1.10	2.1	0.92	3.8

Note: For meaning of the terms e_{11} etc, see Table 9.3

TABLE 9.4(d)

Consumer demand elasticities
(U.K., final energy, constrained parameters)

Year	e_{11}	e_{21}	e_{12}	e_{22}	m_1	m_2	$es_{12} = es_{21}$
1955	-0.89	-1.05	-0.005	-0.94	1.94	0.95	0.83
1956	-0.89	-1.02	-0.005	-0.94	1.91	0.95	0.84
1957	-0.82	-0.90	-0.009	-0.95	1.72	0.96	0.77
1958	-0.86	-0.90	-0.007	-0.95	1.77	0.95	0.81
1959	-0.77	-0.71	-0.012	-0.95	1.49	0.97	0.73
1960	-0.84	-0.69	-0.009	-0.95	1.53	0.96	0.79
1961	-0.79	-0.63	-0.012	-0.96	1.42	0.97	0.76
1962	-0.85	-0.66	-0.009	-0.96	1.52	0.96	0.81
1963	-0.88	-0.59	-0.007	-0.96	1.47	0.97	0.85
1964	-0.75	-0.43	-0.015	-0.97	1.18	0.98	0.72
1965	-0.78	-0.42	-0.013	-0.97	1.21	0.98	0.76
1966	-0.77	-0.38	-0.014	-0.97	1.15	0.99	0.74
1967	-0.74	-0.33	-0.016	-0.97	1.07	0.99	0.72
1968	-0.77	-0.29	-0.014	-0.98	1.06	0.99	0.75
1969	-0.80	-0.30	-0.012	-0.98	1.10	0.99	0.78
1970	-0.79	-0.26	-0.013	-0.98	1.05	0.99	0.78
1971	-0.76	-0.21	-0.015	-0.98	0.98	1.00	0.75
1972	-0.80	-0.12	-0.012	-0.99	0.93	1.00	0.80
1973	-0.85	-0.05	-0.010	-0.99	0.89	1.00	0.84
Average for 1955 to 1973	-0.81	-0.48	-0.010	-0.96	1.30	0.98	0.78

Note: For meaning of the terms e_{11} etc, see Table 9.3

TABLE 9.4(e)

Consumer demand elasticities
(Scotland, effective energy, constrained parameters)

Year	e_{11}	e_{21}	e_{12}	e_{22}	m_1	m_2	$es_{12} = es_{21}$
1955	-8.6	5.0	0.46	-1.3	3.6	0.84	8.9
1956	-8.2	4.8	0.45	-1.3	3.3	0.84	8.5
1957	-8.4	5.0	0.45	-1.3	3.4	0.85	8.7
1958	-8.1	4.8	0.44	-1.3	3.2	0.85	8.4
1959	-8.1	4.9	0.44	-1.3	3.1	0.86	8.4
1960	-8.1	5.0	0.43	-1.3	3.1	0.87	8.4
1961	-7.6	4.7	0.42	-1.3	2.9	0.87	7.9
1962	-7.2	4.4	0.42	-1.3	2.8	0.87	7.5
1963	-7.0	4.3	0.42	-1.3	2.6	0.88	7.3
1964	-7.4	4.7	0.41	-1.3	2.6	0.89	7.7
1965	-7.1	4.5	0.40	-1.3	2.5	0.89	7.4
1966	-7.0	4.5	0.40	-1.3	2.5	0.89	7.3
1967	-7.0	4.5	0.39	-1.2	2.4	0.90	7.3
1968	-6.7	4.3	0.39	-1.2	2.3	0.90	7.0
1969	-6.4	4.1	0.38	-1.2	2.2	0.90	6.7
1970	-6.4	4.2	0.37	-1.2	2.1	0.92	6.7
1971	-6.5	4.3	0.38	-1.2	2.2	0.91	6.8
1972	-6.5	4.4	0.36	-1.2	2.1	0.92	6.8
1973	-6.0	4.1	0.35	-1.2	1.9	0.93	6.3
Average for 1955 to 1974	-7.2	4.5	0.41	-1.3	2.6	0.89	7.5

Note: For meaning of the terms e_{11} etc, see Table 9.3

TABLE 9.6/1

Derived demand elasticities
(U.K. effective energy, constrained parameters)

(Programme 1)

(a) Own-price elasticities

Year	e_{11}	e_{22}	e_{33}
1955	-0.044	-0.044	-0.146
1956	-0.043	-0.044	-0.139
1957	-0.044	-0.044	-0.147
1958	-0.045	-0.045	-0.156
1959	-0.046	-0.044	-0.156
1960	-0.046	-0.043	-0.148
1961	-0.047	-0.042	-0.152
1962	-0.047	-0.042	-0.152
1963	-0.048	-0.042	-0.149
1964	-0.047	-0.040	-0.145
1965	-0.048	-0.040	-0.143
1966	-0.048	-0.040	-0.146
1967	-0.049	-0.041	-0.151
1968	-0.049	-0.041	-0.147
1969	-0.049	-0.040	-0.143
1970	-0.049	-0.041	-0.142
1971	-0.050	-0.043	-0.150
1972	-0.049	-0.043	-0.149
1973	-0.047	-0.040	-0.136
Average for 1955 to 1973	-0.049	-0.042	-0.154

Note: For meaning of the terms e_{11} etc, see Table 9.3

TABLE 9.6/1

Derived demand elasticities
(U.K., effective energy, constrained parameters)

(Programme 1)

(b) Cross-price elasticities

Year	e_{21}	e_{31}	e_{12}	e_{32}	e_{13}	e_{23}
1955	-0.0007	0.0247	-0.0052	0.0401	0.0218	0.0046
1956	-0.0006	-0.0234	-0.0047	0.0370	0.0204	0.0043
1957	-0.0007	-0.0253	-0.0053	0.0406	0.0221	0.0046
1958	-0.0008	0.0271	-0.0061	0.0451	0.0237	0.0051
1959	-0.0008	0.0273	-0.0060	0.0448	0.0238	0.0051
1960	-0.0006	0.0233	-0.0047	0.0383	0.0212	0.0044
1961	-0.0006	0.0239	-0.0048	0.0398	0.0217	0.0045
1962	-0.0006	0.0231	-0.0047	0.0393	0.0213	0.0044
1963	-0.0005	0.0231	-0.0041	0.0369	0.0200	0.0042
1964	-0.0004	0.0194	-0.0035	0.0397	0.0185	0.0039
1965	-0.0004	0.0176	-0.0030	0.0320	0.0171	0.0036
1966	-0.0004	0.0173	-0.0030	0.0331	0.0170	0.0037
1967	-0.0003	0.0170	-0.0030	0.0358	0.0168	0.0040
1968	-0.0003	0.0150	-0.0125	0.0332	0.0152	0.0037
1969	-0.0003	0.0132	-0.0020	0.0310	0.0136	0.0035
1970	-0.0002	0.0119	-0.0017	0.0304	0.0125	0.0035
1971	-0.0002	0.0119	-0.0019	0.0343	0.0125	0.0039
1972	-0.0002	0.0105	-0.0015	0.0336	0.0112	0.0038
1973	-0.0001	0.0084	-0.0009	-0.0272	0.0092	0.0031
Average for 1955 to 1973	-0.0004	0.0194	-0.0038	0.0380	0.0188	0.0042

Note: For meaning of the terms e_{21} etc, see Table 9.3

TABLE 9.6/1

Derived demand elasticities
(U.K., effective energy, constrained parameters)

(Programme 1)

(c) Elasticities of substitution

Year	es_{11}	$es_{12}=$ es_{21}	$es_{13}=$ es_{31}	es_{22}	$es_{23}=$ es_{32}	es_{33}
1955	-0.404	0.019	0.288	-0.017	0.126	-1.425
1956	-0.382	0.019	0.268	-0.016	0.120	-1.338
1957	-0.402	0.019	0.291	-0.017	0.127	-1.438
1958	-0.418	0.018	0.313	-0.017	0.134	-1.542
1959	-0.420	0.018	0.317	-0.017	0.134	-1.556
1960	-0.433	0.021	0.290	-0.017	0.126	-1.428
1961	-0.443	0.021	0.300	-0.017	0.129	-1.481
1962	-0.453	0.021	0.298	-0.017	0.130	-1.478
1963	-0.463	0.023	0.286	-0.017	0.127	-1.431
1964	-0.466	0.024	0.273	-0.016	0.123	-1.374
1965	-0.475	0.025	0.261	-0.016	0.121	-1.332
1966	-0.486	0.026	0.262	-0.017	0.124	-1.361
1967	-0.502	0.027	0.265	-0.017	0.130	-1.426
1968	-0.506	0.028	0.248	-0.017	0.126	-1.366
1969	-0.508	0.029	0.233	-0.017	0.123	-1.312
1970	-0.519	0.031	0.222	-0.017	0.123	-1.295
1971	-0.534	0.031	0.226	-0.018	0.132	-1.386
1972	-0.533	0.032	0.213	-0.018	0.132	-1.370
1973	-0.507	0.032	0.187	-0.017	0.119	-1.214
Average for 1955 to 1973	-0.495	0.025	0.282	-0.017	0.132	-1.462

Note: For meaning of the terms es_{11} etc, see Table 9.3

TABLE 9.6/2

Derived demand elasticities
(U.K. effective energy, constrained parameters)

(Programme 2)

(a) Own-price elasticities

Year	e_{11}	e_{22}	e_{33}
1955	-0.594	-0.445	-1.884
1956	-0.586	-0.442	-1.792
1957	-0.595	-0.444	-1.897
1958	-0.603	-0.451	-1.993
1959	-0.603	-0.446	-2.020
1960	-0.593	-0.438	-1.934
1961	-0.596	-0.438	-2.004
1962	-0.596	-0.437	-2.021
1963	-0.592	-0.435	-2.004
1964	-0.587	-0.428	-1.996
1965	-0.584	-0.426	-1.989
1966	-0.586	-0.430	-2.033
1967	-0.590	-0.438	-2.133
1968	-0.585	-0.436	-2.107
1969	-0.581	-0.435	-2.088
1970	-0.580	-0.440	-2.093
1971	-0.585	-0.452	-2.213
1972	-0.580	-0.454	-2.238
1973	-0.565	-0.437	-2.108
Average for 1955 to 1973	-0.595	-0.441	-2.108

Note: For meaning of the terms e_{11} etc, see Table 9.3

TABLE 9.6/2

Derived demand elasticities
(U.K., effective energy, constrained parameters)

(Programme 2)

(b) Cross-price elasticities

Year	e_{21}	e_{31}	e_{12}	e_{32}	e_{13}	e_{23}
1955	-0.0007	0.477	-0.006	0.891	0.435	0.104
1956	0.0004	0.452	0.003	0.841	0.415	0.099
1957	-0.0009	0.485	-0.007	0.897	0.438	0.104
1958	-0.0002	0.514	-0.017	0.952	0.457	0.109
1959	-0.0025	0.523	-0.020	0.962	0.461	0.108
1960	-0.0012	0.478	-0.009	0.913	0.442	0.104
1961	-0.0020	0.497	-0.016	0.949	0.454	0.107
1962	-0.0021	0.494	-0.017	0.959	0.456	0.108
1963	-0.0017	0.478	-0.014	0.949	0.450	0.107
1964	-0.0014	0.467	-0.012	0.940	0.444	0.105
1965	-0.0011	0.452	-0.009	0.937	0.439	0.105
1966	-0.0014	0.457	-0.012	0.964	0.445	0.108
1967	-0.0022	0.470	-0.019	1.027	0.457	0.114
1968	-0.0015	0.450	-0.139	1.013	0.447	0.114
1969	-0.0010	0.432	-0.009	1.004	0.437	0.113
1970	-0.0006	0.419	-0.006	1.012	0.433	0.115
1971	-0.0014	0.434	-0.013	1.090	0.446	0.123
1972	-0.0012	0.424	-0.011	1.109	0.438	0.125
1973	0.0003	0.386	0.002	1.028	0.408	0.116
Average for 1955 to 1973	-0.0002	0.482	-0.020	1.102	0.462	0.114

Note: For meaning of the terms e_{21} etc, see Table 9.3

TABLE 9.6/2

Derived demand elasticities
(U.K., effective energy, constrained parameters)

(Programme 2)

(c) Elasticities of substitution

Year	es_{11}	es_{12}= es_{21}	es_{13}= es_{31}	es_{22}	es_{23}= es_{32}	es_{33}
1955	-5.687	0.158	4.887	-0.210	1.627	-19.29
1956	-5.586	0.173	4.618	-0.206	1.553	-18.11
1957	-5.679	0.156	4.948	-0.209	1.635	-19.57
1958	-5.745	0.142	5.212	-0.215	1.714	-20.79
1959	-5.764	o.137	5.325	-0.213	1.730	-21.34
1960	-5.839	0.147	5.030	-0.210	1.672	-19.98
1961	-5.890	0.136	5.238	-0.211	1.726	-21.01
1962	-5.943	0.133	5.260	-0.213	1.745	-21.18
1963	-5.999	0.136	5.173	-0.213	1.737	-20.83
1964	-6.043	0.136	5.140	-0.210	1.732	-20.81
1965	-6.103	0.138	5.067	-0.211	1.734	-20.61
1966	-6.151	0.133	5.135	-0.215	1.777	-21.05
1967	-6.227	0.123	5.305	-0.223	1.873	-22.21
1968	-6.271	0.129	5.165	-0.223	1.860	-21.74
1969	-6.308	0.135	5.038	-0.224	1.852	-21.38
1970	-6.366	0.139	4.946	-0.228	1.870	-21.19
1971	-6.411	0.128	5.110	-0.240	1.989	-22.48
1972	-6.422	0.130	5.051	-0.243	2.022	-22.76
1973	-6.383	0.149	4.723	-0.231	1.907	-21.36
Average for 1955 to 1973	-6.161	0.124	5.325	-0.222	1.843	-21.91

Note: For meaning of the terms es_{11} etc, see Table 9.3

CHAPTER 10

Conclusions and Recommendations

10.1 Introduction

There were two major objectives of this study. The first was to compare the patterns of energy consumption between Scotland only and the whole of the U.K. and the second was to analyse the structure of energy demand.

The main problem in attaining the first objective has been one of data. A considerable proportion of the research effort was devoted to the preparation of data for Scotland and this enabled certain overall comparisons to be made. Some major differences between Scotland and the whole of the U.K. in the sectoral consumptions of certain forms of energy were identified, but the data was not sufficiently disaggregated to allow an investigation into the composition of these sectors necessary for obtaining a deeper understanding of the causes for these differences.

With regard to the attainment of the second objective the main problems were both the lack of an adequate data base and the constraints of time. Due to the lack of adequate data on capital and labour in Scotland, the derived demand model could not be estimated for Scotland. Due to the time-constraints (since the non-linear minimisation programmes are highly time-consuming), the unconstrained version of the consumer demand model for Scotland could not be estimated in time for it to be included in this study.

Although the two objectives mentioned above could not be met in their entirety, some important conclusions can, nevertheless, be drawn from this study. While interpreting the results from the demand models one must, however, bear in mind the limitations of all the existing demand models as discussed in Section 2.6.2.1.earlier.

The conclusions from this study are presented first, followed by recommendations for future research.

10.2 Conclusions

10.2.1 Conclusions from the comparison of the trends of energy consumption between Scotland and the whole of the U.K.

Four major conclusions emerge from the comparison of the trends of energy consumption between Scotland and the U.K.

Firstly, the overall trends in the consumption of the principal forms of energy (such as coal and petroleum) are similar between Scotland and the whole of the U.K. This is not surprising in view of the facts that the structure of the economies of Scotland and the whole U.K. are fairly similar and that the energy sectors in the two economies have grown along similar lines.

Secondly, within theseoverall similarities, the rate of growth of final energy consumption compared to the rate of growth of primary energy consumption, has been lower in Scotland compared to the rest of the U.K. This means that losses in the energy sector in Scotland have been comparatively higher than in the rest of the U.K. The main reasons for the higher losses in the energy sector in Scotland are (1) comparatively greater use of electricity which is an "inefficient" form of energy in terms of conversion from the primary to final energy (how "inefficient" electricity is depends on the accounting convention for converting electricity to its primary energy equivalent) and (2) delayed development of natural gas which is efficient in terms of conversion and transmission.

Thirdly, the overall efficiency of energy consumption which is the product of the conversion efficiency and the utilisation efficiency, has been slightly lower in Scotland. This is due to the fact that the higher utilisation efficiency in Scotland has not been able to compensate fully the lower conversion efficiency.

Finally, the share of electricity in the domestic sector and the share of petroleum in the industrial sector have been markedly higher in Scotland compared to the whole of the U.K. In both cases, the main reason for this appears to be the delayed development of natural gas in Scotland.

10.2.2 Conclusions from the consumer demand analysis

Four major conclusions can be drawn from this analysis.

(1) All the five models that are estimated in this study provide results that are economically meaningful. This suggests that the approach of using a generalised constant elasticity of substitution (GCES) utility function is a valid one and that suitable techniques have been established for estimating these functions and obtaining the relevant elasticities.

(2) If energy is measured in terms of effective energy, the resulting income elasticity is estimated to be positive, although less than unity. This can be contrasted with the negative income elasticity (greater than unity) that is obtained in the present study when energy is measured in terms of final energy. It is also possible that the reason for the negative income elasticity of energy in the Jorgenson's study may be that the correction of energy consumption by the Divisia Index used in the Jorgenson study fails to take full account of the changes in the utilisation efficiencies over time.

Since there are no a priori reasons to consider energy as an inferior good, it may be claimed that an analysis in terms of effective energy is more appropriate than an analysis in terms of final energy.

(3) If energy is analysed in terms of effective energy, the tests show that the hypothesis that the utility function is well-behaved can be rejected.

(4) The structure of demand in Scotland may be similar to that of the whole U.K., although the elasticities may be higher for Scotland. The above conclusions are not definitive since the comparison was made between two models that assumed well-behaved utility function, which may not be justifiable.

10.2.3 Conclusions from the derived demand analysis

The results from the model are presented in this study to show that a methodology has been established by which the derived demand model can be estimated.

Owing to (a) possible mis-specification of the model owing to ignoring technical progress (except in the term for energy), (b) constraining the parameters and (c) the fact that the existing programme did not converge completely, there are some doubts as regards to the actual values of the price elasticities and the partial elasticities obtained from the program. Indeed, the results do not correspond to those obtained by Berndt and Wood.

However, the estimation of the model demonstrates that once the model is fully specified all the relevant values of own and cross-price elasticities and the partial elasticities of substitution can be estimated.

10.3 Recommendations for future research

10.3.1 On comparison between Scotland and the U.K.

(a) The analysis has revealed that the share of electricity in the domestic sector is higher in Scotland compared to the rest of the U.K. Since electricity is a comparatively expensive form of energy, the resulting pay-off from conservation is comparatively high (compared to the rest of the U.K.). A study on the potential for conservation in Scotland, in line with the B.R.E. (1975) report for the whole of the U.K., would be a valuable contribution to research.

(b) It has been found that the share of petroleum in the industrial sector is higher in Scotland. It was not possible, due to the lack of disaggregated data, to ascertain whether this was the result of a different composition of industry in Scotland or more petroleum-intensiveness of the same industrial group in Scotland compared to the rest of the U.K. Answers to this question are important in determining the likely rate of absorption of future North Sea oil by the Scottish industry.

10.3.2 <u>On the demand analysis</u>

(a) A major exercise was undertaken in the study to estimate the effective energy consumption and the efficiency values that were collated from various sources and used were approximate values only. Since the values of the elasticities may be quite sensitive to the values of the efficiencies used in estimating effective energy, it would be profitable to do a sensitivity analysis by using a range of efficiency values.

(b) It has been mentioned earlier (Section 8.1.4 clause (4)) that it is conceptually difficult to aggregate effective energy in the domestic sector with the effective energy in the transport sector owing to the very different nature of the uses in the two sectors. A useful analysis would be to estimate the model for the domestic sector only, although this would mean that the problem of substitution between domestic use and transport use of energy by the consumer would be ignored in this case.

(c) The derived demand model for Scotland could not be estimated due to lack of annual data on labour and capital over the period 1955 - 1973. However a model based on the quarterly data for the last five years can be attempted.

(d) So far the derived demand model has, basically, ignored the question of technical progress. If the relevant variables can be measured in terms of the Divisia Index, along the lines followed by Berndt and Wood, then the results from the U.K. and Scotland models can be meaningfully compared with the results obtained from the U.S. model.

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APPENDIX

TABLE 1 Average Gross Calorific Value of Fuels Used

Table 1a Coal (1) (by Sector)

Therms per ton

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Power Stations	230	230	230	230	230	230	230	226	227	229	231	232	234	235	234	229	231	229	229	227
Gas Works	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Coke Ovens	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	285	285	285
Low Temp. Carbonisation Plant	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287	287
Manufactured Fuel Plants	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	277	277	277
Collieries	225	225	225	225	225	225	225	225	225	225	225	240	240	240	240	240	240	240	240	240
Agriculture	300	300	300	300	300	302	302	302	302	302	302	300	300	300	300	300	300	300	300	300
Iron and Steel	268	268	268	268	268	269	269	269	269	269	269	280	280	280	280	280	280	280	280	280
Other Industries	258	258	258	258	258	258	258	258	258	258	258	264	264	260	260	260	260	265	265	265
Rail	280	280	280	280	280	280	280	280	280	280	280	300	300	300	300	300	300	300	300	300
Water Transport	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280
Domestic: House Coal & Miners' Coal	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	280	290	290	290
Domestic: Anthracite & Dry Steam Coal	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	325	321	321	321
Public Administration	270	270	270	270	270	270	270	270	270	270	270	280	280	280	280	280	280	280	280	280
Miscellaneous	270	270	270	270	270	270	270	270	270	270	270	280	280	280	280	280	280	280	280	280
Average: All Classes of Consumers (2)	268	268	268	268	266	265	263	260	261	261	260	262	262	260	258	254	254	253	253	251

(1) The values for the years 1955 to 1959 inclusive are computed by trial and they are usually the same as that for the 1960 published figures in the U.K. Digest of Energy Statistics

(2) These values are obtained from the final estimate. The values are dependent on the composition of different grades of coal in the consumption.

Source: United Kingdom Digest of Energy Statistics (for referense see page 179 of 1973 D.E.S. and equivalent for later years)

Table 1b Petroleum (1) (by Product) Therms per ton

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Liquified Petroleum Gas	477	477	477	477	477	477	477	477	477	477	477	477	478	478	478	478	478	478	478	478
Other Gases	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504	504
Light Distillate Feedstock for gas works	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460	460
Aviation spirit and Wide-cut Gasolene	454	454	454	454	454	454	454	454	454	454	454	454	454	454	454	454	454	454	454	454
Aviation Turbine Fuel	450	450	450	450	450	450	450	450	450	450	450	450	449	449	449	448	449	447	447	447
Motor Spirit	452	452	452	452	452	452	452	425	452	452	452	452	452	452	452	452	452	452	452	452
Burning Oil	448	448	448	448	448	448	448	448	448	448	448	448	448	448	449	449	450	448	448	448
Vaporising Oil	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	443	442
Gas/Diesel Oil (inc. Derv)	437	437	437	437	437	437	437	437	437	437	437	437	438	438	438	438	439	439	439	438
Fuel Oil	412	412	412	412	412	412	412	412	412	412	412	412	413	413	415	415	416	418	418	413
Power Stations	403	403	403	403	403	403	403	403	403	403	403	403	403	419	419	419	419	419	419	416
Average: All products (2)	433	432	431	428	426	427	428	427	430	430	430	430	431	434	435	433	433.7	434	435	432

(1) The thermal values for the years 1955 to 1959 inclusive are taken to be the same as that for the year 1960, published in the U.K. Digest of Energy Statistics.

(2) **These values which are obtained from the final estimate reflect the composition of different products in the consumption.**

Source: **United Kingdom Digest of Energy Statistics (for reference see page 179 of 1973 D.E.S.)**

Table 1c (1) (2) (3)

Conversion Factors used in transforming original units of measurement to Thermal equivalents - U.K. 1955 to 1959 inclusive

Electricity: 34.12 million therms/TWH for all purposes
Coke Oven Gas: 5.25 million therms/1000 million ft 3

1.	Collieries	Coal	225
2.	Petroleum Refinery	Oil	412
3.	Agriculture	Coal	300
		Coke & Breeze	270
		Oil	434
4.	Iron and Steel	Coal	268
		Coke & Breeze Blast Furnaces	253
		Other Purposes	240
		Oil	412
		Creosote/pitch mixture	376
5.	Other Industries	Coal	258
		Coke & Breeze	260
		Oil	417
		Creosote/pitch mixture	376
6.	Rail	Coal	280
		Coke & Breeze	270
		Other Solid Fuel	270
		Oil	434
7.	Road Transport	Oil	448
		Liquid Fuel from Coal	445
8.	Water Transport	Coal	280
		Oil	420
9.	Air Transport	Oil	451
10.	Domestic	Coal, House Coal & Miners' Coal	280
		Anthricite & Dry Steam Coal	300
		Coke & Breeze	270
		Other Solid Fuel	270
		Oil	444
11.	Public Administration	Coal	270
		Coke & Breeze	270
		Oil	417
12.	Miscellaneous	Coal	270
		Coke & Breeze	270
		Oil	417

Table 1c (continued)

13.	All classes of consumers (Final Consumers)	Coal	269
		Coke & Breeze	259
		Other solid fuel	270
		Oil	429
		Creosote/pitch mixture	376
		Liquid Fuel from Coal	445

(1) Petroleum: For the years 1950 to 1959 inclusive, the sector consumption of petroleum is not broken down into products. Hence the thermal equivalent for each sector is estimated by calculating the thermal equivalents for later years. See next Table 1d.

(2) Coke & Breeze: The proportion of each product is not published. Estimated in the same way as petroleum above - see later Table 1e.

(3) Other Solid Fuel: For all industries, the thermal value is assumed to be the same as that for later years, figures for which are published.

Table 1d **Petroleum Values (1) (Estimated)**

	1960	1962	1963	1964	1965	1966	1967	(1955 - 1959)
Petroleum Refinery	413	412	412	412	412	412	413	(412)
Agriculture	439	434	431	433	431	434	434	(434)
Iron & Steel	413	413	413	413	414	414	415	(412)
Other Industries	417	417	417	417	417	417	419	(417)
Railways	438	429	432	434	437	436	433	(434)
Road Transport	448	448	448	448	448	448	448	(448)
Water Transport	420	420	423	423	425	425	425	(420)
Air Transport	451	452	451	452	450	451	450	(451)
Domestic	447	446	445	442	442	444	443	(444)
Public Administration	418	416	416	417	416	417	420	(417)
Miscellaneous	417	418	418	422	421	421	423	(417)
All classes of consumers	430	429	429	429	429	429	429	(429)

Sources: (a) For original units of measurement - Table 10, United Kingdom Digest of Energy Statistics.

(b) For figures on heat supplied basis - Table 19 in the UK D.E.S.

Note (1) Values are obtained by dividing figures from the appropriate tables as quoted in the source above.

Table 1e Coke & Breeze Values (1) (estimated)

	1960	1962	1963	1964	1965	1966	1967	(1955 - 1959)
Agriculture	270	270	270	270	270	270	270	(270)
Iron & Steel: Blast Furnace	254	253	253	255	257	256	256	(253)
Iron & Steel: Other Purposes	241	239	238	237	238	237	237	(240)
Other Industries	263	262	259	257	258	260	260	(260)
Railways	275	258	272	278	256	271	283	(270)
Domestic	270	270	270	270	270	270	270	(270)
Public Administration	270	270	270	269	270	270	270	(270)
Miscellaneous	272	270	270	270	270	270	270	(270)
All classes of consumers	259	259	259	258	259	259	259	(259)

Sources: (a) For original units of measurement - see Table 10 of United Kingdom Digest of Energy Statistics

(b) For figures on heat supplied basis - Table 19 in the UK D.E.S.

Note (1) Values are obtained by dividing figures from the appropxiate tables as quoted in the source above.

Table 1f

Thermal Equivalents

1.	Electricity	34.12 million therms/TWH for all purposes	(1955-1974)
2.	Coke-oven Gas	5.25 million therms/1000 million ft^3	(1955-1974)
3.	Coal	See table 1a	(1955-1974)
4.	Petroleum	By product - see Table 1b	(1955-1974)
		By sector - estimates, see Table 1d (Table necessary since the individual product consumption is not known)	(1955-1974)
5.	Coke	270 therm/ton for all sectors	(1960-1974)
6.	Breeze	220 therm/ton for all sectors	(1960-1974)
7.	Coke & Breeze	Estimated - see Table 1e (Table necessary since the individual consumption is not known)	(1955-1959)
8.	Other Solid Fuel	270 therms/ton for all sectors	(1955-1974)
9.	Creosote & pitch Mixture	376 therms/ton for all sectors	(1955-1974)
10.	Liquid fuel from coal	445 therms/ton	(1955-1959)

TABLE 2 Fuel Consumption in the United Kingdom on Heat Supplied basis - 1955 to 1959 (incl)

Figures in Million Therms

Sector	Type of Fuel	1955	1956	1957	1958	1959
Agri-culture	Coal	104	109	88	91	84
	Coke & Breeze	27	27	27	27	27
	Electricity	40	47	51	60	63
	Oil	437	435	414	421	411
	Total	608	618	580	599	585
Iron and Steel	Coal	1646	1557	1425	1123	999
	Coke & Breeze — Blast Fur.	3099	3285	3423	2942	2666
	Coke & Breeze — Other Fur.	557	533	528	525	566
	Coke Oven Gas	420	441	473	446	425
	Town Gas	149	153	155	157	127
	Electricity	144	151	163	159	176
	Oil	646	689	667	719	832
	Creosote/pitch mixture	117	146	233	201	214
	Total	6778	6955	7067	6272	6005
Other Industry (2)	Coal	10777	9783	9359	8545	8108
	Coke & Breeze	1014	936	832	754	676
	Coke Oven Gas	35	35	35	35	35
	Town Gas	598	611	619	629	677
	Electricity	942	1009	1059	1113	1208
	Oil	1501	1742	1737	2236	2680
	Creosote/pitch mixture	185	185	161	137	109
	Total	14352	14301	13802	13449	13493
Rail	Coal	3448	3410	3212	2906	2664
	Coke & Breeze	43	43	39	39	34
	Other Solid Fuel	154	181	226	274	198
	Electricity	46	49	53	54	58
	Oil	7	8	19	35	61
	Total	3698	3691	3549	3308	3105
Road Transport	Electricity	25	22	21	19	18
	Oil	3293	3418	3163	3694	4066
	Liquid Fuel from Coal	133	134	125	101	51
	Total	3451	3574	3309	3814	4135
Water Transport	Coal	266	241	203	165	144
	Oil	299	335	365	395	412
	Total	565	576	568	560	556
Air Tran.	Oil	766	791	735	706	734
Domes-tic (3)	House Coal & Miners' Coal	10248	10304	9800	10024	9184
	Anthracite & Dry Steam Coal	488	520	488	488	488
	Coke & Breeze	1093	1036	959	1023	980
	Other Solid	232	214	224	255	236
	Town Gas	1389	1371	1326	1339	1290
	Electricity	692	775	810	918	992
	Oil	289	373	357	529	586
	Total	14431	14593	13964	14576	13756
Public Adminis-tration (2)	Coal	1290	1273	1147	1174	1044
	Coke & Breeze	594	567	513	513	405
	Town Gas	93	86	79	75	71
	Electricity	124	132	136	150	158
	Oil	218	267	317	459	542
	Total	2319	2325	2192	2371	2220

Table 2 (continued)

Sector	Type of Fuel	1955	1956	1957	1958	1959
Miscell-aneous (2)	Coal	924	727	830	686	564
	Coke & Breeze	1337	1285	1140	1140	1132
	Town Gas	390	402	388	403	393
	Electricity	236	258	270	303	324
	Oil	133	205	208	296	393
	Total	3020	2877	2836	2828	2806
All Classes of Consu-mers	Coal	28491	27924	26552	25202	23279
	Coke & Breeze	7764	7712	7461	6963	6486
	Other Solid Fuel	386	395	450	529	434
	Coke Oven Gas	455	476	508	481	460
	Town Gas	2619	2623	2567	2603	2558
	Electricity	2249	2443	2563	2776	2997
	Oil	7589	8263	7982	9490	10717
	Creosote/pitch mixture	302	331	394	338	323
	Liquid fuels from Coal	133	134	125	101	50
	Total	49988	50301	48662	48483	47305

Sources:
Consumption in original units of measurement is given in Table 9 og 1962 Digest of United Kingdom Energy Statistics.

Notes:

(1) Heating values obtained by transforming data from Table 9 of 1962 D.E.S. by using equivalents given in Table 1C.

(2) Consumption figures of different fuels particularly that of coal and coke and breeze under sector categories of "Other Industry", "Public Administration" and "Miscellaneous" - have been changed in later publications (such as 1967 digest). This is due partly to changes in definition. Table 2, however, is constructed using data published in Table 9 of 1962 Digest.

(3) Table 9 of 1962 Digest gives the total consumption of domestic coal but does not give the individual consumption of House Coal & Miners' Coal and Anthracite and Dry Steam Coal. The figure for Anthracite and Dry Steam Coal is obtained from Table 44 of 1964 Digest and the House Coal (& Miners Coal) is obtained by deduction from the total.

Annex Consumption in the Colliery and Petroleum Refinery Sectors (1)
(Consumption in Million Therms)

		1955	1956	1957	1958	1959
Collie-ries	Coal	1956	1778	1612	1465	1252
	Coke Oven Gas	16	11	11	11	5
	Electricity	114	129	141	151	152
	Colliery Methane	5	5	9	10	13
	Total	2091	1923	1773	1637	1422
Petrol. Refin-eries	Electricity	12	14	14	17	20
	Oil	849	889	872	1043	1268
	Total	861	903	886	1060	1288

(1) This table is included for the sake of reference only. These two categories of consumption used to be included under final consumption up-to 1962 Digest.

All comments of Table 2 apply here as appropriate.

TABLE 3

Coal Consumption in the United Kingdom

(Figures in Million Therms)

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Industry	Iron & Steel	1646	1557	1425	1123	999	1016	865	701	641	564
	Other Industries	10777	9783	9359	8545	8108	8029	7582	7265	6895	6671
	Total	11723	11340	10784	9668	9107	9045	8447	7966	7536	7235
Transport	Railway	3448	3410	3212	2906	2664	2505	2161	1734	1380	1078
	Water Transport	266	241	203	165	144	125	111	101	89	74
	Total	3714	3651	3415	3071	2808	2630	2272	1835	1469	1152
Domestic		10736	10824	10288	10512	9672	9990	9425	9540	9358	8165
Public & Miscellaneous including Agriculture		2318	2109	2065	1951	1692	1766	1582	1641	1695	1496
Total		28491	27924	26552	28164	23279	23431	21726	20982	20058	18048

		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Industry	Iron & Steel	472	357	265	229	240	210	154	93	100	99
	Other Industries	6587	6316	5799	5680	5332	4824	3908	2954	3056	2795
	Total	7059	6673	6054	5909	5572	5034	4062	3047	3156	2894
Transport	Railway	779	510	239	66	42	35	27	21	23	20
	Water Transport	64	57	48	39	38	35	25	9	4	4
	Total	843	567	287	105	80	70	52	30	27	24
Domestic		8022	7489	6820	6584	6141	5654	4829	4209	4194	3932
Public & Miscellaneous including Agriculture		1485	1393	1241	1035	1090	1081	924	799	687	669
Total		17409	16122	14402	13613	12883	11839	9867	8085	8064	7519

Sources:

(1) For 1955 to 1959 inclusive, Table 2

(2) For 1960 to 1969 inslucive, Table 19 of 1967 U.K. Digest of Energy Statistics

(3) For 1965 to 1973 inclusive, Table 10 of 1974 D.E.S.

(4) For 1974, Table 10 of 1975 D.E.S.

Note: There have been some changes in the definition of consuming categories since 1967. The important changes are

(a) Miscellaneous category:

Up to 1967 this included, among other consumption, consumption by industrial establishments consuming less than 1000 tons/annum and also consumption in the coke ovens other than for carbonisation purposes.

Since 1967 this category excludes industrial establishments mentioned above but includes agriculture.

(b) Other industries:

Up to 1967 excluded small establishments consuming less than 100 tons/annum.

Since 1967 in includes the above consumption (i.e. of categories less than 1000 tons/annum)

TABLE 4 Consumption in Scotland

a = thousand tons; b = million therms

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Collieries		a	1209	1087	905	789	630	552	480	389	362	351	318	289	228	200	173	174	149	138	128	83
		b	272.0	244.6	203.6	177.5	141.8	124.2	108.0	87.5	81.5	79.0	71.6	69.4	54.7	48.0	41.5	41.8	35.8	33.1	30.7	19.9
Fuel Conversion Industries	Power Stations	a	3156	3081	3048	3280	3249	3458	3654	4411	5138	4650	4873	4834	4361	5576	6220	6052	5675	6410	7944	6890
		b	725.9	708.6	701.0	754.4	747.3	795.3	840.4	996.9	1166.6	1064.9	1125.6	1121.5	1020.5	1310.4	1455.5	1385.9	1311.2	1467.9	1819.2	1564.0
	Gas Works	a	2474	2409	2299	2148	1959	1781	1629	1560	1448	1308	1177	944	761	676	640	527	328	152	163	84
		b	742.2	722.7	689.7	644.4	587.7	534.3	488.7	468.0	434.4	392.4	353.1	283.2	228.3	202.8	192.0	158.1	98.4	45.6	48.9	25.2
	Coke Ovens	a	1633	1665	1829	1490	1044	1717	1661	1045	1155	1785	1999	1494	1362	1703	1866	1884	1602	1513	1723	1295
		b	468.7	477.9	524.9	427.6	299.6	492.8	476.7	299.9	331.5	512.3	573.7	426.8	390.9	488.8	535.5	540.7	459.8	431.2	491.1	369.1
	Manfg. Fuel Plants	a		150	140	160	110	100	80	80	90	100	90	100	140	140	150	160	140	130	100	110
		b		42.0	39.2	44.8	30.8	28.0	22.4	22.4	25.2	28.0	25.2	28.0	39.2	39.2	42.0	44.8	39.2	36.4	28.0	30.4
	Total Fuel Conv. Ind.	a	7263	7305	7316	7078	6362	7056	7024	7096	7831	7843	8139	7372	6624	8095	8076	8623	7746	8205	9930	8379
		b	1936.8	1951.2	1954.8	1871.2	1665.4	1850.4	1828.2	1787.2	1957.7	1997.6	2077.6	1861.5	1678.9	2041.2	2225.0	2129.5	1908.6	1981.1	2387.2	1985.9
Industry	Iron & Steel	a	1186	1161	1068	845	743	862	701	528	499	469	431	245	125	88	86	86	48	28	34	34
		b	319.0	312.3	292.7	227.3	199.9	231.9	188.6	142.0	134.2	126.2	115.9	68.6	35.0	24.6	24.1	24.1	13.4	7.8	9.5	9.5
	Other Ind. inc. small consumers	a	4282	4076	3783	3532	3315	3367	3090	2834	2678	2493	2404	2210	1921	1755	1664	1517	1212	892	782	653
		b	1104.8	1051.6	976.0	911.3	855.3	868.7	797.2	731.2	690.9	643.2	620.2	583.4	507.1	456.3	432.6	394.4	315.1	236.4	207.2	173.0
	Total Industry	a	5468	5237	4871	4377	4058	4229	3791	3362	3177	2962	2835	2455	2046	1843	1750	1603	1260	920	816	687
		b	1423.8	1363.9	1268.7	1138.6	1055.2	1100.6	985.8	873.2	825.1	769.4	736.1	652.0	542.1	480.9	456.7	418.5	328.5	244.2	216.7	182.5
Railway	(Water Transport cons. negligible)	a	1870	1850	1745	1486	1343	1229	1020	716	570	430	354	197	33	11	12	10	8	6	6	-
		b	523.6	518.0	488.6	416.1	376.0	344.1	285.6	200.5	159.6	120.4	99.1	55.2	9.2	3.1	3.4	2.8	2.2	1.7	1.7	-
Domestic	Miners' Coal	a	471	501	497	510	490	494	487	479	440	394	370	344	328	301	281	271	257	234	240	220
		b	131.9	140.3	139.2	142.8	137.2	138.3	136.4	134.1	123.2	110.3	103.6	96.3	91.8	84.3	78.7	75.9	72.0	67.9	69.6	63.9
	House Coal	a	3685	3705	3533	3602	3443	3562	3311	3288	3153	2641	2571	2310	2052	2004	1928	1680	1381	1041	1279	1127
		b	1031.8	1037.4	989.2	1008.6	964.0	997.4	927.1	920.6	882.8	739.5	719.9	646.8	574.6	561.1	539.8	470.4	386.7	301.9	370.9	326.8
	Anthracite & Dry Steam Coal	a	88	65	57	59	75	74	65	69	60	66	52	41	23	40	37	33	37	76	48	64
		b	26.6	21.1	18.5	19.2	24.4	24.1	21.1	22.4	19.5	21.5	16.9	13.3	7.5	13.0	12.0	10.7	12.0	24.7	15.6	20.5
	Total Domestic	a	4244	4271	4087	4171	4008	4130	3863	3836	3652	3101	2993	2695	2403	2345	2246	1984	1675	1351	1567	1411
		b	1192.3	1198.8	1146.9	1170.6	1125.6	1059.8	1084.6	1077.1	1025.5	871.3	840.4	756.4	673.9	658.4	630.5	557.0	470.7	394.5	456.1	411.1
Public Service & Miscell. incl Agriculture		a	1056	882	849	1088	983	1123	984	959	871	777	793	695	768	700	540	546	567	599	406	507
		b	285.1	238.1	229.2	293.8	265.4	303.2	265.7	258.9	235.2	209.8	214.1	194.6	215.0	196.0	151.2	152.9	158.8	167.7	113.7	142.0
Total Direct Final Consump. (Ind. Rail. Dom. Pub. Service & Misc.)		a	12638	12240	11552	11122	10392	10711	9658	8873	8271	7270	6975	6042	5250	4899	4584	4143	3510	2876	2795	2605
		b	3424.8	3318.8	3133.4	3019.1	2822.2	2807.7	2621.7	2409.7	2245.4	1970.9	1889.7	1658.2	1440.2	1338.4	1241.8	1131.2	960.2	808.1	788.2	735.6
Total Inland Consumption (incl. Colliers & Fuel Conv. Industries)		a	21110	20630	19773	18989	17384	18319	17162	16538	16464	15464	15432	13703	12102	13194	13597	12940	11405	11219	12854	11067
		b	5633.6	5514.6	5291.8	5067.8	4629.4	4782.3	4557.9	4284.4	4284.6	4047.4	4038.9	3589.1	3173.8	3427.6	3508.3	3302.5	2904.6	2822.3	3206.1	2744.2

Sources:

(1) For years 1955 to 1957 inclusive, Table 2, Digest of Scottish Statistics, April 1961

(2) For years 1958 to 1960 inclusive, Table 2, Digest of Scottish Statistics, April 1964

(3) For years 1961 to 1973 inclusive, Table 105 Scottish Abs. of Statistics, 1974

(4) For 1974, Table 128 of 1975, S.A.S.

Note:

(1) Consumption in "Manufactured Fuel Plants" does not appear in the COAL tables cited above. For years 1964 - 1973 inclusive this figure is obtained from Table 104, 1974 Scottish Abstract of Statistics. For the years 1955 to 1963, these figures are obtained year by year in the Digest of U.K. Statistics. Hence the figures for 1955 to 1963 are liable to some errors.

(2) Public Services & Miscellaneous Category - this appears as "MISCELLANEOUS" category in the COAL tables cited above after deducting consumption in the manufactured fuel plants. However, for the years 1955 to 1957 inclusive, these figures have not been updated in a later publication (which has been the case after 1957). Hence these figures are liable to slight error.

(3) It also seems by comparing the figures for 1958 to 1960, in April 1961 and April 1964 publications, that the consumption under "iron and steel" industry may be liable to very slight errors (not updated). Total for "INDUSTRY" category, however, remains firm.

TABLE 5

United Kingdom: Coke and Breeze and Other Solid Fuel consumption

Table 5a Coke & Breeze (consumption figures in million therms)

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Industry	Iron and Steel	3656	3818	3951	3467	3232	3936	3683	3338	3366	3809	3863	3457	3233	3511	3521	3485	3049	2899	3081	2620
	Other Industries	1014	936	832	754	676	874	878	748	657	587	493	413	398	310	334	348	245	210	227	194
	Total	4670	4754	4783	4221	3908	4810	4561	4086	4023	4396	4356	3870	3631	3821	3855	8833	3294	3109	3308	2814
Domestic		1093	1036	959	1023	980	1120	1154	1305	1406	1432	1194	1183	1134	1034	905	699	451	337	319	328
Railways		43	43	39	39	34	33	32	31	30	25	23	19	17	18	15	14	5	2	-	-
Public & Miscellaneous (incl. agriculture)		1958	1879	1680	1680	1564	1355	1221	133	1402	1154	1080	960	854	867	778	595	273	213	211	322
Total		7764	7712	7461	6963	6486	7318	6968	6755	6861	7007	6653	6032	5636	5740	5553	5141	4023	3661	3838	3464

Sources:

(1) For 1955 to 1959 inclusive, see Table 2

(2) For 1960 to 1964 inclusive, see Table 19 of 1967 Digest of U.K. Energy Statistics

(3) For 1965 to 1973 inslucive, see Table 10 of 1974 D.E.S.

(4) For 1974, see Table 10 of 1975 D.E.S.

Table 5b Other Solid Fuel (consumption figures in million therms)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Industry	113	91	84	77	63	48	43	40	42	38	27	25	25	25	24	27	22	19	18	34
Domestic	119	123	140	178	173	184	192	192	208	208	513	550	593	692	777	784	856	851	815	772
Miscellaneous											32	48	49	50	55	56	48	81	72	51
Railways	154	181	226	274	198	153	157	149	174	101										
Total	386	395	450	529	434	385	392	381	424	347	572	623	667	767	856	867	926	951	905	857

Sources:

(1) Same as that for Table 5a above.

(2) See also table 33 of 1975 D.E.S. and its equivalent for earlier years.

TABLE 6 Coke, Breeze and Other Solid Fuel Consumption in Scotland

Table 6a Coke & Breeze

Table 6a/1 Analysis of United Kingdom Data (for use in the transformation of data for Scotland)

All figures are in million tons

UNITED KINGDOM		1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coke Ovens	Coke	16.86	17.07	16.12	15.32	16.25	16.58	16.33	15.15	13.20	14.56	12.33
	Breeze	2.20	2.29	2.01	2.07	2.42	2.53	2.46	2.01	1.93	1.55	1.64
	Coke and Breeze	19.06	19.36	18.13	17.39	18.69	19.11	18.79	17.14	15.13	16.11	14.97
	Ratio of Breeze to Coke & Breeze (1)	0.115	0.118	0.111	0.119	0.129	0.132	0.131	0.117	0.127	0.096	0.133
Gas Works	Coke	8.89	7.80	7.23	6.23	4.60	3.0	1.86	0.76	0.22	0.19	0.01
	Breeze	2.39	2.00	1.75	1.58	1.25	0.78	0.55	0.24	0.05	0.02	
	Coke and Breeze	11.28	9.8	8.98	7.81	5.85	3.78	2.41	1.00	0.27	0.21	0.01
	Ratio of Breeze to Coke and Breeze (2)	0.193	0.212	0.20	0.195	0.202	0.214	0.206	0.228	0.24	0.185	

Source: Digest of United Kingdom Energy Statistics - Coke & Breeze tables (for example see Table 73 of 1974 Digest)

Note: (1) For Scotland assume this ratio to be 0.07
(2) For Scotland assume this ratio to be 0.23

Table 6a/2 Coke & Breeze Production in Scotland

SCOTLAND		1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total disposal of coke from coke ovens and gasworks (1)	a	1727	1333	1180	1407	1403	1415	1097	1010	1181	1036
Total production of coke at coke ovens and gasworks (1) of which :	b	1549	1171	1023	1212	1297	1286	995	912	1103	860
Coke Oven Coke (1)	c	1218	921	827	1040	1142	1179	943	897	1093	854
Gas Works Coke (1)	d	331	250	196	172	155	107	52	.15	10	6
Estimate: Disposal of coke - from coke ovens c/b × a	e	1358	1048	954	1207	1259	1297	1040	993	1170	1029
Estimate: Disposal of coke - from gas works = a - e	f	369	285	226	200	171	118	57	17	11	7
Total coke & breeze from (2) coke oven - (assuming 93% coke, 7% Breeze) = e/0.93	g	1460	1127	1026	1298	1354	1395	1118	1068	1258	1107
Total coke & breeze from (2) gas works - (assuming 77% coke, 23% breeze) = f/0.77	h	532	411	326	288	247	170	82	25	16	9
Total coke and breeze from coke ovens and gas works = g + h	j	1992	1538	1352	1586	1601	1565	1200	1093	1274	1116

Source:

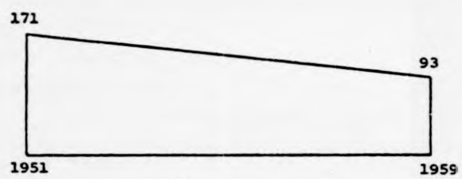
(1) Scottish Abstract of Statistics 1974, Table 110, for the years 1965 to 1973 and equivalent table for later years.

(2) Table 6a

Table 6a/3 Scotland - Coke and Breeze
Analysis of consumption by sector

(a) Domestic consumption of coke: 1955 to 1958.

Table 110 of 1974 Abstract of Scottish Statistics shows that domestic consumption of coke in 1951 is 171 thousand tons and in 1959 is 93 thousand ton.



By proportionality: change in the consumption by year = $\frac{171 - 93}{8} = \frac{78}{8} = 10$.

Hence consumption.

1951	1952	1953	1954	1955	1956	1957	1958	1959
171	161	151	141	131	121	111	101	91

Figures for 1955 to 1958 are used later.

(b) Railway consumption All figures are in million tons (unless otherwise specified)

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
UNITED KINGDOM	Total Final Consumption	a	29.93	29.76	28.85	26.87	25.05	28.27	27.17	25.98	26.52	27.11	25.60	23.35	21.81	22.70	21.42	19.91	15.59	14.07	14.61	13.20
	Railway Consumption	b	0.16	0.16	0.15	0.14	0.13	0.12	0.12	0.11	0.11	0.09	0.09	0.07	0.06	0.06	0.06	0.05	0.02			
	Ratio: b/a	c	.0053	.0054	.0052	.0052	.0052	.0040	.0044	.0042	.0042	.0033	.0035	.0030	.0028	.0026	.0028	.0025	.0012			
SCOTLAND	Total Final Consumption	d	1.871	1.821	1.841	1.627	1.321	1.780	1.662	1.242	1.244	1.689	1.871	1.469	1.330	1.573	1.598	1.563	1.198	1.090	1.273	1.116
	Rail consumption = d × b/a (thousand ton)	e	10	10	10	8	7	7	7	5	5	6	7	4	4	4	4	4	1			

Table 6a/3 (cont.)

(c) Consumption in "Other Industry" and "Public & Miscellaneous" sector

United Kingdom figures are in million tons, Scotland figures are in thousand tons.

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1968	1970	1971	1972	1973	1974
UNITED KINGDOM	Total of "Other Industry" and a "Public & Misc."	a						10.86		10.43	10.61	9.79	9.18	8.2	7.52	7.44	7.26	6.57	4.58	3.95	3.56	3.75
	Other Industry	b						5.97		5.59	5.52	5.61	5.27	4.74	4.45	4.32	4.48	4.44	3.62	3.2	2.83	2.56
	Ratio b/a	c	assume to be 0.55					0.55	assume 0.55	0.54	0.52	0.57	0.57	0.58	0.59	0.58	0.62	0.68	0.79	0.81	0.79	0.68
SCOTLAND	Total of "Other Industry" and "Public & Misc." (1)	d	895	823	726	740	656	670	631	593	597	597	654	581	488	477	436	400	245	178	237	196
	Other Industry $= d \times \frac{b}{a}$	e	492	453	399	407	361	369	347	320	310	340	373	337	288	277	270	272	194	144	187	133
	Public & Misc.	d-e	403	370	327	333	295	301	284	273	287	257	281	244	200	200	166	118	51	34	50	63

(1) "Other Industry" plus "Public & Miscellaneous" is obtained by deducting consumption in the Domestic sector (previous Table 6a/3a) Rail (Table 6a/3b) and Iron and Steel (or blast furnaces - as published in the Scottish Abstract of Statistics, see Table 110 of 1974 Abstract for reference) from the total consumption.

Notes

(1) "Other Industry" category includes Coke and Braaze used in Iron and Steel industry for "other purposes".

(2) United Kingdom: For the years 1955 to 1961 (except 1960) the figures as published in the 1962 U.K. Digest of Energy Statistics (see Table 9 of 1962 Digest) have different definitions to "Other Industry" and "Miscellaneous" categories than those given in later publication. Figure for 1960, are however published in 1967 D.E.S. and conform to later definition.

Note that the maximum error for our purposes is small (For 1955 - say total coke oven and breeze production is 1088 thousand ton; Breeze production is 7% (assume) of 1088 = 75.6 th. ton, Gas coke Breeze = 280.0 th. ton. Total Breeze production = 355.6 th. ton, of which gas works consumption is 73 th. ton and export is 153 th. ton, making this total = 73 + 153 = 226. This makes Breeze consumption = 355 - 226 = 129.6 . ∴ Likely error = 129.6 × (270 - 220)/1000, where 270 is heating equivalent for coke in therms/ton and 220 is for breeze, so this error is approximately 7.0 million therms).

Table 6a/4 Summary Table: Coke & Breeze disposal in Scotland

Notation: a = thousand tons; b = million therms

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total Inland	Coke	a										1653	1727	1333	1180	1407	1430	1415	1097	1010	1161	1036
	Coke & Breeze (1)	a	2142	2053	2058	1875	1533	1944	1792	1396	1378	1799	1992	1538	1352	1586	1601	1565	1200	1093	1274	1116
Gas Works	Coke	a	112	99	85	124	122	85	65	96	75	60	66	32	8	8	3	2	2	3	1	-
	Breeze (2)	a	73	62	63	57	45	39	47	57	56	47	52	25								
	Coke & Breeze	a	185	161	148	181	167	124	112	153	131	107	118	57	8	8	3	2	2	3	1	-
Power Station	Coke & Breeze	a	86	71	69	67	45	40	18	1	3	3	3	12	14	1						
Final Consumers	Coke & Breeze	a	1871	1821	1841	1627	1321	1780	1662	1242	1244	1689	1871	1469	1330	1577	1598	1563	1198	1090	1273	1116
		b	505	492	497	439	357	480	448	335	336	456	505	397	359	426	431	422	323	294	344	301
Iron & Steel (Blast Furnaces)	Coke only	a	835	867	995	778	565	989	934	544	539	989	1110	797	768	1027	1087	1106	917	884	1008	892
		b	225	234	269	210	153	267	252	147	145	267	297	215	207	277	293	299	248	239	272	241
Other Industry	Coke & Breeze	a	492	453	399	407	361	369	347	320	310	340	373	337	288	277	270	272	194	144	187	133
		b	133	122	108	110	97	99	94	86	84	92	101	91	78	75	73	73	52	39	50	36
Total Industry	Coke & Breeze	a	1327	1320	1394	1185	926	1358	1281	864	849	1329	1483	1134	1056	1304	1357	1378	1111	1028	1195	1025
		b	358	356	377	320	250	366	346	233	229	359	398	306	285	352	366	372	300	278	322	277
Domestic	Coke only (3)	a	131	121	111	101	93	114	90	100	103	97	100	87	70	69	71	53	35	28	28	28
		b	35	33	30	27	25	31	24	27	28	26	27	23	19	19	19	14	9	8	8	8
Rail	Coke only (4)	a	10	10	9	8	7	7	7	5	5	6	7	4	4	4	4	4	1			
		b	3	3	2	2	2	2	2	1	1	1	2	1	1	1	1	1				
Public & Misc.	Coke & Breeze (5)	a	403	370	327	333	295	301	284	273	287	257	281	244	200	200	166	118	51	34	50	63
		b	109	100	88	90	80	81	77	74	77	69	76	66	54	54	45	32	14	9	14	17

(1) Coke and Breeze, for years 1965 to 1973 inclusive. Data is available on coke, but not on breeze. Taking U.K. proportion, the production of breeze at coke ovens and gas works is estimated. Disposal is assumed to be the same as production. See Table 6a/2.

(2) Breeze, for years 1965 and 1966. Proportion between coke and breeze is assumed to be the same as that for year 1964 for which data is available. From 1967 onwards, breeze consumption is assumed to be nil.

(3) Coke Domestic: Data for 1955 to 1958 inclusive constructed, see Table 6a/3a. Consumptions for 1973 and 1974 are assumed to be the same as that for 1972.

(4) **Rail Coke. Data for 1955 to 1971 constructed, see Table 6 a/3b.**

(5) **Coke and Breeze - Data for 1955 to 1974 constructed, see Table 6a/2.**

Note:

The heating value for coke and breeze is taken to be 270 therms per ton throughour. Breeze has in fact a lower heating value of about 220 therms per ton, but since coke forms a major part of coke and breeze (90% or more), the error will be small, maximum of about 2%

Sources:

(a) Scottish Digest of Scottish Statistics, coke and breeze tables (for example Table 5 of April 1966)

(b) Scottish Abstract of Statistics, coke table (for example Table 110 of 1974 Abstract)

(c) United Kingdom Digest of Energy Statistics, coke and breeze tables (for example Table 29 and 36 of the 1975 Digest).

Table 6b

Scotland: Manufactured Fuel

Notation: a = million ton; b = million therm

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total coal supply to the manufactured fuel plant (1)		a		.15	.14	.16	.11	.10	.08	.08	.09	.10	.09	.10	.14	.14	.15	.16	.14	.13	.10	.11
Total output of manufactured fuel (2)		a		.12	.112	.128	.088	.08	.064	.064	.072	.080	.072	.080	.112	.112	.120	.128	.112	.104	.080	.088
		b (3)		32	30	35	24	22	17	17	19	22	19	22	30	30	32	35	30	28	22	24
Consumption (4)	Domestic	b		10	9	11	9	10	8	9	9	13	18	19	27	27	29	31	28	25	19	21
	Industry	b		8	6	5	4	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1
	Railways	b		15	15	18	11	9	7	7	8	6										
	Others	b											1	2	2	2	2	2	1	2	2	2

(1) For sources, see Table 27 of 1975 Digest of U.K. Energy Statistics and its equivalent tables for earlier years.

(2) The total output is obtained by using U.K. ratio between output of and input to the manufactured fuel plants. For the years 1965 to 1974, this ratio varies for 0.78 to 0.93 in the U.K. ; A figure of 0.8 has been used throughout for Scotland.

(3) Conversion figure used is 270 therms/ton

(4) Consumption in different sectors is obtained by taking U.K. ratio of consumption in each sector to total consumption. For U.K. figures see Table 5b.

Table 6b

Scotland: Manufactured Fuel

Notation: a = million ton; b = million therm

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total coal supply to the manufactured fuel plant (1)		a		.15	.14	.16	.11	.10	.08	.08	.09	.10	.09	.10	.14	.14	.15	.16	.14	.13	.10	.11
Total output of manufactured fuel (2)		a		.12	.112	.128	.088	.08	.064	.064	.072	.080	.072	.080	.112	.112	.120	.128	.112	.104	.080	.088
		b (3)		32	30	35	24	22	17	17	19	22	19	22	30	30	32	35	30	28	22	24
Consumption (4)	Domestic	b		10	9	11	9	10	8	9	9	13	18	19	27	27	29	31	28	25	19	21
	Industry	b		8	6	5	4	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1
	Railways	b		15	15	18	11	9	7	7	8	6										
	Others	b											1	2	2	2	2	2	1	2	2	2

(1) For sources, see Table 27 of 1975 Digest of U.K. Energy Statistics and its equivalent tables for earlier years.

(2) The total output is obtained by using U.K. ratio between output of and input to the manufactured fuel plants. For the years 1965 to 1974, this ratio varies for 0.78 to 0.93 in the U.K. : A figure of 0.8 has been used throughout for Scotland.

(3) Conversion figure used is 270 therms/ton

(4) Consumption in different sectors is obtained by taking U.K. ratio of consumption in each sector to total consumption. For U.K. figures see Table 5b.

TABLE 7 Petroleum consumption in the United Kingdom

Table 7a Analysis of consumption for the years 1955 to 1959
All consumption figures are in thousand tons

Sector	Type of product	1955	1956	1957	1958	1959	Check table 1960
Agri-culture	Burning Oil	25	20	18	17	16	15
	Vaporising Oil - Tractors	640	535	487	415	342	265
	Vap. Oil. Station. Eng.	17	14	11	10	8	7
	Gas/Diesel Oil - Agr. Heaters & Driers	30	36	33	39	42	51
	Fuel Oil - Agr. Heaters & driers	26	37	30	33	22	35
	Gas/Diesel Oil - Power Units	268	359	377	457	516	558
	Total	1006	1001	956	971	946	931
Iron and Steel	Gas/Diesel Oil - open hearth	1	1	-	1	2	2
	Gas/Diesel Oil - Other Manufacturing	64	68	59	68	60	68
	Fuel Oil - Open Hearth	1018	1066	1061	1080	1303	1557
	Fuel Oil - Other Manufacturing	486	538	500	596	655	794
	Total	1569	1673	1620	1745	2020	2421
Other Industries	Butane and Propane (1)	30	30	30	30	45	51
	Burning Oil	52	49	48	46	48	50
	Vaporising Oil	20	17	15	15	14	14
	Gas/Diesel Oil	867	950	868	1029	1078	1187
	Fuel Oil (3)	2276	2764	2821	3852	4841	6189
	Total	3245	3810	3782	4938	6026	7417
Rail	Gas/Diesel Oil	17	18	44	80	141	242
Road Transport	Motor Spirit & Derv Fuel (4)	7841	8121	7540	8673	9400	10207
Water Transport	Gas/Diesel Oil-Marine Craft	157	185	214	252	287	336
	Fuel Oil - Marine Craft	544	605	647	684	689	720
	Total	701	790	861	936	976	1056
Air Transport	Aviation Fuels	1698	1754	1630	1565	1628	1764
Domestic	Butane & Propane (5)	29	34	36	35	47	55
	Kerosene: (6) Burning Oil Premier	560}	711}	679}	1021}	987	1043
	Kerosene: (6) Burning Oil Standard					117	160
	Gas/Diesel Oil - Central Heating (7)	53	83	84	129	161	231
	Fuel.Oil - Central Htg.	9	11	6	7	7	12
	Total	651	839	805	1192	1319	1501
Public Adminis-tration	Kerosene (Burning Oil)	57	51	51	40	35	27
	Gas/Diesel Oil (8)	136	179	203	309	402	561
	Fuel Oil (8)	650	902	1005	1460	1805	2374
Miscel-laneous	Vaporising Oil - Fishing	12	8	7	5	5	3
	Gas/Diesel Oil (9)	17	21	19	21	23	25
	Fuel Oil (9)	147	152	158	163	167	176
	Total Public Admin. + Miscellaneous	1019	1313	1443	1998	2437	3166

Table 7a (continued)

		1955	1956	1957	1958	1959	Check table 1960
Domestic	Butane & Propane	29	34	36	35	47	55
	Burning Oil	560	711	679	1021	1104	1203
	Gas/Diesel Oil	53	83	84	129	161	231
	Fuel Oil	9	11	6	7	7	12
	Total	651	839	805	1192	1319	1501
Industrial (Iron & Steel plus Other Industries)	Butane and Propane (1)	30	30	30	30	45	51
	Burning Oil	52	49	48	46	38	50
	Vaporising Oil	20	17	15	15	14	14
	Gas/Diesel Oil	932	1019	927	1098	1140	1257
	Fuel Oil (3)	3780	4368	4382	5528	6799	8540
	Total	4814	5483	5402	6683	8046	9838
Transport (Rail, Road, Water & Air)	Gas/Diesel Oil	174	203	258	332	428	578
	Fuel Oil	544	605	647	684	689	720
	Motor Spirit (4)	6240	6324	5745	6624	7124	7625
	Derv Fuel (4)	1601	1797	1795	2049	2276	2582
	Aviation Fuels	1698	1754	1630	1565	1628	1764
	Total	10257	10683	10075	11254	12145	13269
Agriculture + Public + Miscellaneous	Burning Oil	82	71	69	57	51	42
	Vaporising Oil	669	557	505	430	355	275
	Gas/Diesel Oil	451	595	632	826	983	1195
	Fuel Oil	823	1091	1193	1656	1994	2575
	Total	2025	2314	2399	2969	3383	4087
All Consumers	Butane and Propane	59	64	66	65	92	106
	Aviation fuels	1698	1754	1630	1565	1628	1764
	Motor Spirits	6240	6324	5745	6624	7124	7625
	Burning Oil	694	831	796	1124	1203	1295
	Vaporising Oil	689	574	520	445	369	289
	Derv Fuel	1601	1797	1795	2049	2276	2582
	Gas/Diesel Oil	1610	1900	1901	2385	2712	3261
	Fuel Oil	5156	6075	6228	7875	9489	11847
	Total	17747	19319	18681	22132	24896	28769
Refinery Consumption		2060	2157	2117	2532	3078	3343
All Consumers + Refinery Consumption		19807	21476	20798	24664	27974	32012
Published Figures (for comparison) (10)		19511	21180	20503	24441	27860	32120
Difference between estimated and published (11)		296	296	275	223	114	8

(1) Figure for 1955 is not available, assumed same as for the year 1956.

(2) This category includes - Bakeries, Glass, Ceramics, Industrial Furnaces (Metallurgical & Other), Steam Raising (Other Industries) Stationary Oil Engines (Other Industries), Mobile Diesel Engines, Rail Traction (Industrial) and Other Manufacturing.

(3) Adjusted, tó take account of the difference between recorded deliveries of oil for electricity generation and recorded consumption for generation.

(4) All motor spirits are assumed to be consumed in the Transport sector although published statistics do not account for a small part of the delivery.

(5) For years 1955 to 1958, the consumption is obtained by subtraction, using Table 9 of the 1962 U.K. Digest of Energy Statistics.

(6) Premier Kerosene is equivalent to "other" category while Standard Kerosene consists of both "boiler" and "lighting and corking" category.

(7) Domestic consumption apply to only "private houses".

(8) This category is equivalent to "other premises" category.

Table 7a (continued)

(9) This category consists of "petroleum industry (other uses)".

(10) Figures published in Table 9 of 1962 U.K. D.E.S.

(11) The difference is mainly due to the figures in the Transport sector under the heading of "motor spirits".

Tables No. 146 of 1967 D.E.S. and No. 9 of 1962 D.E.S. do not correspond to the table No. 119 of 1961 D.E.S. which gives end use of "motor spirits". Since "motor spirit" is not specifically included in any of the other sectors in the published statistics, the whole of "motor spirit" delivery is included in the transport sector in the above table. That is the reason why the total figure in the table is slightly higher than the published figure.

Sources:

(a) Table 133 of 1963, U.K. Digest of Energy Statistics

(b) Table 135 of 1963 D.E.S.

(c) Table 124 of 1960 D.E.S.

(d) Table 9 of 1962 D.E.S.

(e) Table 119 of 1961 D.E.S.

Table 7b United Kingdom: Sector consumption of each product as a ratio of its total delivery
(Table to be used later for constructing a table for Scotland)

Notations: a = consumption in the sector in million tons
b = final consumption of the product in million tons
c = the ratio of a to b in percentage
d = consumption in the sector in million therms (i.e. a converted by using heating equivalents of previous table 1b)

DOMESTIC SECTOR		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Butane & Propane (1)	a	0.029	0.034	0.036	0.035	0.047	0.055	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.08	0.09
	b	0.059	0.064	0.066	0.065	0.092	0.106	0.13	0.150	0.18	0.22	0.29	0.38	0.37	0.39	0.48	0.55	0.75	1.00	1.31	1.29
	c	49	53	54	54	51	52	46	33	28	27	21	16	16	18	15	13	10	6	6	7
	d	13.8	16.2	17.2	16.7	22.4	26.2	28.6	23.8	23.85	28.62	28.62	28.62	28.68	33.46	33.46	33.46	33.46	33.46	38.24	43.02
Burning Oil	a	0.56	0.711	0.679	1.021	1.104	1.203	1.13	1.33	1.55	1.34	1.43	1.44	1.50	1.66	1.83	2.01	2.07	2.43	2.7	2.36
	b	0.694	0.831	0.796	1.124	1.203	1.295	1.23	1.43	1.67	1.47	1.59	1.65	1.75	1.97	2.20	2.44	2.52	2.88	3.13	2.74
	c	81	96	85	90	92	93	92	93	93	91	90	87	86	84	83	82	82	84	86	86
	d	250.8	318.5	304.2	457.4	494.6	528.9	506.2	595.8	694.4	600.3	640.6	645.1	672.0	743.7	821.7	902.5	931.5	1088.6	1209.6	1057.3
Gas/Diesel Oil	a	0.053	0.083	0.084	0.129	0.161	0.231	0.32	0.43	0.48	0.50	0.53	0.53	0.53	0.58	0.64	0.74	0.71	0.84	0.89	0.81
	b	1.61	1.90	1.90	2.385	2.712	3.261	3.76	4.37	4.99	5.49	6.13	6.72	7.49	8.49	9.66	10.90	11.61	13.21	13.98	12.62
	c	3.3	4.4	4.4	5.4	5.9	7.1	8.5	9.8	9.6	9.1	8.6	7.9	7.1	6.8	6.6	6.8	6.1	6.4	6.4	6.4
	d	23.2	36.2	36.7	56.4	70.4	101.0	139.8	187.9	209.8	218.5	231.6	231.6	232.1	254.0	280.3	324.1	311.7	368.8	390.7	354.8
Fuel Oil	a	0.009	0.011	0.006	0.007	0.007	0.012	0.13	0.14	0.15	0.16	0.17	0.15	0.18	0.20	0.21	0.17	0.11	0.08	0.07	0.07
	b	5.156	6.08	6.23	7.88	9.49	11.85	13.13	15.36	17.52	19.02	21.04	22.16	23.26	24.35	25.55	26.52	25.06	23.63	22.89	20.48
	c	0.2	0.2	0.1	0.1	0.1	0.1	1.0	0.9	0.86	0.84	0.81	0.68	0.77	0.82	0.82	0.64	0.44	0.34	0.31	0.34
	d	3.7	4.5	2.5	2.8	2.8	4.9	53.6	57.6	61.8	65.9	70.0	61.8	74.2	82.4	86.5	70.0	45.3	32.9	28.8	28.8
Total Domestic		291	375	361	533	590	671	728	865	990	913	971	967	1007	1114	1222	1330	1322	1524	1667	1482
Check with published figures (2)							671			992	911	969	967	1006	1115	1222	1335	1321	1523	1668	1482
INDUSTRIAL SECTOR																					
Butane and Propane	a	0.03	0.03	0.03	0.03	0.045	0.051	0.07	0.1	0.13	0.16	0.23	0.32	0.31	0.32	0.41	0.48	0.68	1.01	1.23	1.20
	b	0.059	0.064	0.066	0.065	0.092	0.106	0.130	0.15	0.18	0.22	0.29	0.38	0.37	0.39	0.48	0.55	0.75	1.08	1.31	1.29
	c	50	47	46	46	49	48	54	67	72	73	79	84	84	82	85	87	90	94	94	93
	d	14.3	14.3	14.3	14.3	21.4	24.3	33.4	47.7	62.0	76.3	109.7	152.6	148.2	153.0	196.0	229.4	325.0	482.8	588.0	574.0
Burning Oil	a	0.052	0.049	0.048	0.046	0.048	0.050	0.060	0.06	0.07	0.09	0.12	0.18	0.22	0.27	0.33	0.40	0.42	0.42	0.40	0.35
	b	0.694	0.831	0.796	1.124	1.203	1.295	1.23	1.43	1.67	1.47	1.59	1.65	1.75	1.97	2.20	2.44	2.52	2.88	3.13	2.74
	c	7.5	5.9	6.0	4.1	4.0	3.9	4.9	4.2	4.2	6.1	7.6	10.9	12.6	13.7	15.0	16.3	16.7	14.6	12.8	12.8
	d	23.3	22.0	21.5	20.6	21.5	22.4	26.9	26.9	31.4	40.3	53.8	80.6	98.6	121.0	148.2	179.6	189.0	188.2	179.2	156.8
Vaporising Oil	a	0.020	0.017	0.015	0.015	0.014	0.014	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01						
	b	0.689	0.574	0.520	0.445	0.369	0.289	0.26	0.21	0.18	0.15	0.12	0.10	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03
	c	2.9	3.0	2.9	3.4	3.8	4.8	7.7	9.5	11.0	13.0	17.0	20.0	22.0	14.0						
	d	8.9	7.5	6.6	6.6	6.2	6.2	8.9	8.9	8.86	8.86	8.86	8.86	8.86	4.43						
Fas/Diesel Oil	a	0.932	1.019	0.927	1.098	1.140	1.257	1.43	1.63	1.84	2.14	2.43	2.76	3.2	3.73	4.38	4.91	5.13	6.0	6.07	5.23
	b	1.61	1.90	1.90	2.385	2.712	3.261	3.76	4.37	4.99	5.49	6.13	6.72	7.49	8.49	9.66	10.90	11.61	13.21	13.98	12.62
	c	57.9	53.6	48.8	46.0	42.0	38.5	38.0	37.3	36.9	39.0	39.6	41.1	42.7	43.9	45.3	45.1	44.2	45.4	43.4	41.4
	d	407.3	445.3	405.1	479.8	498.2	549.3	624.9	712.3	804.1	935.2	1061.9	1206.1	1401.6	1633.7	1918.4	2150.6	2252.1	2634.0	2644.7	2290.7
Fuel Oil (3)	a	3.780	4.368	4.382	5.528	6.799	8.540	10.06	11.68	13.41	14.97	16.67	17.67	18.61	19.27	20.12	21.0	20.19	19.32	19.04	17.18
	b	5.156	6.08	6.23	7.88	9.49	11.85	13.13	15.36	17.52	19.02	21.04	22.16	23.26	24.35	25.55	26.52	25.06	23.63	22.89	20.48
	c	73.3	71.8	70.3	70.2	71.6	72.0	76.6	76.0	76.5	78.7	79.2	79.7	80.0	79.1	78.8	79.2	80.5	81.8	83.1	83.9
	d	1557.4	1799.6	1805.4	2277.5	2801.2	3518.5	4144.7	4812.2	5525.0	6167.6	6868.0	7280.0	7686.0	7958.5	8349.8	8715.0	8399.0	8075.8	7958.7	7078.2
Total Industrial		2011	2289	2253	2799	3349	4121	4839	5086	6431	7228	8102	8728	9343	9871	10612	11275	11165	11381	11391	1010
Check with published figures (2)							4121			6432	7228	8106	8726	9332	9870	10613	11273	11167	11383	11390	10081

Table 7b (continued)

TRANSPORT SECTOR		1955	1956	1957	1958	1959	1960	1961
Burning Oil	a							
	b							
	c							
	d							
Gas/Diesel Oil	a	0.174	0.203	0.258	0.332	0.428	0.578	0.82
	b	1.61	1.90	1.90	2.385	2.712	3.261	3.76
	c	10.8	10.7	13.6	13.9	15.8	17.7	21.8
	d	76.0	88.7	112.7	145.1	187.0	252.6	358.3
Fuel Oil	a	0.544	0.605	0.647	0.684	0.689	0.720	0.78
	b	5.156	6.08	6.23	7.88	9.49	11.85	13.13
	c	10.6	10.0	10.4	8.7	7.3	6.1	5.9
	d	224.1	249.3	266.6	281.8	283.9	296.6	321.4
Motor Spirit	a	6.24	6.324	5.745	6.624	7.124	7.625	8.00
	b	Same as column a above						
	c	all	all	all	all	all	all	all
	d	2820.5	2858.4	2596.7	2994.0	3220.0	3446.5	3616.0
Derv Fuel	a	1.601	1.797	1.795	2.049	2.276	2.582	2.84
	b	Same as column a above						
	c	all	all	all	all	all	all	all
	d	699.6	785.3	784.4	895.4	994.6	1128.3	1241.1
Aviation Spirit	a						0.27	0.27
	b							
	c						all	all
	d						122.6	122.6
Wide-cut Gasolene	a						0.72	1.01
	b							
	c						all	all
	d						329.6	458.5
Aviation Turbine Fuel (4)	a	1.698	1.755	1.630	1.565	1.628	0.78	0.88
	b							
	c	all	all	all	all	all	all	all
	d	770.9	796.3	740.0	710.5	739.1	351.0	396.0
Total Transport		4591	4778	4500	5026	5425	5925	6514
Check with published figures (2)							5866	

TRANSPORT SECTOR		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Burning Oil	a	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
	b	1.43	1.67	1.47	1.59	1.65	1.75	1.97	2.20	2.44	2.52	2.88	3.13	2.74
	c	0.7	0.6	0.7	0.6	0.6	0.6	1.0	0.5	0.4	0.4	0.3	0.3	0.4
	d	4.48	4.48	4.48	4.48	4.48	4.48	8.96	4.49	4.49	4.50	4.48	4.48	4.48
Gas/Diesel Oil	a	0.96	1.12	1.2	1.34	1.4	1.42	1.57	1.63	1.71	1.67	1.59	1.72	1.80
	b	4.37	4.99	5.49	6.13	6.72	7.49	8.49	9.66	10.90	11.61	13.21	13.98	12.62
	c	22.0	22.4	21.9	21.9	20.8	19.0	18.5	16.9	15.7	14.4	12.0	12.3	14.3
	d	419.5	489.4	524.4	585.6	611.8	622.0	687.7	714.0	749.0	733.1	698.0	755.1	788.4
Fuel Oil	a	0.85	0.78	0.74	0.70	0.65	0.58	0.45	0.46	0.51	0.39	0.30	0.28	0.28
	b	15.36	17.52	19.02	21.04	22.16	23.26	24.35	25.55	26.52	25.06	23.63	22.89	20.48
	c	5.5	4.5	3.9	3.3	2.9	2.5	1.9	1.9	1.9	1.6	1.3	1.2	1.4
	d	350.2	321.4	304.9	288.4	267.8	239.5	185.9	199.2	211.7	162.2	125.4	117.0	117.0
Motor Spirit	a	8.44	8.92	9.88	10.64	11.22	11.99	12.74	13.21	14.00	14.73	15.65	16.66	16.22
	b													
	c	all	all	all	all	all	all	all	all	all	all	all	all	all
	d	3814.9	4030.8	4465.8	4809.3	5071.4	5419.5	5758.5	5970.9	6328.0	6658.0	7074.0	7530.3	7331.4
Derv Fuel	a	30.4	3.31	3.64	3.85	4.04	4.29	4.58	4.79	4.96	5.11	5.17	5.57	5.43
	b													
	c	all	all	all	all	all	all	all	all	all	all	all	all	all
	d	1328.5	1446.5	1590.7	1682.5	1765.5	1879.0	2006.0	2098.0	2172.5	2243.3	2369.6	2445.2	2376.3
Aviation Spirit	a	0.22	0.24	0.19	0.17	0.13	0.13	0.10	0.10	0.07	0.06	0.06	0.06	0.05
	b	same as column a above												
	c	all	all	all	all	all	all	all	all	all	all	all	all	all
	d	99.9	109.0	86.26	77.18	68.1	59.0	45.4	45.4	31.78	27.24	27.24	27.24	22.7
Wide-cut Gasolene	a	0.81	0.52	0.45	0.32	0.28	0.30	0.34	0.28	0.15	0.08	0.08	0.07	0.08
	b	same as column a above												
	c	all	all	all	all	all	all	all	all	all	all	all	all	all
	d	367.7	236.1	204.3	145.3	127.1	136.2	154.4	127.1	68.1	36.3	36.3	31.8	27.24
Aviation Turbine Fuel (4)	a	1.08	1.48	1.66	1.90	2.15	2.48	2.72	2.92	3.20	3.61	3.87	4.14	3.63
	b	same as column a above												
	c	all	all	all	all	all	all	all	all	all	all	all	all	all
	d	486.0	666.0	747.0	855.0	967.5	1113.5	1221.3	1311.1	1433.6	1620.9	1729.9	1550.6	1622.6
Total Transport		6871	7305	7928	8448	8884	9473	10068	10470	10999	11486	11965	12762	12292
Check with published figures (2)			7303	7927	8448	8887	9493	10072	10466	11002	11483	11962	12760	12295

Table 7b (continued)

MISCELLANEOUS (5)

Burning Oil	a	0.082	0.071	0.069	0.057	0.051	0.042	0.04	0.03	0.04	0.03	0.03	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02
	b	0.694	0.831	0.796	1.124	1.203	1.295	1.23	1.43	1.67	1.47	1.59	1.65	1.75	1.97	2.20	2.44	2.52	2.88	3.13	2.74
	c	11.8	8.5	8.7	5.1	4.2	3.2	3.3	2.1	2.3	2.0	1.9	1.2	1.1	1.0	1.4	0.8	0.8	0.7	0.6	0.7
	d	36.7	31.8	30.9	25.5	22.8	18.8	17.9	13.4	17.9	13.4	13.4	9.0	9.0	9.0	13.5	9.0	9.0	9.0	9.0	9.0
Vaporising Oil	a	0.669	0.557	0.505	0.430	0.355	0.275	0.24	0.19	0.16	0.13	0.10	0.08	0.07	0.06	0.06	0.05	0.04	0.03	0.03	0.03
	b	0.689	0.574	0.520	0.445	0.369	0.289	0.26	0.21	0.18	0.15	0.12	0.10	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.03
	c	97.1	97.0	97.1	96.6	96.2	95.2	92.3	91.0	89.0	87.0	83.0	80.0	78.0	86.0	all	all	all	all	all	all
	d	296.4	246.8	223.7	190.5	157.3	121.8	106.3	84.2	70.9	57.6	44.3	35.4	31.0	26.6	26.6	22.2	17.7	13.3	13.3	13.3
Gas/Diesel Oil	a	0.451	0.595	0.632	0.826	0.983	1.195	1.19	1.35	1.55	1.65	1.83	2.03	2.28	2.61	3.01	3.54	4.10	4.78	5.30	4.78
	b	1.61	1.90	1.90	2.385	2.712	3.261	3.76	4.37	4.99	5.49	6.13	6.72	7.49	8.49	9.66	10.90	11.61	13.21	13.98	12.62
	c	28.0	31.3	33.3	34.6	36.2	36.6	31.6	31.0	31.1	30.0	29.9	30.2	30.4	30.7	31.2	32.5	35.3	36.2	38.0	37.9
	d	197.1	260.0	276.2	361.0	429.6	522.2	520.0	590.0	677.4	721.1	799.7	887.1	998.6	1143.2	1318.4	1550.5	1800.0	2098.4	2326.7	2093.6
Fuel Oil	a	0.823	1.091	1.193	1.656	1.994	2.575	2.16	2.69	3.18	3.15	3.50	3.69	3.92	4.43	4.74	4.84	4.37	3.93	3.5	2.95
	b	5.156	6.08	6.23	7.88	9.49	11.85	13.13	15.36	17.52	19.02	21.04	22.16	23.26	24.35	25.55	26.52	25.06	23.63	22.89	20.48
	c	16.0	17.9	19.1	21.0	21.0	21.7	16.5	17.5	18.2	16.6	16.6	16.7	16.9	18.2	18.6	18.3	17.4	16.6	15.3	14.4
	d	339.1	449.5	491.5	682.3	821.5	1060.9	889.9	1108.3	1310.2	1297.8	1442.0	1520.3	1619.0	1829.6	1967.1	2008.6	1813.6	1642.7	1463.0	1215.4
Total Miscellaneous		869	988	1022	1259	1431	1724	1534	1796	2076	2090	2299	2452	2658	3008	3326	3590	3640	3763	3812	3331
Check with published figures (2)							1727			2072	2093	2297	2454	2661	3006	3327	3588	3646	3766	3805	3335

Table 7b (continued)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total All Sectors	7762	8430	8136	9617	10795	12441	13615	15140	16803	18159	19821	21031	22481	24061	25630	27194	27613	28633	29631	27207
Check with published figures (2)						12385			16799	18159	19820	21034	22492	24063	25628	27198	27617	28634	29623	27193

(1) Consumption for years 1955 to 1959 is partly estimated.

(2) See Table 19 of 1967 U.K. Digest of Energy Statistics and equivalent publication for later years.

(3) Consumption includes "other deliveries", which is the difference between actual and recorded use of fuel oil by electricity generating and gas industries.

(4) For years 1955 to 1959, separate figures are not available for the three consistent of Aviation Fuels. Table shows the total of Aviation Fuels.

(5) Sector includes Agriculture, Public Administration and other Miscellaneous.

Sources:

(1) For the years 1955 to 1959 - see previous Table 7a

(2) For later years, see Table 19 of 1967 U.K. D.E.S. and equivalent table for other years.

TABLE 8 Petroleum Consumption in Scotland

Table 8a Analysis of consumption by product (original units of measurement)
Figures in thousand tons

Product		1955	1956	1957	1958	1959	1960	1961
Butane and Propane	Total Delivery (1)	4.6	9.8	9.3	11.4	13.1	24.2	36.2
	Use in Gasworks (2)							18.9
	Final Use (3)	4.6	9.8	9.3	11.4	13.1	24.2	17.3
Aviation Fuels (4)	Aviation Spirit							
	Wide-cut Gasolene							
	Aviation Turbine Fuel	133.0	172.2	139.8	134.6	178.1	176.7	214.5
Motor Spirits		512.0	513.1	466.6	528.0	564.2	594.3	634.2
Burning Oil		53.3	58.3	55.9	75.3	74.1	78.3	77.5
Vaporising Oil		81.3	65.4	57.4	45.3	34.1	26.6	21.5
Derv Fuel		166.0	207.0	208.8	237.2	256.4	278.8	301.8
Gas/ Diesel Oil	Total Delivery	217.6	242.9	251.3	313.8	341.4	383.8	464.6
	Use in Power Stations (5)	15.6	14.7	14.4	15.4	16.2	16.4	16.7
	Final Use	202.0	228.2	236.9	298.4	325.2	367.4	447.9
Fuel Oil	Total Delivery	357.2	457.8	512.2	634.0	741.0	916.4	1055.9
	Use in Power Stations (5)	1.1	1.1	2.0	1.9	4.0	7.6	10.2
	Final Use	356.1	456.7	510.0	632.1	737.0	908.8	1045.7
Total Final Use		1528.3	1710.7	1684.7	1962.3	2182.2	2455.1	2760.4

Product		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Butane and Propane	Total Delivery (1)	32.6	74.7	120.0	141.1	178.0	192.1	200.2	214.8	223.3	182.8	172.8	198.4	175.5
	Use in Gasworks (2)	29.3	54.5	90.0	119.5	146.7	163.5	165.6	176.1	146.7	83.9	44.0	25.2	15.0
	Final Use (3)	3.3	20.2	30.0	21.6	31.3	28.6	34.6	38.7	76.6	98.9	128.8	173.2	160.5
Aviation Fuels (4)	Aviation Spirit	36.4	34.3	27.6	29.4	16.0	16.4	13.9	14.3	9.2	5.3	6.8	9.2	8.1
	Wide-cut Gasolene	29.7	34.8	29.2	15.6	18.9	15.7	2.9	4.6	5.5	10.4	3.9	2.4	0.5
	Aviation Turbine Fuel	126.9	149.1	156.6	169.9	195.1	226.5	270.8	277.5	297.7	320.0	309.0	349.4	314.4
Motor Spirits		668.3	707.1	774.2	812.6	843.6	878.9	949.7	996.0	1028.8	1112.3	1180.5	1285.0	1242.5
Burning Oil		83.1	94.6	85.3	97.8	105.4	107.1	120.5	142.6	152.1	152.9	190.8	218.5	196.7
Vaporising Oil		17.3	14.3	11.2	9.4	7.4	6.4	5.5	4.5	3.7	4.1	3.9	3.5	2.4
Derv Fuel		329.3	348.4	373.0	385.2	393.3	396.3	452.4	480.0	477.4	484.8	507.6	544.7	513.8
Gas/ Diesel Oil	Total Delivery	537.5	580.7	637.0	725.5	783.1	784.5	925.0	1011.6	1122.2	1167.1	1280.3	1410.3	1449.8
	Use in Power Stations (5)	18.3	20.1	19.6	27.0	48.0	62.0	61.0	65.0	48.0	48.0	53.0	60.0	61.0
	Final Use	519.2	560.6	617.4	698.5	735.1	722.5	864.0	946.6	1074.2	1119.1	1227.3	1350.3	1388.8
Fuel Oil	Total Delivery	1246.6	1493.9	1766.7	2041.3	2577.5	2959.7	2918.1	3267.9	3900.1	4361.3	4588.3	4419.2	4348.7
	Use in Power Stations (5)	10.2	21.3	41.4	93.0	392.0	548.0	409.0	515.0	1062.0	1482.0	1597.0	1400.0	1489.0
	Final Use	1235.4	1472.6	1725.3	1948.3	2185.2	2411.7	2509.1	2752.9	2838.1	2879.3	2991.3	3019.2	2859.7
Total Final Use		3049.9	3436.0	3829.8	4188.3	4531.6	4810.1	5223.4	5657.7	5963.3	6196.1	6549.9	6959.4	6687.4

(1) Years 1962 and 1963. The total delivery figures and figures for use in gasworks are estimated. The total delivery figures for Petroleum Gases are obtained from Digest of U.K. Energy Statistics (for example see Table 39 of 1973 Digest) which is 48.6 for 1962. The consumption of Refinery Gases used in the gasworks is obtained from Digest of Scottish Statistics (for example see Table 6 of 1966 Digest); these figures are in financial years which is converted to calendar years by taking 3/4 and 1/4 proportion and this gives a figure of 8 million therms. This is equivalent to $8 \times 10^3/504 = 16$ thousand ton. ∴ Consumption of Propane and Butane = 48.6 − 16 = 32.6. Similarly for 1963: $112.7 - 19 \times 10^3.504 = 112.7 - 38 = 74.7$. Note that the 1962 figure for final use is very low and is liable to some error.

(2) Propane and Butane used by gasworks is estimated from financial year figures to that for calendar year. See note (1) above.

(3) See note (1) above.

(4) Year 1955 to 1960. Separate figures for the three types of Aviation Fuels are not available. The total is shown under Aviation Turbine Fuel for these years.

(5) Gas/Diesel Oil and Fuel Oil used by power stations. For the years 1955 to 1964 inclusive figures were obtained from Digest of Scottish Statistics (see Table 5 of April 1961, Table 9 of April 1966). Consumption in the South of Scotland Electricity Board was assumed to be entirely of Fuel Oil while that in the North of Scotland Hydro Board, entirely of Gas/Diesel Oil.

For years 1965 to 1974, the overall figures for Gas/Diesel plus Fuel Oils were taken from Table 127 of 1975 Abstract of Scottish Statistics. The split between the two fuels were obtained in the following way. Example for the year 1970, From Table 114 of 1974 Abs. of Scottish Statistics, the consumption of Gas/Diesel Oil is 49.6 and of fuel is 1085.8 (adding together Oil used for Steam for both SSEB and NSHEB and this gives total for Fuel Oil, adding together Oil used for Gas Turbine in the SSEB and Diesel for NSHEB gives total for Gas/Diesel Oil) which is obtained by converting from financial year to calendar year figures by taking proportion of 3/4 and 1/4. Hence the consumption of Gas/Diesel Oil for

$$1970 = \frac{1110}{(49.6\ )\ 1085.8)} \times 49.6 = \frac{1110}{1135.6} \times 49.6 = 48.0$$

Sources: (a) As mentioned above.

(b) For total delivery of each product - Institute of Fuel, London.

Table 8b Scotland: Sector Consumption of Petroleum
(From Product Consumption - using U.K. Transformation)

Notations: a = the percentage ratio of consumption in the sector to the total delivery, of the product (Obtained from United Kingdom - Special Table 7b)

b = total delivery of that product in Scotland, thousand tons.

c = a × b, i.e. consumption in that sector, thousand tons.

d = c in million therms (using conversion factors of Table 1b)

* = thousand tons
** = million therms

DOMESTIC SECTOR		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Butane and Propane (1)	a	49	53	54	54	51	52	46	33	28	27	21	16	16	18	15	13	10	6	6	7
	b	4.6	9.8	9.3	11.4	13.1	24.2	17.3	3.3	20.2	30.0	21.6	31.3	28.6	34.6	38.7	76.6	98.9	128.8	173.2	160.5
	c	2.25	5.19	5.02	6.16	6.68	12.58	7.96	1.09	5.66	8.1	4.54	5.01	4.58	6.23	5.81	9.96	9.89	7.73	10.39	11.24
	d	1.06	2.48	2.39	2.94	3.19	6.0	3.8	0.52	2.7	3.86	2.17	2.39	2.19	2.98	2.78	4.76	4.73	3.69	4.97	5.37
Burning Oil	a	81	86	85	90	92	93	92	93	93	91	90	87	86	84	83	82	82	84	86	86
	b	53.3	58.3	55.9	75.3	74.1	78.3	77.5	83.1	94.6	85.3	97.8	105.4	107.1	120.5	142.6	152.1	152.9	190.8	218.5	196.7
	c	43.17	50.14	47.52	65.77	68.17	72.82	71.3	77.28	87.98	77.62	88.02	91.7	92.11	101.22	118.36	124.72	125.38	160.27	187.91	169.16
	d	19.34	22.46	21.29	29.47	30.54	32.62	31.94	34.62	39.42	34.77	39.43	41.08	41.27	45.35	53.03	55.88	56.42	71.8	84.18	75.78
Gas/Diesel Oil	a	3.3	4.4	4.4	5.4	5.9	7.1	8.5	9.8	9.6	9.1	8.6	7.9	7.1	6.8	6.6	6.8	6.1	6.4	6.4	6.4
	b	202.0	228.2	236.9	298.4	325.2	367.4	447.9	519.2	560.6	617.4	698.5	735.1	722.5	864.0	946.6	1074.2	1119.1	1227.3	1350.3	1388.8
	c	6.7	10.04	10.42	16.11	19.19	26.09	38.07	50.88	53.82	56.18	60.1	58.1	51.3	58.8	62.5	73.0	68.3	78.5	86.4	88.9
	d	2.91	4.39	4.55	7.04	8.39	11.4	16.64	22.24	23.52	24.55	26.26	25.39	22.47	25.75	27.38	31.97	29.98	34.46	37.93	38.93
Fuel Oil	a	0.2	0.2	0.1	0.1	0.1	0.1	1.0	0.9	0.86	0.84	0.81	0.68	0.77	0.82	0.82	0.64	0.44	0.34	0.31	0.34
	b	356.1	456.7	510.0	632.1	737.0	908.8	1045.7	1236.4	1472.6	1725.3	1948.3	2185.5	2411.7	2509.1	2752.9	2838.1	2879.3	2991.3	3019.2	2859.7
	c	0.71	0.91	0.51	0.63	0.74	0.91	10.46	11.13	12.66	14.49	15.78	14.86	18.57	20.58	22.57	18.16	12.67	10.17	9.36	9.72
	d	0.28	0.38	0.21	0.26	0.31	0.38	4.31	4.59	5.22	5.97	6.5	6.12	7.67	8.5	9.37	7.54	5.27	4.25	3.91	4.02
Total Domestic	*	52.83	66.28	63.5	88.67	94.78	112.4	127.79	140.38	160.12	156.39	168.44	169.67	166.56	186.83	209.24	225.84	216.24	256.67	294.06	269.3
	**	23.59	29.71	28.44	39.71	42.43	50.4	56.69	61.97	70.86	69.15	74.36	74.98	73.6	82.58	92.56	100.15	96.4	114.2	130.99	124.1
INDUSTRIAL SECTOR																					
Butane & Propane (1)	a	50	47	46	46	49	48	54	67	72	73	79	84	84	82	85	87	90	94	94	93
	b	4.6	9.8	9.3	11.4	13.1	24.2	17.3	3.3	20.2	30.0	21.6	31.3	28.6	34.6	38.7	76.6	98.9	128.8	173.2	160.5
	c	2.3	4.61	4.28	5.24	6.42	11.62	9.34	2.21	14.54	21.9	17.06	26.09	24.02	28.37	32.9	66.64	89.01	120.07	162.81	149.27
	d	1.09	2.2	2.04	2.5	3.06	5.54	4.46	1.05	6.93	10.45	8.14	12.54	11.48	13.56	15.73	31.85	42.55	57.87	77.82	71.35
Burning Oil	a	7.5	5.9	6.0	4.1	4.0	3.9	4.9	4.2	4.2	6.1	7.6	10.9	12.6	13.7	15.0	16.3	16.7	14.6	12.8	12.8
	b	53.3	58.3	55.9	75.3	74.1	78.3	77.5	83.1	94.6	85.3	97.8	105.4	107.1	120.5	142.6	152.1	152.9	190.8	218.5	196.7
	c	4.0	3.44	3.35	3.09	2.96	3.05	3.80	3.49	3.97	5.2	7.43	11.49	13.49	16.51	21.39	24.79	25.53	27.86	27.97	25.18
	d	1.8	1.54	1.5	1.38	1.33	1.37	1.7	1.56	1.78	2.33	3.33	5.15	6.04	7.4	9.6	11.13	11.4	12.48	12.53	11.28
Vaporising Oil	a	2.9	3.0	2.9	3.4	3.8	4.8	7.7	9.5	11.0	13	17	20	22	14						
	b	81.3	65.4	57.4	45.3	34.1	26.6	21.5	17.3	14.3	11.2	9.4	7.4	6.4	5.5						
	c	2.35	1.96	1.66	1.54	1.3	1.28	1.66	1.64	1.57	1.46	1.6	1.48	1.41	0.77						
	d	1.04	0.87	0.74	0.68	0.58	0.57	0.74	0.73	0.7	0.65	0.71	0.66	0.63	0.34						
Gas/Diesel Oil	a	57.9	53.6	48.8	46.0	42.0	38.5	38.0	37.3	36.9	39.0	39.6	41.1	42.7	43.9	45.3	45.1	44.2	45.4	43.4	41.4
	b	202.0	228.2	236.9	298.4	325.2	367.4	447.9	519.2	560.6	617.4	698.5	735.1	722.5	864.0	946.6	1074.2	1119.1	1227.3	1350.3	1388.8
	c	117.0	122.32	115.61	137.26	136.48	141.45	170.2	193.66	206.86	240.79	276.6	302.13	308.51	379.3	428.81	484.46	494.64	557.19	586.03	574.96
	d	51.11	53.45	50.52	59.98	59.69	61.81	74.38	84.63	90.4	105.23	120.87	132.03	135.14	166.13	187.83	212.19	217.15	244.6	257.27	251.83
Fuel Oil	a	73.3	71.8	70.3	70.2	71.6	72.0	76.6	76.0	76.5	78.7	79.2	79.7	80.0	79.1	78.8	79.2	80.5	81.8	83.1	83.9
	b	356.1	456.7	510.0	632.1	737.0	908.8	1045.7	1236.4	1472.6	1725.3	1948.3	2185.5	2411.7	2509.1	2752.9	2838.1	2879.3	2991.3	3019.2	2859.7
	c	261.0	327.90	358.5	443.7	527.7	654.3	801.0	939.7	1126.5	1357.8	1543.1	1741.8	1929.4	1984.7	2169.3	2247.8	2317.8	2446.9	2509.0	2399.3
	d	107.54	135.1	147.7	182.8	217.41	269.57	330.0	387.16	464.12	559.41	635.75	717.62	796.84	819.68	900.26	932.84	964.21	1022.8	1048.8	990.9
Total Industrial	*	386.7	460.24	483.4	590.83	674.96	811.7	986.0	1140.7	1353.4	1627.1	1845.7	2082.9	2276.8	2409.6	2652.4	2823.6	2926.7	3153.0	3285.8	3148.7
	**	162.58	193.16	202.5	247.34	282.07	338.86	411.28	475.13	563.93	678.07	768.8	868.0	950.12	1007.1	1113.4	1188.0	1235.3	1337.7	1396.4	1325.3

Table 8b (continued)

TRANSPORT SECTOR		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Burning Oil	a								0.7	0.6	0.7	0.6	0.6	0.6	1.0	0.5	0.5	0.4	0.4	0.3	0.4
	b								83.1	94.6	85.3	97.8	105.4	107.1	120.5	142.6	152.0	152.9	190.8	218.5	196.7
	c								0.585	0.568	0.597	0.587	0.632	0.643	1.205	0.713	0.761	0.612	0.763	0.656	0.786
	d								0.26	0.25	0.27	0.26	0.28	0.29	0.54	0.32	0.34	0.28	0.34	0.29	0.35
Gas/Diesel Oil	a	10.8	10.7	13.6	13.9	15.8	17.7	21.8	22.0	22.4	21.9	21.9	20.8	19.0	18.5	16.9	15.7	14.4	12.0	12.3	14.3
	b	202.0	228.2	236.9	298.4	325.2	367.4	447.9	519.2	520.6	617.4	698.5	735.1	722.5	864.0	946.6	1074.2	1119.1	1227.3	1350.3	1388.8
	c	21.8	24.4	32.2	41.5	51.4	65.0	97.6	114.2	125.6	135.2	153.0	152.9	137.3	159.8	160.0	168.6	161.2	147.3	166.1	198.6
	d	9.53	10.66	14.07	18.14	22.46	28.41	42.65	49.91	54.89	59.08	66.86	66.82	60.14	70.0	70.08	73.84	70.77	64.67	72.92	86.99
Fuel Oil	a	10.6	10.0	10.4	8.7	7.3	6.1	5.9	5.5	4.5	3.9	3.3	2.9	2.5	1.9	1.9	1.9	1.6	1.3	1.2	1.4
	b	356.1	456.7	510.0	632.1	737.0	908.8	1045.7	1236.4	1472.6	1725.3	1948.3	2185.5	2411.7	2509.1	2752.9	2838.1	2879.3	2991.3	3019.2	2859.7
	c	37.7	45.7	53.0	55.0	53.8	55.4	61.7	68.0	66.3	67.3	64.3	63.4	60.3	47.7	52.3	53.9	46.1	38.9	36.2	40.0
	d	15.54	18.83	21.84	22.66	22.17	22.83	25.42	28.02	27.32	27.73	26.52	26.15	24.90	19.7	21.71	22.37	19.18	16.26	15.13	16.53
Motor Spirits	a	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all
	b	512.0	513.1	466.6	528.0	564.2	594.3	634.2	668.3	707.1	774.2	812.6	843.6	878.9	949.7	996.0	1028.8	1112.3	1180.5	1289.0	1247.5
	c		Same as column b above																		
	d	231.42	231.92	210.9	238.66	255.02	268.62	286.66	302.07	319.61	349.94	367.3	381.31	397.26	429.26	450.19	465.02	502.76	533.59	582.63	561.61
Derv Fuel	a	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all
	b	186.0	207.0	208.8	237.2	256.4	278.8	301.8	329.3	348.4	373.0	385.2	393.3	396.3	452.4	480.0	477.4	484.8	507.6	544.7	513.8
	c		Same as column b above																		
	d	81.29	90.46	91.25	103.66	112.05	121.84	131.89	143.9	152.25	163.0	168.33	171.87	173.58	198.15	210.24	209.1	212.83	222.84	239.12	225.04
Aviation Spirit	a								all	all	all	all	all	all	all	all	all	all	all	all	all
	b								36.4	34.3	27.6	29.4	16.0	16.4	13.9	14.3	9.2	5.3	6.8	9.2	8.1
	c								same as column b above												
	d								16.53	15.57	12.53	13.35	7.26	7.45	6.31	6.49	4.18	2.41	3.09	4.18	3.68
Wide-cut Gasolene	a								all	all	all	all	all	all	all	all	all	all	all	all	all
	b								29.7	34.8	29.2	15.6	18.9	15.7	2.9	4.6	5.5	10.4	3.9	2.4	0.6
	c								same as column b above												
	d								13.48	15.8	13.26	7.08	8.58	7.13	1.32	2.09	2.5	4.72	1.77	1.09	2.72
Aviation Turbine Fuel (2)	a	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all	all
	b	133.0	172.2	139.8	134.6	178.1	176.7	214.5	126.9	149.1	156.6	169.9	195.1	226.5	270.8	277.5	297.7	329.0	309.0	349.4	314.4
	c		Same as column b above																		
	d	59.84	77.49	62.91	60.59	80.15	79.52	96.5	57.11	67.11	70.47	76.46	87.8	101.93	121.86	124.88	134.0	148.05	139.05	157.23	140.54
Total Transport	*	890.5	962.4	900.4	996.3	1103.9	1170.2	1309.8	1373.4	1466.2	1563.7	1630.6	1683.8	1732.0	1898.4	1985.4	2041.9	2149.7	2194.8	2397.7	2318.8
	**	397.63	429.36	400.97	443.69	491.85	521.22	583.12	611.28	652.79	696.26	726.16	750.07	772.68	847.14	886.0	911.35	961.0	981.61	1072.59	1037.5

Table 8b (continued)

MISCELLANEOUS SECTOR (3)

Burning Oil	a	11.8	8.5	8.7	5.1	4.2	3.2	3.3	2.1	2.3	2.0	1.9	1.2	1.1	1.0	1.4	0.8	0.8	0.7	0.6	0.7
	b	53.3	58.3	55.9	75.3	74.1	78.3	77.5	83.1	94.6	85.3	97.8	105.4	107.1	120.5	142.6	152.1	152.9	190.8	218.5	196.7
	c	6.3	5.0	4.9	3.8	3.1	2.5	2.6	1.7	2.2	1.7	1.9	1.3	1.2	1.2	2.0	1.2	1.2	1.3	1.3	1.4
	d	2.8	2.24	2.19	1.70	1.39	1.12	1.16	0.76	0.99	0.76	0.85	0.58	0.54	0.54	0.9	0.54	0.54	0.58	0.58	0.63
Vaporising Oil	a	97.1	97.0	97.1	96.6	96.2	95.2	92.3	91.0	89.0	87.0	83.0	80.0	78.0	86.0	all	all	all	all	all	all
	b	81.3	65.4	57.4	45.3	34.1	26.6	21.5	17.3	14.3	11.2	9.4	7.4	6.4	5.5	4.5	3.7	4.1	3.9	3.5	2.4
	c	78.9	63.4	55.7	43.8	32.8	25.3	19.8	15.7	12.7	9.7	7.8	5.9	5.0	4.7	4.5	3.7	4.1	3.9	3.5	2.4
	d	35.0	28.09	24.68	19.4	14.53	11.21	8.77	6.96	5.63	4.3	3.46	2.61	2.22	2.08	1.99	1.64	1.82	1.73	1.55	1.06
Gas/Diesel Oil	a	28.0	31.3	33.3	34.6	36.2	36.6	31.6	31.0	31.1	30.0	29.9	30.2	30.4	30.7	31.2	32.5	35.3	36.2	38.0	37.9
	b	202.0	228.2	236.9	298.4	325.2	367.4	447.9	519.2	560.6	617.4	698.5	735.1	722.5	864.0	946.6	1074.2	1119.1	1227.3	1350.3	1388.8
	c	56.6	71.4	78.9	103.2	117.7	134.5	141.5	161.0	174.3	185.2	208.9	222.0	219.6	265.2	295.3	349.1	395.0	444.3	513.1	526.4
	d	24.72	31.2	34.48	45.10	51.44	58.78	61.84	70.36	76.17	80.93	91.28	97.01	96.19	116.16	129.34	152.91	173.41	195.05	225.25	230.54
Fuel Oil	a	16.0	17.9	19.1	21.0	21.0	21.7	16.5	17.5	18.2	16.6	16.6	16.7	16.9	18.2	18.6	18.3	17.4	16.6	15.3	14.4
	b	356.1	456.7	510.0	632.1	737.0	908.8	1045.7	1236.4	1472.6	1725.3	1948.3	2185.5	2411.7	2509.1	2752.9	2838.1	2879.3	2991.3	3019.2	2859.7
	c	56.98	81.7	97.4	132.7	154.8	197.2	172.5	216.4	268.0	286.4	323.4	365.0	407.6	456.7	512.0	519.4	501.0	499.6	461.9	411.80
	d	23.47	33.66	40.13	54.67	63.78	81.25	71.07	89.16	110.42	118.0	133.24	150.38	168.34	188.62	212.48	215.55	208.42	208.83	193.07	170.07
Total	*	198.8	221.5	236.9	283.5	308.4	359.7	336.4	394.8	457.2	483.0	542.0	594.2	633.4	727.8	813.8	873.4	901.3	949.1	979.8	942.0
Miscellaneous Sector	**	86.0	95.19	101.48	120.87	131.14	152.36	142.84	167.24	193.21	203.99	228.83	250.58	267.29	307.4	344.71	370.64	384.19	406.19	420.45	402.30
Total	*	1528.8	1710.4	1684.2	1959.3	2182.0	2454.0	2760.0	3049.3	3437.0	3830.2	4186.8	4530.7	4808.8	5222.7	5660.8	5964.8	6194.0	6553.6	6957.4	6678.8
All Sectors	**	669.79	747.42	733.39	851.61	947.49	1062.8	1193.9	1315.6	1480.7	1647.4	1798.2	1943.6	2063.6	2244.2	2436.6	2570.1	2676.9	2839.7	3020.4	2889.2

(1) Total delivery of Butane and Propane is estimated for years 1962 and 1963. See note (1) of Table 8a

(2) See note 4 of Table 8a

(3) Miscellaneous sector includes agriculture, public administration and miscellaneous categories

Source: See previous Table 8a

Table 8c Summary Table. Petroleum Consumption in Scotland

Notation: a = thousand tons; b = million therms

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Power Stations (1)	Gas/Diesel Oil	a	15.6	14.7	14.4	15.4	16.2	16.4	16.7	18.3	20.1	19.6	27.0	48.0	62.0	61.0	65.0	48.0	48.0	53.0	60.0	61.0
		b	6.8	6.4	6.3	6.7	7.1	7.2	7.3	8.0	8.8	8.6	11.8	21.0	27.2	26.7	28.5	21.0	21.1	23.3	26.3	26.7
	Fuel Oil	a	1.1	1.1	2.0	1.9	4.0	7.6	10.2	10.2	21.3	41.4	93.0	392.0	548.0	409.0	515.0	1062.0	1482.0	1597.0	1400.0	1489.0
		b	0.5	0.5	0.8	0.8	1.7	3.1	4.2	4.2	8.8	17.1	38.2	161.5	226.0	169.0	213.7	440.7	616.5	667.5	585.2	613.5
	Total	a	16.7	15.8	16.2	17.3	20.2	24.0	26.9	28.5	41.4	61.0	420.0	440.0	610.0	470.0	580.0	1110.0	1530.0	1650.0	1460.0	1550.0
		b	7.3	6.9	7.1	7.5	8.8	10.3	11.5	12.2	17.6	25.7	50.0	182.5	253.2	195.7	242.2	461.7	636.6	690.8	611.5	640.2
Gas Works	L.D.F. (2)	a	25.0	24.0	23.0	39.0	37.0	23.0	15.0	28.0	21.0	36.0	85.0	226.0	306.0	379.0	416.0	424.0	117.0	141.0	147.0	119.0
		b	11.5	11.0	10.6	17.9	17.0	10.6	6.9	12.8	9.7	16.6	39.1	104.0	140.8	174.3	191.4	195.0	53.8	64.9	67.6	54.7
	Butane & Propane	a							18.8	29.3	54.5	90.1	119.5	146.7	163.2	165.6	176.1	146.7	83.8	44.0	25.2	15.0
		b							9.0	14.0	26.0	43.0	57.0	70.0	78.0	79.0	84.0	70.0	40.0	21.0	12.0	7.0
	Refinery Gases (3)	a								15.8	37.7	54.0	60.0	62.0	58.0	55.0	49.0	42.0	38.0	40.0	30.0	28.0
		b								8.0	19.0	27.2	30.2	31.2	29.2	27.7	24.7	21.2	19.2	20.2	15.1	14.1
	Total	a	25.0	24.0	23.0	39.0	37.0	23.0	33.8	73.1	113.2	180.1	264.5	434.7	527.2	599.6	641.1	612.7	238.8	225.0	202.0	162.0
		b	11.5	11.0	10.6	17.9	17.0	10.6	15.9	34.8	54.7	86.8	126.3	205.2	248.0	281.0	300.1	286.2	113.0	106.1	94.7	75.8
Refinery: (treated as Fuel Oil)		a	181	187	219	254	286	349	349	404	427	428	423	455	453	469	539	573	717	736	971	843
		b	74.6	77.0	90.2	104.6	117.8	143.8	143.8	166.5	175.9	176.3	174.3	187.5	187.1	193.7	223.7	237.8	298.3	307.7	405.9	348.2
Total in Fuel Conversion Industries		a	222.7	226.8	258.2	310.3	343.2	396.0	397.8	505.1	581.6	669.1	807.5	1329.7	1590.2	1538.6	1760.1	2295.7	2485.8	2611.0	2633.2	2555.0
		b	93.4	94.9	107.9	130.0	143.6	164.7	171.2	213.5	248.2	288.8	350.6	575.2	688.3	670.4	766.0	985.7	1047.9	1104.6	1112.1	1064.2
Total Final Consumption (direct) (4)		a	1528.0	1710.7	1684.7	1962.3	2182.2	2455.1	2760.4	3049.9	3436.0	3829.8	4188.3	4531.6	4810.1	5223.4	5657.7	5963.3	6196.1	6549.9	6957.4	6678.8
		b	669.8	747.4	733.4	851.6	947.5	1062.8	1193.9	1315.6	1480.8	1647.5	1798.2	1943.6	2063.7	2244.2	2436.7	2570.2	2676.9	2839.8	3020.5	2889.3
Total Inland Consumption		a	1750.7	1937.5	1942.9	2272.6	2525.4	2851.1	3158.2	3555.0	4017.6	4498.9	4995.8	5861.3	6401.3	6762.0	7417.8	8259.0	8681.9	9160.9	9592.6	9233.8
		b	763.2	842.3	841.3	981.6	1091.1	1227.5	1365.1	1529.1	1729.0	1936.3	2148.8	2518.8	2752.0	2914.6	3202.7	3555.9	3724.8	3944.4	4132.6	3953.5

(1) See note (5) of Table 8a

(2) For years 1955 to 1960 - see Table 8 of 1961, April, Digest of Scottish Statistics

For years 1961 to 1974 - see Tables 39 of 1973, U.K. Digest of Energy Statistics, Table 34 of 1974, U.K. D.E.S. and Table 44 of 1975, U.K. D.E.S.

For years 1955 to 1960 the oil consumption in Gasworks is assumed to be totally of L.D.F. In fact the consumption will include Gas/Diesel and Fuel Oil, but separate figures are not available, and error in assuming L.D.F. as constituting the whole, will be small.

(3) Refinery gas consumption has been negligible up to 1960. For the years 1961 to 1963, figures are estimated from financial year data (by taking 1/4 + 3/4 of successive years). See Table 6, April 1966, Digest of Scottish Statistics.

(4) Due to rounding up errors, there is a slight difference between the equivalent figures as obtained in previous Tables 8a and 8b. These figures here are taken from Table 8a.

TABLE 9

Gas Consumption - United Kingdom

Notation: a = Coke-oven gas; b = Town gas; c = natural gas;
d = All gas

Million therm

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Industry	Iron and Steel	a	420	441	473	446	425	515	483	425	426	499	508	457	435	460	424	439	422	405	466	337
		b	149	153	155	157	127	145	144	136	140	146	148	142	132	113	122	129	112	76	13	7
		c														27	52	115	231	361	383	388
		d	569	594	628	603	552	660	627	561	566	645	656	599	567	600	598	683	765	842	962	732
	Other Industries	a	35	35	35	35	35	36	34	15	21	24	22	26	26	23	28	23	22	36	46	50
		b	598	611	619	629	677	717	705	711	721	750	771	790	770	787	728	577	300	382	300	189
		c														24	145	595	1831	2869	3901	4503
		d	633	646	654	664	712	753	739	726	742	774	793	816	796	834	901	1195	2153	3287	4247	4742
	Total	a	455	476	508	481	460	551	517	440	447	523	530	483	461	483	452	462	444	441	512	387
		b	747	764	774	786	804	862	849	847	861	896	919	932	902	900	850	706	412	458	313	196
		c														51	197	710	2062	3230	4284	4891
		d	1202	1240	1282	1267	1264	1413	1366	1287	1308	1419	1449	1415	1363	1434	1499	1878	2916	4129	5209	5474
Domestic		a																				
		b	1389	1371	1326	1339	1290	1298	1300	1401	1537	1614	1869	2177	2472	2801	3026	2915	2508	2217	1590	1035
		c													1	28	185	627	1422	2292	3225	4345
		d	1389	1371	1326	1339	1290	1298	1300	1401	1537	1614	1869	2177	2473	2829	3211	3542	3930	4509	4815	5380
Public + Commercial		a																				
		b	483	488	467	478	464	476	469	503	524	516	550	576	609	651	660	645	606	538	420	288
		c														3	44	117	260	458	663	981
		d	483	488	467	478	464	476	469	503	524	516	550	576	609	654	704	762	866	996	1083	1269
Total		a	455	476	508	481	460	551	517	440	447	523	530	483	461	483	452	462	444	441	512	387
		b	2619	2623	2567	2603	2558	2636	2618	2751	2922	3026	3338	3685	3983	4352	4536	4266	3526	3213	2323	1519
		c													1	82	426	1454	3744	5980	8172	10217
		d	3074	3099	3075	3083	3018	3187	3135	3191	3369	3549	3868	4168	4445	4917	5414	6182	7714	9634	11007	12123

Sources:

(a) For 1955 - 1959 inclusive, Table 2

(b) For 1960 - 1964 inclusive, Table 19 of United Kingdom Digest of Energy Statistics

(c) For 1965 - 1973 inclusive, Table 10 of 1974 U.K. D.E.S.

(d) For 1974, Table 10 of 1975 D.E.S.

TABLE 10

Gas Consumption in Scotland

Table 10a Coke Oven Gas (consumption in million therms)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Steelworks (1) (Direct Consumption)	5	4	5	4	2	4	3	3	12	28	43	33	31	44	50	52	47	28	46	36 (2)

(1) This consumption is included in the "industrial category" while compiling later Scottisy Summary Tables - see Table 14.

(2) This figure has been estimated from the ratio of coke production figures for 1973 and 1974.

Source: (a) Year by year, United Kingdom Digest of Energy Statistics (for example see Table 96 of 1973 Digest)

(b) Abstract of Regional Statistics (for example see Table 49 of 1974 Digest)

Table 10b Town and Natural Gas (consumption in million therms

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic (1)	122	117	114	110	105	99	97	101	108	119	129	153	164	171	183	200	198	217	229	254
Industrial	41	42	45	42	44	48	50	50	53	57	59	63	62	58	65	68	71	127	175	222
Commercial + Public Admin + Public Lighting	37	37	37	36	34	34	35	37	38	38	38	41	43	43	46	48	48	49	59	64
Total	200	196	196	188	183	181	182	188	199	214	226	257	268	272	294	316	317	393	463	540

(1) Includes cateogires under credit and prepayment.

Sources:

(a) For years 1955 to 1964 - data constructed from financial year figures (by taking 1/4 and 3/4 of successive years) for the Annual Reports of Scottish Gas.

(b) For years 1965 to 1972 - data obtained from monthly consumption figures, as supplied by the Scottish Gas Board.

(c) For years 1972 to 1974 - from quarterly consumption figures supplied by Scottish Gas.

TABLE 11 Electricity Consumption in the United Kingdom

Table 11a U.K. Nuclear & Hydro Electricity - Primary Energy Equivalent

Procedure:

Nuclear: For Industrial Supply, equivalent is 2220 kwh/ton coal equivalent.
For Public Supply, equivalent is 2460 kwh/ton
Use Power Station Coal Heating Value to convert Coal Equivalent to therms

Hydro: For all types of generation - use 1750 kwh/ton coal equivalent up to 1959 incl. (my figure)
use 1850 kwh/ton coal equivalent up to 1967 incl.
use 1950 kwh/ton coal equivalent since 1967

Notation: a = GWH; b = coal equivalent; c = heating value (therms per ton) d = million therms

Nuclear Electricity		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Industrial Supply	a		58	409	305	1201	2079	2399	2715	2984	3005
	b		.026	.184	.137	.540	.936	1.08	1.222	1.343	1.352
Public Supply	a								762	2965	4624
	b								.306	1.192	1.859
Total Nuclear	b		.026	.184	.137	.540	.936	1.08	1.528	2.535	3.211
Power Station Coal	c		230	230	230	230	230	230	226	227	229
Total Nuclear	d		5.98	42.32	31.51	124.2	215.28	248.4	345.3	575.44	735

Hydro Electricity		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Generated	a	1697	2271	2749	2705	2705	3132	3853	3863	3293	3387
	b	.969	1.29	1.57	1.54	1.54	1.69	2.07	2.08	1.77	1.82
Power Station Coal	c	230	230	230	230	230	230	230	226	227	229
Total Hydro	d	223	297	361	354	354	389	476	470	402	417

Sources: Table 4, 1973 D.E.S.
Table 3, 1974 D.E.S.

Table 11b Electricity Consumption: United Kingdom

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	692	775	810	918	992	1149	1305	1559	1785	1787	1953	2041	2128	2275	2464	2629	2754	2966	3114	3157
Industrial	1086	1160	1222	1272	1384	1546	1599	1653	1732	1915	1998	2052	2078	2258	2400	2491	2506	2497	2727	2589
Traction	71	71	74	73	76	77	78	82	82	81	80	85	88	90	93	94	94	91	89	92
Other Consumers	400	437	457	513	545	627	682	781	863	904	991	1044	1097	1197	1288	1353	1403	1449	1562	1444
Total	2249	2443	2563	2776	2997	3399	3664	4075	4462	4687	5022	5222	5391	5820	6245	6567	6757	7003	7492	7282

Sources: **For the years 1955 to 1959 inclusive, Table 2.**
For the years 1960 to 1964 inclusive, Table 19 of 1967 Digest of Energy Statiscs
For the years 1965 to 1973 inclusive, Table 10 of 1973 D.E.S.
For 1974, Table 10 of 1975 D.E.S.

TABLE 12 Electricity Consumption - Scotland

Table 12a North of Scotland Hydro-Electric Board. (1)

Notation: a = GWH; b = million therms

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	421	472	506	570	618	699	804	965	1117	1206	1402	1570	1661	1838	2056	2298	2327	2457	2791	2837
	b	14.4	16.1	17.3	19.4	21.1	23.8	27.4	32.9	38.1	41.1	47.8	53.6	56.7	62.7	70.2	78.4	79.4	83.8	95.2	96.8
Industrial	a	345	357	369	376	382	428	448	492	503	567	579	625	642	738	844	769	1154	1560	2391	2409
	b	11.8	12.2	12.6	12.8	13.0	14.6	15.3	16.8	17.2	19.3	19.8	21.3	21.9	25.2	28.8	26.2	39.4	53.2	81.6	82.2
Total	a	1061	1168	1231	1349	1421	1602	1783	2057	2309	2486	2770	3044	3184	3507	3926	4187	4623	5200	6501	6462
	b	36.2	39.9	42.0	46.0	48.5	54.7	60.8	70.2	78.8	84.8	94.5	103.9	108.6	119.7	134.0	142.9	157.7	177.4	221.8	220.5
All other consumers (2)	a	295	339	356	403	421	475	531	600	689	713	789	849	881	931	1026	1120	1142	1183	1319	1216
(by substraction)	b	10.0	11.6	12.1	13.8	14.4	16.3	18.1	20.5	23.5	24.4	26.9	29.0	30.0	31.8	35.0	38.3	38.9	40.4	45.2	41.5

Table 12b South of Scotland Electricity Board

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	1410	1569	1665	1918	2116	2451	3024	3842	4418	4608	5208	5631	5946	6414	7037	7573	7793	7963	8622[3]	8562
	b	48.1	53.5	56.8	65.4	72.2	83.6	103.2	131.1	150.7	157.2	177.7	192.1	202.9	218.8	240.1	258.4	265.9	271.7	294.2	292.1
Industrial	a	2577	2749	2859	2879	2961	3205	3392	3580	3762	4129	4394	4566	4654	4872	5128	5223	5093	4970	5425	5133
	b	87.9	93.8	97.5	98.2	101.0	109.4	115.7	122.1	128.4	140.9	149.9	155.8	158.8	166.2	175.0	178.2	173.8	169.6	185.1	175.1
Traction	a	14	6	-	20	96	85	81	101	97	94	90	85	84	83	82	82	83	76	78	125
	b	0.5	0.2	-	0.7	3.3	2.9	2.8	3.4	3.3	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.6	2.7	4.3
Total	a	4875	5299	5562	5990	6435	7153	8083	9335	10282	10946	12051	12799	13338	14238	15341	16154	16312	16326	17853	17228
	b	166.3	180.8	189.8	204.4	219.6	244.1	275.8	318.5	350.8	373.5	411.2	436.7	455.1	485.8	523.4	551.2	556.6	557.0	609.1	587.8
All other consumers	a	874	975	1038	1173	1262	1412	1586	1812	2005	2115	2359	2517	2654	2869	3094	3276	3343	3317	3728	3408
(by subtraction)	b	29.8	33.3	35.5	40.1	43.1	48.2	54.1	61.9	68.4	72.2	80.5	85.9	90.5	98.0	105.5	111.8	114.1	113.1	127.1	116.3

Table 12c Scotland (total)

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	b	62.5	69.6	74.1	84.8	93.3	107.4	130.6	164.0	188.8	198.3	225.5	245.7	259.6	281.5	310.3	336.8	345.3	355.5	389.4	388.9
Industrial	b	99.7	106.0	110.1	110.0	114.0	124.0	131.0	138.9	145.6	160.2	169.7	177.1	180.7	191.4	203.8	204.4	213.2	222.8	266.7	257.3
Traction	b	0.5	0.2	-	0.7	3.3	2.9	2.8	3.4	3.3	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.6	2.7	4.3
All Other Consumers	b	39.8	44.9	47.6	53.9	57.5	64.5	72.2	82.4	91.9	96.6	107.4	114.9	120.5	129.8	140.5	150.1	153.0	153.5	172.3	157.8
Total	b	202.5	220.7	231.8	250.4	268.1	298.8	336.6	388.7	429.6	458.3	505.7	540.9	563.7	605.5	657.4	694.1	714.3	734.4	831.1	808.3

(1) There is a very small consumption for traction in NSHEB but it is ignored here.

(2) This category consists of farm, public lighting, public and commercial.

(3) This figure from SSEB appears as 8474, figure used here is for U.K. D.E.S.

Sources: Digest of Energy Statistics (Ref. Table 71 of 1974 D.E.S.) and equivalent tables
South of Scotland Electrisity Board
North of Scotland Hyrdo Electricity Board

TABLE 13

Summary Tables of Energy Consumption in the United Kingdom

Table 13a Coal: Primary Consumption

Notation: a = million tons; b = million therms

		1955	1956	1957	1958	1959	1960 (Check Table ↓)
Final Consumption (1)	b	28491	27924	26552	25202	23279	23433
Collieries (2)	a	8.69	7.9	7.2	6.5	5.6	4.9
	b	1956	1778	1612	1465	1252	1099
Electricity Supply Industries	a	42.9	45.6	46.4	46.1	46.0	51.1
	b	9867	10488	10672	10603	10580	11753
Gas Works	a	27.9	27.8	26.4	24.8	22.5	22.3
	b	8370	8340	7920	7440	6750	6690
Coke Ovens	a	27.0	29.3	30.7	27.8	25.7	28.5
	b	7749	8409	8811	7979	7376	8180
Manufactured Fuel Plant (3)	a	1.6	1.8	2.1	2.2	1.7	1.4
	b	448	504	588	616	476	392
Northern Ireland	a	3.0	3.0	3.0	2.9	2.7	2.9
	b	810	810	810	783	729	783
Total Supply	b	57691	58253	56965	54158	50298	52355
Check with published figures (4)	b						(52173)

(1) Final consumption figures for 1955 to 1959 are obtained from Table 2. For 1960, the figures are obtained from Table 19 of 1967 United Kingdom Digest of Energy Statistics.

(2) For colliery consumption, comments apply as note (1) above.

(3) Figures for Northern Ireland are not split into separate categories. Consumptions figures in million tons were obtained from Table 44 of 1964 D.E.S. and a heating equivalent of 270 therms per ton was applied throughout.

(4) Published figure obtained from Table 166 of 1971 Annual Abstract of Statistics.

Note: For heating equivalent of coal of various categories, see Table 1.

Table 13b Petroleum: Primary Consumption

Notation: a = million tons; b = million therms

			1955	1956	1957	1958	1959	1960 (Check Table ↓)
Final Consumption (1)		b	7589	8263	7982	9490	10717	12385
Petroleum Refinery (2)		a	2.06	2.16	2.12	2.53	3.08	3.34
		b	849	889	872	1043	1268	1376
(3) Power Station	Gas/Diesel Oil	a	0.048	0.054	.048	.057	.054	.047
		b	21	24	21	25	24	21
	Fuel Oil	a	0.193	0.366	0.649	2.587	4.161	5.414
		b	80	151	267	1066	1714	2231
(4) Gas Works	Butane & Propane	a					.031	.044
		b					15	21
	Gas Diesel Oil	a	0.503	0.434	0.393	0.548	0.361	0.235
		b	220	190	172	239	158	103
	Fuel Oil	a	0.033	0.029	0.053	0.117	0.159	0.164
		b	14	12	22	48	66	68
	L.D.F.	a	0.025	0.024	0.023	0.041	0.225	0.400
		b	12	11	11	19	104	184
Total Supply		b	8785	8540	9347	11930	14066	16389
Check with published figures (5)		b						16463

(1) See note (1) of Table 13a

(2) See annex of Table 2 and Table 19 of 1967 U.K. D.E.S., also see note (1) of Table 13a

(3) See Table 124 of 1960 U.K. Digest of Energy Statistics. Consumption figures constitute of two items (i) Steam Raising: Public Electricity Generation and (ii) Stationary Oil Engines, Public Electricity Supply.

(4) See note (2) of Table 8c

(5) See note (4) of Table 13a

Note: For heating equivalent of petroleum of different categories, See Table 1.

Table 13c U.K. Final Energy Consumption (million therms)

		1955	1956	1957	1958	1959	1960	1961
Coal and Other Solid Fuels	Domestic	11948	11983	11387	11713	10825	11294	10771
	Industrial	16506	16185	15651	13966	13078	13903	13051
	Transport	3911	3875	3680	3384	3040	2816	2461
	Pub + Mis + Agr	4276	3988	3745	3631	3256	3121	2603
	Total	36641	36031	34463	32694	30199	31134	29086
Petroleum and other Liquid Fuels	Domestic	289	373	357	529	586	671	731
	Industrial	2449	2762	2789	3293	3835	4516	5175
	Transport	4498	4686	4407	4931	5324	5919	6573
	Pub + Mis + Agr	788	907	937	1176	1346	1727	1535
	Total	8024	8728	8501	9929	11091	12833	14014
Gas	Domestic	1389	1371	1326	1339	1290	1298	1300
	Industrial	1202	1240	1282	1267	1264	1413	1366
	Transport							
	Pub + Mis + Agr	483	488	467	478	464	476	469
	Total	3074	3099	3075	3084	3018	3187	3135
Electricity	Domestic	692	775	810	918	992	1149	1305
	Industrial	1086	1160	1222	1272	1384	1546	1599
	Transport	71	71	74	73	76	77	78
	Pub + Mis + Agr	400	437	457	513	545	627	682
	Total	2249	2443	2563	2776	2997	3399	3664
Total Final Consumption		49988	50301	48602	48483	47305	50553	49899

		1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal and Other Solid Fuels	Domestic	11037	10972	9805	9729	9222	8547	8310	7823	7137	6136	5397	5328	5032
	Industrial	12092	11601	11669	11442	10568	9710	9735	9451	6894	7378	6175	6482	5472
	Transport	2015	1673	1278	866	586	304	123	95	84	57	32	27	24
	Pub + Mis + Agr	2974	3097	2650	2597	2401	2144	1952	1923	1732	1245	1093	970	1012
	Total	28118	27343	25402	24634	22777	20705	20120	19292	17847	14816	12697	12807	11940
Petroleum and other Liquid Fuels	Domestic	869	992	911	969	967	1006	1115	1222	1335	1321	1523	1668	1462
	Industrial	5991	6815	7540	8406	9044	9609	10091	10790	11426	11265	11455	11464	10131
	Transport	6918	7357	7984	8491	8933	9536	10100	10478	11008	11483	11962	12760	12295
	Pub + Mis + Agr	1794	2072	2093	2297	2454	2661	3006	3327	3588	3646	3764	3805	3335
	Total	15572	17236	18528	20163	21398	22812	24312	25817	27357	27715	28704	29697	27243
Gas	Domestic	1401	1537	1614	1869	2177	2473	2829	3211	3542	3930	4509	4815	5380
	Industrial	1287	1308	1419	1449	1415	1363	1434	1499	1878	2910	4129	5109	5474
	Transport													
	Pub + Mis + Agr	503	524	516	550	576	609	654	704	762	866	996	1083	1269
	Total	3191	3369	3549	3868	4168	4445	4917	5414	6182	7714	9634	1107	12123
Electricity	Domestic	1559	1785	1787	1953	2041	2128	2275	2464	2629	2754	2966	3114	3157
	Industrial	1653	1732	1915	1998	2052	2078	2258	2400	2491	2506	2497	2727	2589
	Transport	82	82	81	80	85	88	90	93	94	94	91	69	92
	Pub + Mis + Agr	781	813	904	991	1044	1097	1197	1288	1353	1403	1449	1562	1444
	Total	4075	4462	4687	5022	5222	5391	5820	6245	6567	6757	7003	7492	7262
Total Final Consumption		50956	52410	52115	53687	53565	53353	55169	56768	57953	57002	58038	61003	58486

Sources:

(1) For 1955 to 1959, Table 2.

(2) For 1960 to 1964, Table 19 of 1967, U.K. Digest of Energy Statistics

(3) For 1965 to 1973, Table 10 of 1974 Digest

(4) For 1974, Table 10 of 1975 Digest

Table 13d U.K. Primary Energy Consumption

Notation: a = million tons; b = million therms; c = GWH

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal	a	215.2	217.5	212.9	202.4	189.4	196.7	191.8	192.2	194.0	187.2	184.6	174.4	163.8	164.5	161.1	154.4	138.7	120.9	131.3	115.9
	b	57691	58253	56965	54148	50298	52173	50435	49985	50551	48782	48046	45727	42895	42715	41573	39284	35256	30625	33156	29048
Petroleum	a	20.3	22.1	21.7	27.9	33.0	38.6	41.7	46.2	50.2	54.9	60.5	65.7	70.2	74.0	79.8	85.7	86.7	92.7	93.7	87.6
	b	8785	9540	9347	11930	14066	16463	17835	19716	21590	23628	26031	28271	30275	32139	34688	37111	37605	40272	40799	77878
Natural Gas and Colliery Methane	b	5	7	12	16	26	28	29	42	56	103	326	318	535	1208	2354	4486	7235	10264	11105	13282
Nuclear Electricity	c		58	409	305	1201	2079	2399	3660	6961	8842	16324	21529	24712	27710	29124	26022	27394	29378	27997	33617
	b		6	42	32	124	215	248	345	567	723	1376	1800	2076	2360	2457	2183	2275	2450	2317	2789
Hydro Electricity	c	1697	2271	2749	2705	2705	3132	3853	3863	3293	3387	4286	4438	5044	4328	3838	5087	3508	3856	3945	4145
	b	223	297	361	354	354	389	476	470	408	430	528	554	630	521	460	610	421	463	473	496
Gross Inland	b	66704	68103	66727	66490	64868	69268	69023	70558	73172	73666	73607	76670	76411	78943	81532	83674	82792	84074	87850	83494
Less: Changes in distributed stocks of coal and other solid fuels	a	1.7	3.5	5.3	3.8	2.8	1.2	1.8	0.3	0.2	0.6		0.8	0.9							
	b	459	945	1431	1026	756	344	484	88	72	164	-8	203	233	-35	-79	-38	419	114	171	29
Net Inland	b	66245	67158	65296	65464	64112	68924	68539	70470	73100	73502	76315	76467	76178	78978	81611	83712	82373	83960	87679	83523

Sources:

Coal: For 1955 to 1959, Table 2
For 1955 to 1974, U.K. Digest of Energy Statistics (For example see Table 10 of 1974 Digest); also available from Annual Abstract of Statistics.

Petroleum: Same source as that for coal.

Natural Gas and Colliery Methane: U.K. D.E.S.

Nuclear and Hydro Electricity: Original values (GWH) for all years were obtained from D.E.S.. For the computation of heating values for some years, see Table 11 a.

Changes in Distributed stocks of coal and other solid fuels:

(a) Data obtained from Annual Abstract of Statistics (for example see Table 172 of 1974 Abstract)

(b) For conversion to heating value from original units, equivalent is 270 therms per ton.

Table 13e Summary Table. Primary & Final Energy Consumption
(million therms)

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Gross Inland	66704	68103	66727	66490	64868	69268	69023	70558	73172	73666
Export & Stock Changes	459	945	1431	1026	756	344	484	88	72	164
Net Inland	66245.	67185	65296	65464	64112	68924	68539	70470	73100	73502
Fuel Conversion Industries	16257	16857	16694	16981	16807	18371	18640	19514	20690	21336
Final Consumers:	49988	50301	48602	48483	47305	50553	49899	50956	52410	52166
of which Domestic	14318	14502	13880	14495	13693	14412	14107	14866	15286	14117
Industrial	21243	21347	20953	19798	19561	21378	21191	21033	21456	22543
Transport	8480	8632	8161	8388	8440	8812	9112	9015	9112	9343
Public + Misc + Agr	5947	5820	5608	5798	5611	5951	5489	6052	6556	6163
of which Coal & Other Solid	36641	36031	34463	32694	30199	31134	29086	28118	27343	25402
Petroleum & Other Liquid	8024	8728	8501	9929	11090	12833	14014	15572	17236	18528
Gas	3074	3099	3075	3084	3018	3187	3135	3191	3369	3549
Electricity	2249	2443	2563	2776	2998	3399	3664	4075	4462	4687

	1965	1966	1967	1968	1969	1970	1971	1973	1973	1974
Gross Inland	73607	76670	76411	78943	81532	83674	82792	84074	87850	83494
Export & Stock Changes	-8	203	233	-35	-79	-38	419	114	171	29
Net Inland	76315	76467	76178	78978	81611	83712	82373	83960	87679	83523
Fuel Conversion Industries	22628	22902	22825	23809	24843	25759	25371	25922	26676	24997
Final Consumers:	53687	53565	53353	55169	56768	57953	57002	58039	61003	58488
of which Domestic	14520	14407	14154	14529	14720	14643	14141	14395	14925	15051
Industrial	23295	23079	22760	23518	24140	24689	24067	24256	25762	23936
Transport	9437	9604	9928	10313	10666	11186	11634	12085	12876	12411
Public + Misc + Agr	6435	6475	6511	6809	7242	7435	7160	7302	7420	7090
of which Coal & Other Solid	24634	22777	20705	20120	19292	17847	14816	12697	12807	11840
Petroleum & Other Liquid	20163	21398	22812	24312	25817	27357	27715	28704	29697	27243
Gas	3868	4168	4445	4917	5414	6182	7714	9634	11007	12123
Electricity	5022	5222	5391	5820	6245	6567	6757	7003	7492	7282

Note:

(a) Liquid fuel from coal is included under petroleum

(b) Consumption figures quoted here for 1973 have been taken from 1974 Digest of Energy Statistics. The 1975 Digest gives slightly different figures for 1973.

TABLE 14 SUMMARY TABLES OF ENERGY CONSUMPTION IN SCOTLAND

Table 14a Sector Consumption by Types of Energy

Notation: a = thousand tons; b = million therms; c = GWH

SCOTLAND			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
DOMESTIC SECTOR	Coal	a	4244	4271	4087	4171	4008	4130	3863	3836	3653	3101	2993	2695	2403	2345	2246	1984	1675	1351	1557	1411
		b	1192.3	1198.8	1146.9	1170.6	1125.6	1059.8	1084.6	1077.1	1025.5	871.3	840.4	756.4	673.9	658.4	630.5	557.0	470.7	394.5	456.1	411.1
	Coke & Breeze	a	131	121	111	101	93	114	90	100	103	97	100	87	70	69	71	53	35	28	28	28
		b	35	33	30	27	25	31	24	27	28	26	27	23	19	19	19	14	9	8	8	8
	Other Solid	a		38	35	42	35	38	31	32	35	48	65	71	100	101	109	116	104	93	72	79
		b		10	9	11	9	10	8	9	9	13	18	19	27	27	29	31	28	25	19	21
	All solid Fuels	a	4375	4430	4233	4214	4136	4282	3984	3968	3791	3246	3158	2853	2573	2515	2426	2153	1814	1472	1667	1518
		b	1227	1242	1186	1209	1160	1101	1113	1113	1063	910	885	795	720	704	679	602	508	428	483	440
	Petroleum & Other Liquid	a	53	66	64	89	95	112	128	140	160	156	168	170	167	187	209	226	216	257	294	269
		b	24	30	28	40	42	50	57	62	71	69	74	75	74	83	93	100	96	114	131	124
	Gas	a																				
		b	122	117	114	110	105	99	97	101	108	119	129	153	164	171	183	200	198	217	229	254
	Electricity	c	1831	2042	2171	2488	2734	3150	3828	4808	5536	5614	6643	7192	7606	8252	9093	9870	10120	10420	11266	11399
		b	62	70	74	85	93	107	131	164	189	198	227	245	260	282	310	337	345	356	384	389
	TOTAL	b	1436	1459	1402	1444	1400	1357	1398	1440	1431	1296	1315	1268	1218	1240	1265	1239	1147	1115	1227	1207
INDUSTRIAL SECTOR	Coal	a	5468	5237	4871	4377	4058	4229	3791	3362	3177	2962	2835	2455	2046	1843	1750	1603	1260	920	816	687
		b	1423.8	1363.9	1268.7	1138.6	1055.2	1100.6	985.8	873.2	825.1	769.4	736.1	652.0	542.1	480.9	456.7	418.5	328.5	244.2	216.7	182.5
	Coke & Breeze	a	1327	1320	1394	1185	926	1358	1281	864	849	1329	1483	1134	1056	1304	1357	1378	1111	1028	1195	1025
		b	358	356	377	320	250	366	346	233	229	359	398	306	285	352	366	372	300	278	322	277
	Other Solid	a		28	21	19	13	10	7	7	7	9	3	3	4	4	3	4	3	2	2	3
		b		8	6	5	4	3	2	2	2	2	1	1	1	1	1	1	1	1	1	1
	All solid Fuels	a	6795	6595	6286	5561	4997	5597	5079	4233	4033	4300	4321	3592	3106	3151	3110	2985	2374	2050	2013	1715
		b	1782	1728	1652	1464	1309	1470	1334	1108	1056	1130	1135	959	828	834	824	792	630	523	540	461
	Petroleum & Other Liquid	a	387	460	483	591	675	812	986	1141	1353	1627	1846	2083	2277	2410	2652	2824	2927	3153	3266	3149
		b	163	193	203	247	282	339	411	475	564	678	769	868	950	1007	1113	1188	1235	1338	1396	1325
	Creosote/pitch	a	110	118	133	113	97	117	104	114	85	85	102	80	70	70	51	49	22	9	9	9
	Liquid for Coal	b	45	48	53	44	37	44	39	44	33	33	39	31	27	26	19	18	8	4	3	3
	All Liquid	a	497	578	616	704	772	929	1090	1255	1438	1712	1948	2163	2347	2480	2703	2873	2949	3162	3295	3158
		b	208	241	256	291	319	383	450	519	597	711	808	899	977	1033	1132	1206	1243	1342	1399	1328
	Town & Natural Gas	b	41	42	45	42	44	48	50	50	53	57	59	63	62	58	65	68	71	127	175	222
	Coke Oven Gas	b	5	4	5	4	2	4	3	3	12	28	43	33	31	44	50	52	47	28	46	36
	All gas	b	46	46	50	46	46	52	53	53	65	85	102	96	93	102	115	120	118	155	221	258
	Electricity	c	2966	3056	3183	3219	3330	3613	3813	4043	4265	4694	4973	5185	5296	5611	5972	5992	6247	6554	7832	7542
		b	101	104	109	110	114	123	130	138	146	160	170	177	181	191	204	204	213	221	267	257
	TOTAL	b	2137	2119	2067	1911	1768	2028	1967	1818	1864	2086	2215	2131	2079	2160	2275	2322	2204	2244	2427	2304
TRANSPORT SECTOR	Coal	a	1870	1850	1745	1486	1343	1229	1020	716	570	430	354	197	33	11	12	10	8	6	6	-
		b	523.6	518.0	488.6	416.1	376.0	344.1	285.6	200.5	159.6	120.4	99.1	55.2	9.2	3.1	3.4	2.8	2.2	1.7	1.7	-
	Coke & Breeze	a	10	10	9	8	7	7	7	5	5	6	7	4	4	4	4	4	1			
		b	3	3	2	2	2	2	2	1	1	1	2	1	1	1	1	1				
	Other Solid	a		54	56	67	40	32	26	25	30	23										
		b		15	15	18	11	9	7	7	8	6										
	Total Solid Fuel	a	1880	1914	1810	1561	1390	1268	1053	746	605	459	361	201	37	15	16	14	9	6	6	-
		b	527	536	506	436	389	355	295	209	169	127	101	56	10	4	4	4	2	2	2	
	Petroleum	a	1891	962	900	996	1104	1170	1310	1373	1466	1564	1631	1684	1732	1898	1985	2042	2150	2195	2398	2318
		b	398	429	401	444	492	521	583	611	653	696	726	750	773	847	886	911	961	982	1073	1038
	Gas																					
	Electricity	c	25	13	15	21	96	85	71	101	97	93	90	85	84	83	82	82	83	76	78	125
		b	1			1	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	4
	TOTAL	b	926	965	907	881	884	879	880	823	825	826	830	809	786	854	893	918	966	987	1078	1042

Table 14a (cont.)

SCOTLAND			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	Coal	a	1056	882	849	1088	983	1123	984	959	871	777	793	695	768	700	540	546	567	599	406	507
		b	285.1	238.1	229.2	293.8	265.4	303.2	265.7	258.9	235.2	209.8	214.1	194.6	215.0	196.0	151.2	152.9	158.8	167.7	113.7	142.0
	Coke &	a	403	370	327	333	295	301	284	273	287	257	281	244	200	200	166	118	51	34	50	63
	Breeze	b	109	100	88	90	80	61	77	74	77	69	76	66	54	54	45	32	14	9	14	17
OTHER	Other	a											4	6	8	7	8	8	5	9	6	6
SECTOR	Solid	b											1	2	2	2	2	2	1	2	2	2
(Public	Total Solid	a	1459	1252	1176	1421	1278	1424	1268	1232	1158	1034	1078	945	976	907	714	672	623	642	462	576
+ Misc	Fuel	b	394	338	317	384	345	384	343	333	312	279	291	263	271	252	198	187	174	179	130	161
+ Agri-	Petroleum	a	199	222	237	284	308	360	336	395	457	483	542	594	633	728	814	873	901	949	960	942
culture)		b	86	95	101	121	131	152	143	167	193	204	229	251	267	307	345	371	384	406	420	402
	Gas	b	37	37	37	36	34	34	35	37	38	38	38	41	43	43	46	48	48	49	59	64
	Electricity	c	1164	1357	1443	1610	1695	1907	2153	2440	2693	2829	3148	3386	3535	3800	4119	4406	4475	4499	4983	4624
		b	40	46	49	55	58	65	73	83	92	97	107	116	121	130	141	150	153	154	170	159
	TOTAL	b	557	516	504	596	568	635	594	620	635	618	665	671	702	732	730	756	759	788	779	785
Total Fuel Consumption		b	5056	5059	4879	4831	4641	4900	4842	4702	4755	4830	5027	4883	4783	4985	5162	5238	5076	5130	5511	5339

Notes:

(1) Coke Oven Gas - Total consumption of this fuel is included in the "INDUSTRIAL" sector.

(2) Creosote/pitch mixture - all included in the "INDUSTRIAL" sector - consumption before the year 1962 is assumed to be 10% of United Kingdom consumption.

Table 14b Final Energy Consumption in Scotland by types of Fuel

Notation: a = thousand tons; b = million therms; c = GWH

			1955	1956	1957	1958	1959	1960	1961
Coal and Other Solid Fuel	Coal	a	12638	12240	11552	10122	10392	10711	9658
		b	3425	3319	3133	3019	2822	2807	2622
	Coke & Breeze	a	1871	1821	1841	1627	1321	1780	1662
		b	505	492	497	439	357	480	448
	Other solid	a		120	112	128	88	80	64
		b		32	30	35	24	22	17
	Total Solid Fuel	a	14509	14181	13505	11877	11801	12571	11384
		b	3930	3843	3660	3493	3203	3309	3087
Gas	Coke Oven Gas	a	5	4	5	4	2	4	3
	Town & Nat. Gas	a	200	196	196	188	183	181	182
	Total Gas	a	205	200	201	192	185	185	185
Electricity		c	5986	6468	6812	7338	7855	8755	9865
		b	205	221	232	250	268	299	337
Petroleum and Other Liquid Fuel	Petroleum	a	756	1711	1685	1962	2182	2455	2760
		b	670	747	733	852	948	1063	1194
	Creosote & Pitch Mix.	a	110	128	133	113	97	117	104
		b	30 + 15	33 + 15	39 + 14	33 + 11	32 + 5	39 + 5	33 + 6
	Total Liquid Fuel	a	1529	1829	1818	2075	2279	2572	2864
		b	715	795	786	896	985	1107	1233
Grand Total Consumption		b	4717	5059	4879	4831	4641	4900	4842

			1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal and Other Solid Fuel	Coal	a	8873	8271	7270	6975	6042	5250	4899	4584	4143	3150	2876	2795	2605
		b	2410	2245	1971	1890	1658	1440	1338	1242	1131	960	808	788	736
	Coke & Breeze	a	1242	1244	1689	1871	1469	1330	1577	1598	1563	1198	1090	1273	1116
		b	335	336	456	505	397	359	426	431	422	323	294	344	302
	Other solid	a	64	72	80	72	80	112	122	120	128	112	104	80	88
		b	17	19	22	19	22	30	30	32	35	30	28	22	24
	Total Solid Fuel	a	10179	9587	9039	8918	7591	6692	6588	6302	5834	4820	4070	4148	3809
		b	2762	2600	2449	2417	2077	1829	1794	1705	1588	1313	1130	1154	1062
Gas	Coke Oven Gas	a	3	12	28	43	33	31	44	50	52	47	28	46	36
	Town & Nat. Gas	a	188	199	214	226	257	268	272	294	316	317	393	463	540
	Total Gas	a	191	211	242	269	290	299	316	344	368	364	421	509	576
Electricity		c	11392	12591	13430	14854	15848	16522	17746	19266	20350	20925	21549	24159	23690
		b	389	430	458	507	541	564	605	657	694	714	735	824	808
Petroleum and Other Liquid Fuel	Petroleum	a	3050	3436	3829	4188	4532	4810	5223	5657	5963	6196	6550	6959	6678
		b	1316	1481	1648	1798	1944	2064	2244	2437	2570	2677	2840	3021	2889
	Creosote & Pitch Mix.	a	114	85	85	102	80	70	70	51	49	22	9	9	9
		b	38 + 6	28 + 5	28 + 5	35 + 4	27 + 4	24 + 3	24 + 3	18 + 1	18	8	4	3	3
	Total Liquid Fuel	a	3164	3521	3914	4290	4612	4880	5293	5708	6012	6218	6559	6968	6687
		b	1360	1514	1681	1837	1975	2091	2270	2456	2588	2685	2844	3024	2892
Grand Total Consumption		b	4702	4755	4830	5027	4883	4783	4895	5162	5238	5076	5130	5511	5338

Note:

(1) Coke & Breeze A small proportion of Scottish Coke and Breeze is Breeze. However, it is difficult to break down the respective consumption of coke and breeze in Sectors. For this reason all coke and breeze is assumed to have a thermal value of 270 th/ton, i.e. that of coke. This will lead to overestimation of consumption; the error is however small. For example, if in 1955, the final consumption of breeze was 129.6 th/ton (see Table 6c footnote (2), the overestimation is of the order of .1296 × (270 − 22) = 7.0 million therms. For later years the error ought to be even smaller, since a higher proportion of coke and breeze for final consumption is made of coke.

(2) **Creosote/pitch mixture: Taken from Abstract of Regional Statistics.**

(3) Liquid fuels for coal: Taken from Abstract of Regional Statistics and added to Creosote-pitch category. (Goes to Railway in Final Consumption)

(4) **Creosote pitch/mixture and liquid fuel for coal - for years previous to 1962 no data is available, judging for data 1963-1973, the Scottish consumption is assumed to b 10% of U.K. consumption.**

Table 14c **Primary Energy Consumption in Scotland**

Notation: a = million tons; b = million therms; c = GWH

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal (gross) (1)	a	21.11	20.63	19.77	18.99	17.38	18.32	17.16	16.36	16.46	15.46	15.43	13.7	12.1	13.19	13.6	12.94	11.41	11.22	12.85	11.07
	b	5634	5515	5292	5068	4629	4782	4558	4282	4285	4047	4039	3589	3173	3428	3508	3303	2905	2822	3206	2746
Petroleum (2)	a	1.751	1.938	1.943	2.273	2.525	2.851	3.158	3.555	4.018	4.499	4.996	5.861	6.4	6.762	7.418	8.259	8.682	9.161	9.593	9.234
	b	763	842	841	982	1091	1228	1365	1529	1729	1936	2149	2519	2752	2915	3203	3556	3725	3944	4133	3954
Natural Gas + Colliery Methane (3)	b							1	2	3	5	6	6	5	4	5	23	249	365	445	561
Nuclear Electricity (4)	c					259	995	1202	1404	1465	2860	3711	3663	3483	3341	3707	3723	3784	3594	3517	3701
	b					24	93	112	129	135	262	362	361	345	331	363	366	366	349	341	355
Hydro Electricity (4)	c	1062	1560	1930	1974	2097	2410	3058	2950	2528	3426	3978	3898	4637	3405	3078	4282	3241	3250	3697	3853
	b	139	205	254	259	276	300	380	360	310	427	495	487	584	411	369	514	384	382	434	449
Import of Electricity (5)	c	383	570	409	535	653	247	400	518	799	652	433	464	949	1720	1305	-58	355	-164	-932	+42
	b	47	70	50	66	80	30	49	64	98	81	54	58	120	207	157	- 7	43	- 19	-109	+ 4
Import of Coke (6)	a	.058	.066	.062	.052	.043	.047	.062	.079	.112	0.15	0.13	0.13	0.15	0.18	0.11	0.13	0.12	0.07	0.09	0.17
	b	16	18	17	14	12	13	17	21	30	41	35	35	41	49	30	34	31	19	24	45
Total Gross Inland	b	6599	6650	6454	6389	6112	6446	6482	6389	6590	6709	7140	7055	7020	7345	7635	7789	7703	7862	8474	8114
Stock change of coke and manuf. fuel	a										-.01	-.04	+.03	-.01	-.01	-.03		+.02	-.02	+.01	-.02
	b										- 3	- 11	- 8	- 3	- 3	- 8		+ 5	- 5	+ 3	- 4
Total Net Inland	b	6599	6650	6454	6389	6112	6446	6482	6389	6590	6802	7151	7063	7023	7348	7643	7789	7698	7867	8471	8118

(1) Figures obtained from Coal Tables in the Digest of Scottish statistics and Scottish Abstract of Stastics (for example see Table 105 of 1974 SAS)

(2) Total delivery figures are obtained from Institute of Petroleum.

(3) Figures obtained from Digest of Scottish Statistics and Scottish Abstract of Statistics (see Table 104 of 1974 SAS).

(4) Figures obtained from Scottish Abstract of Statistics (see Table 104 of 1974 SAS) since 1964. For previous years, see individual electricity generation tables (for example Table 9 of April 1966 Digest of Scottish Statistics); for these years the conversion factors used are: Nuclear Electricity 2460 kwh/ton coal equivalent. Hydro Electricity 1750 kwh/ton coal equivalent for 1955 to 1959 and 1850 kwh/ton coal equivalent for 1960 to 1963.

(5) Import of electricity - sources same as (4) above. Conversion factor used is
1 Twh = 34.12 million therm ×3.6 multiplier
= 122.83 million therm.

(6) Sources are Scottish Abstracts of Statistics (see Table 110 and 104 of 1974 SAS) The heating equivalent is taken as 270 therms/ton

(7) Stock Changes are available from Scottish Abstract of Statistics (See Tables 104 and 105) since 1961. No figures are available for years before 1961.

Table 14d Summary Table. Primary and Final Energy Consumption in Scotland

All consumption figures are in million therms

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1946	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Gross Inland		6599	6650	6454	6389	6112	6446	6486	6389	6590	6799	7140	7055	7020	7345	7635	7789	7703	7862	8474	8114
Export and Stock Changes											-3	-11	-8	-3	-3	-8		+5	-5	+3	-4
Net Inland		6599	6650	6454	6389	6112	6446	6482	6389	6590	6802	7151	7163	7023	7348	7643	7789	7698	7867	8471	8118
Fuel Conversion Industries		1543	1591	1574	1557	1472	1547	1643	1688	1835	1976	2126	2284	2238	2362	2480	2554	2622	2733	2960	2780
Final Consumers: (1)		5056	5059	4880	4832	4640	4899	4839	4701	4755	4826	5025	4879	4785	4986	5163	5235	5076	5134	5511	5338
of which	Domestic	1436	1459	1402	1444	1400	1357	1398	1440	1431	1296	1315	1268	1218	1240	1265	1239	1147	1115	1227	1207
	Industrial	2137	2119	2067	1911	1788	2028	1967	1818	1864	2086	2215	2131	2079	2160	2275	2322	2204	2244	2427	2304
	Transport	926	965	907	881	884	879	880	823	825	826	830	809	786	854	893	918	966	987	1078	1042
	Public & Misc & Agr.	557	516	504	596	568	635	594	620	635	618	665	671	702	732	730	756	759	788	779	785
of which	Coal & Other Solid Fuel	3930	3843	3660	3493	3203	3309	3087	2762	2600	2449	2414	2077	1829	1794	1705	1588	1313	1130	1154	1062
	Petroleum and Other Liquid Fuel	715	795	786	896	985	1107	1233	1360	1514	1681	1837	1975	2091	2270	2456	2588	2685	2844	3024	2892
	Gas	205	200	201	192	185	185	185	191	211	242	269	290	299	316	344	368	364	421	509	576
	Electricity	203	221	232	250	268	299	337	389	430	458	507	541	-564	605	657	694	714	735	824	808

(1) The total by adding the consumption by sectors is slightly different from the total obtained by adding the type of fuels. The former total appears in this table and is used in the analysis.

TABLE 15 Effective Energy Consumption in the United Kingdom
(All consumption figures are in million therms)

DOMESTIC		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other Solid Fuel	Final Energy	11948	11983	11387	11713	10825	11294	10771	11037	10972	9805	9729	9222	8457	8310	7823	7137	6136	5397	5328	5032
	Efficiency (%)	25.0	25.75	26.5	27.25	28.0	28.75	29.5	30.25	31.0	31.75	32.5	33.25	34.0	34.75	35.5	36.25	37.0	37.75	38.5	39.25
	Effective Energy	2987	3086	3018	3192	3031	3247	3177	3339	3401	3113	3162	3066	2906	2888	2777	2587	2270	2037	2051	1975
Petroleum	Final Energy	289	373	357	529	586	671	731	869	992	911	969	967	1006	1115	1222	1335	1321	1523	1668	1462
	Efficiency (%)	60.0	60.5	61.0	61.5	62.0	62.5	63.0	63.5	64.0	64.5	65.0	65.5	66.0	66.5	67.0	67.5	68.0	68.5	69.0	69.5
	Effective Energy	173	226	218	325	363	419	461	552	635	588	630	633	664	741	819	901	898	1043	1151	1030
Gas	Final Energy	1389	1371	1326	1339	1290	1298	1300	1401	1537	1614	1869	2177	2473	2829	3211	3542	3930	4509	4815	5360
	Efficiency (%)	60.0	60.5	61.0	61.5	62.0	62.5	63.0	63.5	64.0	64.5	65.0	65.5	66.0	66.5	67.0	67.5	68.0	68.5	69.0	69.5
	Effective Energy	833	829	809	823	800	811	819	890	984	1041	1215	1426	1632	1881	2151	2391	2672	3089	3322	3739
Electricity	Final Energy	692	775	810	918	992	1149	1305	1559	1785	1787	1953	2041	2128	2275	2464	2629	2754	2966	3114	3157
	Efficiency (%)	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73	73
	Effective Energy	505	566	591	670	724	839	953	1138	1303	1305	1426	1490	1553	1661	1799	1919	2010	2165	2273	2305
Total	Final Energy	14318	14502	13880	14499	13693	14112	14107	14866	15286	14117	14520	14407	14154	14529	14720	14643	14141	14395	14925	15051
	Effective Energy	4498	4707	4636	5010	4918	5316	5410	5919	6323	6047	6433	6615	6755	7171	7546	7798	7850	8334	8797	9049
Ratio: Effective/Final (%)		31.4	32.4	33.4	34.5	35.9	36.9	38.4	39.8	41.4	42.9	44.3	45.9	47.7	49.4	51.3	53.3	55.0	57.9	58.9	60.1

INDUSTRIAL (1)		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other Solid Fuel	Final Energy	16506	16185	15651	13966	13078	13903	13051	12092	11601	11669	11442	10568	9710	9735	9451	8894	7378	6175	6482	5472
	Effective Energy	9904	9711	9391	8380	7847	8342	7831	7255	6961	7001	6865	6341	5826	5841	5671	5336	4427	3705	3889	3283
Petroleum	Final Energy	2449	2762	2798	3293	3835	4516	5175	5991	6815	7540	8406	9044	9609	10091	10790	11426	11265	11465	11464	10131
	Effective Energy	1714	1933	1959	2305	2685	3161	3623	4194	4771	5278	5884	6331	6726	7064	7553	7998	7886	8026	8025	7092
Gas	Final Energy	1202	1240	1282	1267	1264	1413	1366	1287	1308	1419	1449	1415	1363	1434	1499	1878	2918	4129	5109	5474
	Effective Energy	841	868	897	887	885	989	956	901	916	993	1014	991	954	1004	1049	1315	2043	2890	3576	3832
Electricity	Final Energy	1086	1160	1222	1272	1384	1546	1599	1653	1732	1915	1998	2052	2078	2258	2400	2491	2506	2497	2727	2569
	Effective Energy	869	928	978	1018	1107	1287	1279	1322	1386	1532	1598	1642	1662	1806	1920	1993	2005	1998	2182	2071
Total	Final Energy	21243	21347	20953	19798	19561	21378	21191	21023	21456	22543	23295	23079	22760	23518	24140	24689	24067	24256	25782	23936
	Effective Energy	13328	13440	13225	12590	12524	13729	13689	13672	14034	14804	15361	15305	15168	15715	16193	16642	16361	16619	17672	16278
Ratio: Effective/Final (%)		62.8	63.0	63.1	63.6	64.0	64.2	64.6	65.0	65.4	65.7	65.9	66.3	66.6	66.8	67.1	67.4	68.0	68.5	68.5	68.0

(1) Efficiency figures used to transform final energy to effective energy are:
Coal and Other Solid: 60%, Petroleum: 70%, Gas: 70%, Electricity: 80%.

TRANSPORT (1)			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other Solid Fuel		Final Energy	3911	3875	3680	3384	3040	2816	2461	2015	1673	1278	866	586	304	123	95	84	57	32	27	24
		Effective Energy	313	310	294	271	243	225	197	161	134	102	69	47	24	10	8	7	5	3	2	2
Petroleum	Motor Spirits	Final	2821	2858	2597	2994	3220	3447	3616	3815	4032	4465	4809	5071	5420	5759	5971	6328	6658	7074	7530	7331
		Effective	564	572	519	599	644	689	723	763	806	893	962	1014	1084	1152	1194	1266	1332	1415	1506	1466
	Derv & Others	Final	1677	1828	1810	1937	2104	2472	2957	3103	3325	3519	3682	3862	4116	4341	4507	4680	4825	4888	5230	4964
		Effective	470	512	507	542	589	692	828	869	931	985	1031	1081	1152	1215	1262	1310	1351	1369	1464	1390
Electricity		Final Energy	71	71	74	73	76	77	78	82	82	81	80	85	88	90	93	94	94	91	89	92
		Effective Energy	43	43	44	44	46	46	47	49	49	49	48	51	53	54	56	56	56	55	53	55
Total		Final Energy	8480	8632	8161	8388	8440	8812	9112	9015	9112	9343	9437	9604	9928	10313	10666	11186	11634	12085	12876	12411
		Effective Energy	1390	1437	1364	1456	1522	1652	1795	1842	1920	2029	2110	2193	2313	2431	2520	2639	2744	2842	3025	2913
Ratio: Effective/Final (%)			16.4	16.6	16.7	17.4	18.0	18.7	19.7	20.4	21.1	21.7	22.4	22.8	23.3	23.6	23.6	23.6	23.8	23.5	23.5	23.5

(1) The efficiencies assumed are: Coal: 8%, Motor Spirit: 20%, Diesel (DERV) and all other petroleum fuels: 28%, Electricity: 60%.

TABLE 15 (cont.)

PUBLIC + MISC + AGRICULTURE		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other Solid Fuel	Final Energy	4276	3988	3745	3631	3256	3121	2803	2974	3097	2650	2597	2401	2144	1952	1923	1732	1245	1093	970	1042
	Efficiency (%)	50.0	50.5	51.0	51.5	52.0	52.5	53.0	53.5	54.0	54.5	55.0	55.5	56.0	56.5	57.0	57.5	58.0	58.5	59.0	59.5
	Effective Energy	2138	2014	1910	1870	1693	1639	1486	1591	1672	1444	1428	1333	1201	1103	1096	996	722	639	572	620
Petroleum	Final Energy	788	907	939	1176	1346	1727	1535	1794	2072	2093	2297	2454	2661	3006	3327	3588	3646	3764	3805	3335
	Efficiency (%)	65	65.25	65.5	65.75	66	66.25	66.5	66.75	67	67.25	67.5	67.75	68	68.25	68.5	68.75	69	69.25	69.5	69.75
	Effective Energy	512	592	615	773	888	1144	1021	1197	1388	1408	1550	1663	1809	2052	2279	2467	2516	2607	2644	2326
Gas	Final Energy	483	488	467	478	464	476	469	503	524	516	550	576	609	654	704	762	866	996	1083	1269
	Efficiency (%)	65	65.25	65.5	65.75	66	66.25	66.5	66.75	67	67.25	67.5	67.75	68	68.25	68.5	68.75	69	69.25	69.5	69.75
	Effective Energy	314	318	306	314	306	315	312	336	351	347	771	390	414	446	482	525	598	690	753	885
Electricity	Final Energy	400	437	457	513	545	627	682	781	863	904	991	1044	1097	1197	1288	1353	1403	1449	1562	1444
	Efficiency (%)	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62	62
	Effective Energy	248	271	283	318	336	389	423	484	535	560	614	647	680	742	799	839	870	898	968	895
Total	Final Energy	5947	5820	5608	5798	5611	5951	5489	6052	6556	6163	6435	6475	6511	6809	7242	7435	7160	7302	7420	7090
	Effective Energy	3212	3195	3114	3275	3225	3487	3242	3608	3946	3759	3963	4033	4104	4343	4656	4826	4706	4834	4935	4726
Ratio: Effective/Final (%)		54.0	54.9	55.5	56.5	57.5	58.6	59.1	59.6	60.2	61.0	61.6	62.3	63.0	63.8	64.3	64.9	65.7	66.2	66.5	66.7

ALL SECTORS		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
All types of energy	Final Energy	49988	50301	48602	48483	47305	50553	49899	50956	52410	52166	53687	53565	53353	55169	56768	57953	57002	58038	61003	58483
	Effective Energy	22428	22779	22339	22331	22189	24184	24136	25041	26223	26639	27867	28146	28340	29660	30915	31905	31661	32629	34429	32966
	Efficiency (%)	44.8	45.2	45.9	46.0	46.9	47.8	48.4	49.1	50.0	51.1	51.9	52.5	53.1	53.8	54.5	55.1	55.5	56.2	56.4	56.4

TABLE 16 Effective Energy Consumption in Scotland
(All consumption figures are in million therms)

DOMESTIC		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal &	Final Energy	1227	1242	1186	1209	1160	1101	1113	1113	1063	910	885	795	720	704	679	602	508	428	483	440
Other	Efficiency (%)	25.0	25.75	26.5	27.25	28.0	28.75	29.5	30.25	31.0	31.75	32.5	33.25	34.0	34.75	35.5	36.25	37.0	37.75	38.5	38.75
Solid Fuel	Effective Energy	307	320	314	329	325	317	328	337	330	289	288	264	245	245	241	218	188	162	186	171
Petroleum	Final Energy	24	30	28	40	42	50	57	62	71	69	74	75	74	83	93	100	96	114	131	124
	Efficiency (%)	60	60.5	61	61.5	62	62.5	63	63.5	64	64.5	66	66.5	66	66.5	67	67.5	68	68.5	69	69.5
	Effective Energy	14	18	17	25	26	31	36	39	45	45	48	49	49	55	62	68	65	78	90	86
Gas	Final Energy	122	127	114	110	105	99	97	101	108	119	129	153	164	171	183	200	198	217	229	254
	Efficiency (%)	60	60.5	61	61.5	62	62.5	63	63.5	64	64.5	65	65.5	66	66.5	67	67.5	68	68.5	69	69.5
	Effective Energy	73	77	70	68	65	62	61	64	69	77	84	100	108	114	123	135	135	149	158	177
Electricity	Final Energy	61	70	74	85	93	107	131	164	189	198	227	245	262	282	310	337	345	356	384	389
	Efficiency (%)	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71	71
	Effective Energy	43	50	53	60	66	76	93	116	134	141	161	175	186	200	220	239	245	253	273	276
Total	Final Energy	1434	1459	1402	1444	1400	1357	1398	1440	1431	1296	1315	1268	1218	1240	1265	1239	1147	1115	1227	1207
	Effective Energy	437	465	454	482	482	486	518	556	578	552	581	588	588	614	646	660	633	642	707	710
Ratio:	Effective/Final (%)	30.5	31.9	32.4	33.4	34.4	35.8	37.1	38.6	40.3	42.6	44.2	46.4	48.3	49.5	51.1	53.3	55.2	57.6	57.6	59.8

INDUSTRIAL (1)		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other	Final Energy	1782	1728	1652	1464	1309	1470	1307	1108	1056	1130	1135	959	828	834	824	792	630	523	540	461
Solid Fuel	Effective Energy	1069	1037	991	878	785	882	784	665	634	678	681	575	497	500	494	475	378	314	324	277
Petroleum	Final Energy	208	241	256	291	319	383	450	519	597	711	808	899	977	1033	1132	1206	1243	1342	1399	1328
	Effective Energy	146	169	179	204	223	268	315	363	418	498	566	629	684	723	792	844	870	939	979	930
Gas	Final Energy	46	46	50	46	46	52	53	53	65	85	102	96	93	102	115	120	118	155	221	258
	Effective Energy	32	32	35	32	32	36	37	37	46	60	71	67	65	71	81	84	83	109	155	181
Electricity	Final Energy	101	104	109	110	114	123	130	138	146	160	170	177	181	191	204	204	213	224	267	257
	Effective Energy	81	83	87	88	91	98	104	110	117	128	136	142	145	153	163	163	170	179	214	206
Total	Final Energy	2137	2119	2067	1911	1788	2028	1967	1818	1864	2086	2215	2131	2079	2160	2275	2322	2204	2244	2427	2304
	Effective Energy	1328	1321	1292	1202	1131	1284	1240	1175	1215	1364	1454	1413	1391	1447	1530	1566	1501	1541	1672	1594
Ratio:	Effective/Final (%)	62.1	62.3	62.5	62.9	63.3	63.3	63.0	64.6	65.2	65.4	65.6	66.3	66.9	67.0	67.3	67.4	68.1	68.7	68.9	69.2

(1) Efficiency estimates are: Coal and Other Solid: 60%,
Petroleum: 70%, Gas: 70%, Electricity: 80%.

TRANSPORT (1)			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other	Final Energy		527	536	506	436	389	355	295	209	169	127	101	56	10	4	4	4	2	2	2	-
Solid Fuel	Effective Energy		42	43	40	35	31	28	24	17	14	10	8	4	1							
Petroleum	Motor Spirits	Final	231	232	211	239	255	269	287	302	320	350	367	381	397	429	450	465	503	534	583	562
		Effective	46	46	42	48	51	54	57	60	64	70	73	76	79	86	90	93	101	107	117	112
	DERV & Others	Final	167	197	190	205	237	252	296	309	333	346	359	369	376	418	436	446	458	448	490	476
		Effective	47	55	53	57	66	71	83	87	93	97	101	103	105	117	122	125	128	125	137	133
Electricity	Final Energy		1			1	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	4
	Effective Energy		1			1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Total	Final Energy		926	965	907	881	884	879	880	823	825	826	830	809	786	854	893	918	966	987	1078	1042
	Effective Energy		136	144	135	141	150	155	166	166	173	179	184	185	187	205	214	220	231	234	256	247
Ratio:	Effective/Final (%)		14.7	14.9	14.9	16.0	17.0	17.6	18.9	20.2	21.0	21.7	22.2	22.9	23.8	24.0	24.0	24.0	23.9	23.7	23.7	23.7

(1) The efficiencies assumed are: Coal: 8%, Motor Spirit: 20%,
Diesel (Derv) and all other petroleum fuels: 28%,
Electricity: 60%.

TABLE 16 (cont.)

PUBLIC + MISC + AGRICULTURE		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal & Other	Final Energy	394	338	317	384	345	384	343	333	312	279	291	263	271	252	198	187	174	179	130	161
Solid Fuels	Efficiency (%)	50	50.5	51	51.5	52	52.5	53	53.5	54	54.5	55	55.5	56	56.5	57	57.5	58	58.5	59	59.5
	Effective Energy	197	171	162	198	179	202	182	178	168	152	160	146	152	142	113	108	101	105	77	96
	Final Energy	86	95	101	121	131	152	143	167	193	204	229	251	267	305	345	371	384	406	420	402
Petroleum	Efficiency (%)	65	65.25	65.5	65.75	66	66.25	66.5	66.75	67	67.25	67.5	67.75	68	68.25	68.5	68.75	69	69.25	69.5	69.75
	Effective Energy	56	62	66	80	86	101	95	111	129	137	155	170	182	210	236	255	265	281	292	280
	Final Energy	37	37	37	36	34	34	35	37	38	38	38	41	43	43	46	48	48	49	59	64
Gas	Efficiency (%)	65	65.25	65.5	65.75	66	66.25	66.5	66.75	67	67.25	67.5	67.75	68	68.25	68.5	68.75	69	69.25	69.5	69.75
	Effective Energy	24	24	24	24	22	23	23	25	25	26	26	28	29	29	32	33	33	34	41	45
	Final Energy	40	46	49	55	58	65	73	83	92	97	107	116	121	130	141	150	153	154	170	158
Electricity	Efficiency %	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
	Effective Energy	24	28	29	33	35	39	44	50	55	58	64	70	73	78	85	90	92	92	102	95
Total	Final Energy	557	516	504	596	568	635	594	620	635	618	665	671	702	732	730	756	759	788	779	785
	Effective Energy	301	285	281	335	322	365	344	364	377	373	405	414	436	459	466	486	491	512	512	516
Ratio: Effective/Final (%)		54.0	55.2	55.8	56.2	56.7	57.5	57.9	58.7	59.4	60.4	60.9	61.7	62.1	62.7	63.8	64.3	64.7	65.0	65.7	65.7

ALL SECTORS		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
All types	Final Energy	5056	5059	4880	4832	4640	4899	4839	4701	4755	4826	5025	4879	4785	4986	5163	5235	5076	5134	5511	5338
of	Effective Energy	2202	2215	2162	2160	2085	2290	2268	2261	2343	2468	2624	2600	2602	2725	2856	2932	2856	2929	3147	3067
energy	Efficiency (%)	43.6	43.8	44.3	44.7	44.9	46.7	46.9	48.1	49.3	51.5	52.2	53.3	54.4	54.7	55.3	56.0	56.3	57.1	57.1	57.5

TABLE 17 Coke and Coal prices in the United Kingdom and Scotland

Table 17a Domestic Sector: Scotland: Index of Coal and Coke Prices (1)

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
House (2) Coal Groups 'C'	Aberdeen Price	p./cwt										65	66.25	70.83	72.5	75	80	91	100	108	111	138
		p/therm										4.64	4.73	5.06	5.18	5.36	5.71	6.50	7.14	7.45	7.66	9.52
	Edinburgh Price	p./cwt										56.25	56.67	62.5	63.75	67	69	79	85	94	95	117
		p./therm										4.02	4.05	4.46	4.55	4.79	4.93	5.64	6.04	6.48	6.55	8.07
	Weighted Price Aberdeen[1] Edinburgh[3]	p./therm										4.18	4.19	4.58	4.68	4.9	5.09	5.81	6.26	6.67	6.73	8.43
U.K. Price for Coal & Coke. See T.17b		p./therm	1.82	2.32	2.46	2.60	2.65	2.86	3.02	3.25	3.45	3.55	3.67	4.01	4.22	4.27	4.54	5.1	5.54	5.97	5.93	7.27
Ratio of prices: Scotland/U.K. (3)			(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	(1.17)	1.17	1.17	1.17	1.14	1.14	1.11	1.14	1.12	1.13	1.13	1.11	1.13	1.16
Compare U.K. Coals & Coke prices - with coke prices alone (4) (assume 270 terms/ton)		p./ton	5.9	6.78	7.13	6.83	6.82	7.43	7.56	7.29	8.25	9.046	9.123	9.33	9.593	10.303	11.398	12.801	14.701	16.308	18.058	28.89
		p./therm	2.22	2.51	2.63	2.52	2.52	2.74	2.80	2.70	3.05	3.34	3.37	3.45	3.54	3.81	4.22	4.73	5.44	6.03	6.67	10.67

(1) Figures are not available for the years 1955 to 1963

(2) Prices refer to winter prices for delivery between 5 to 9 cwt. - Source U.K. Digest of Energy Statistics (see Table 85 of 1974 Digest)

(3) The price ratio for all the years between 1955 to 1963 is assumed to be the same as that for 1964 and is used in Table 17b.

(4) Source: Annual Reports of the National Coal Board. Figures were given in £/ton, conversion factor used is 270 therms/ton. Figures from 1963 onwards were in financial years, calendar year figures are constructed on the basis of 1/4 and 3/4 of consecutive years. The figure for 1974 is an estimate, by taking an increase of 60% over 1973 prices.

Table 17b Domestic Sector: United Kingdom and Scotland: Coal and Coke Prices

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
United Kingdom	Consumer (1) Expenditure	£m	220	280	282	307	288	323	325	359	379	348	357	370	361	355	355	364	340	322	316	366
	Consumption	million therm	11948	11983	11387	11713	10825	11294	10771	11037	10972	9805	9729	9222	8547	8310	7823	7137	6136	5397	5328	5032
	Price	p./therm	1.82	2.32	2.46	2.60	2.65	2.86	3.02	3.25	3.45	3.55	3.67	4.01	4.22	4.27	4.54	5.1	5.54	5.97	5.93	7.27
Scotland	See Table 17a above	pence/ therm	2.13	2.71	2.88	3.04	3.10	3.35	3.53	3.80	4.04	4.18	4.19	4.58	4.68	4.90	5.09	5.81	6.26	6.67	6.73	8.43

(1) Source: National Income and Expenditure Blue Book

(2) Coal and coke is considered homogeneous in price since Scottish consumption of coke is a small percentage of the total consumption of coal and coke, also the price of coke is not very different for that of Bituminous Coal Group C as can be seen from Table 17a above. 1955-1963, price ratio of Table 17b used. For 1964 to 1974 weighted price as constructed in Table 17b used.

Table 17c Industrial Sector: United Kingdom

Notation: a = million therms; b = £/ton; c = Pence/therm; d = £ million

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal	Consumption	a	11723	11340	10784	9668	9107	9045	8447	7966	7536	7235	7059	6673	6054	5889	5572	5034	4062	3047	3156	2894
	Price (1)	b	4.1	4.7	5.0	5.3	5.3	5.4	5.6	5.8	5.8	5.8	5.8	5.9	5.7	5.5	5.6	6.7	8.0	8.6	9.0	9.0
		c	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	Expenditure	d	186.40	206.40	208.13	198.19	186.69	189.04	183.30	179.24	169.56	162.79	158.83	148.81	130.77	124.85	119.8	129.88	125.11	99.03	107.30	107.08
Coke and Other Solid	Consumption (2)	a	4783	4845	4867	4298	3971	4858	4604	4126	4065	4434	4383	3895	3656	3846	3879	3860	3316	3128	3326	2848
	Price (3)	c	2.22	2.51	2.63	2.52	2.52	2.74	2.80	2.70	3.05	3.34	3.37	3.45	3.54	3.81	4.22	4.73	5.44	6.03	6.67	10.67
	Expenditure	d	106.18	121.61	128.00	108.31	100.07	133.11	128.91	111.40	123.98	148.10	147.71	134.38	129.42	146.53	163.69	182.58	180.39	188.62	221.84	303.88
Coal Coke and Other Solid	Consumption	a	16506	16185	15651	13966	13078	13903	13051	12092	11601	11669	11442	10568	9710	9735	9451	8694	7378	6175	6462	5742
	Price	c	1.77	2.02	2.15	2.19	2.19	2.32	2.39	2.40	2.53	2.66	2.68	2.68	2.68	2.79	3.00	3.51	4.14	4.66	5.08	7.16
	Expenditure	d	292.58	328.01	336.13	306.5	286.76	322.15	312.21	290.64	293.54	310.89	306.54	283.19	260.19	271.38	283.49	312.46	305.50	287.65	329.14	410.96

(1) £/ton figures obtained from D.E.S. (see Table 86 of 1974 Digest). For conversion to pence/therm, 'other industry' coal heating value is used - see previous Table 1a

(2) Consumption includes other solid fuel

(3) See previous Table 17a

Table 17d Industrial Sector: Scotland

Notation: a = Average price in the U.K.
b = Price ratio: Scotland/U.K. (for coal the price refers to the total of all coals including power station coal)
c = a × b

Notation: * = million therm.
** = price/therm
*** = £m

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal	Consumption	*	1424	1364	1269	1139	1055	1101	986	873	825	769	736	652	542	481	457	419	329	244	217	183
	Price (1) a	**	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	b		1.01	1.03	1.02	1.04	1.03	1.04	1.02	1.10	1.13	1.14	1.13	1.12	1.08	1.10	1.12	1.08	1.06	1.06	1.02	1.00
	c	**	1.61	1.87	1.97	2.13	2.11	2.17	2.21	2.48	2.54	2.57	2.54	2.50	2.33	2.33	2.41	2.79	3.26	3.45	3.47	3.70
	Expenditure	***	22.93	25.51	25.00	24.26	22.26	23.89	21.79	21.65	20.96	19.76	18.69	16.30	12.63	11.21	11.01	11.69	10.71	8.42	7.51	6.77
Coke (2)	Consumption (2)	*	358	364	383	325	254	369	348	235	231	361	399	307	286	353	367	373	301	279	323	278
	Price (3) a	**	2.22	2.51	2.63	2.52	2.52	2.74	2.80	2.70	3.05	3.34	3.37	3.45	3.54	3.81	4.22	4.73	5.44	6.03	6.67	10.67
	b		1.23	1.33	1.18	1.25	1.31	1.24	1.24	←					assume	1.20						→
	c	**	2.73	3.34	3.10	3.15	3.30	3.40	3.47	3.24	3.66	4.01	4.04	4.14	4.25	4.57	5.06	5.68	6.53	7.24	8.00	12.8
	Expenditure	***	9.77	12.16	11.87	10.24	8.38	12.55	12.08	7.61	8.45	14.48	16.12	12.71	12.16	16.13	18.57	21.19	19.66	20.20	25.84	35.58
Coal and Coke	Consumption	*	1782	1728	1652	1464	1309	1470	1334	1108	1056	1130	1135	959	828	834	824	792	630	523	540	461
	Price	**	1.84	2.18	2.23	2.36	2.34	2.48	2.54	2.64	2.79	3.03	3.07	3.03	2.99	3.28	3.59	4.15	4.82	5.47	6.18	9.19
	Expenditure	***	32.70	37.67	36.87	34.50	30.64	36.44	33.87	29.26	29.41	34.24	34.81	29.01	24.79	27.34	29.58	32.88	30.39	28.62	33.37	42.35

(1) The ratio is obtained from the figures quoted as "average proceeds per saleable ton" in the Annual Report of the N.C.B., for 1974 this ratio is assumed to be 1.0

(2) Consumption includes other solid fuel.

(3) Coke prices are obtained from the Annual Reports of the N.C.B.

Table 17e Price of coal and coke in the Railways (1)

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Railway Coal and Coke	Expenditure on Coal & Coke (2) £m	48.001	61.325	63.825	62.805	56.55	53.94	50.3	44.26	31.8	26.2	15.3	9.7								
	Heating Value Therms/ton	280	280	280	280	280	280	280	280	280	280	280	300								
	Consumption in million therms (3)	3653	3642	3487	3231	2906	2698	2401	1921	1590	1210	804	531								
	Average Price pence/therm	1.31	1.68	1.83	1.94	1.95	2.0	2.1	2.3	2.0	2.17	1.90	1.83								
	Consumption quoted in British Rail Report m. ton (4)	12.091	12.126	11.58	10.745	9.635	9.02	7.797	6.273	←	B.R.B. discontinues this series since 1962 Annual Report										→
	Consumption in m. therm	3386	3395	3242	3009	2698	2526	2183	1756												
	Av. price pence/therm	1.42	1.81	1.97	2.09	2.1	2.14	2.3	2.52												
	Compare with Indus. (5) Sector Price p./therm	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70

(1) The consumption figures given in the D.E.S. refer to "Railways". Figures quoted in the Annual Report of British Railways Board is for "loco coal" and "steam traction". The figures from B.R.B. for 1955 include a small expenditure on diesel fuel oil. Since 1963 (reorganisation of the British Transport Commission for setting up separate British Railways Board) these figures refer to "expenditure on fuel and power: Coal and Coke". The expenditure figures quoted in the B.R.B. Report for later years i.e. after 1965 may be particularly distorted due to possible stock depletion caused by the rapid transition towards Diesel Traction.

(2) Source: Annual Report of the British Railways Board. See note (1) above.

(3) Source: Digest of Energy Statistics

(4) These figures do not correspond exactly with the D.E.S. figures.

(5) This price is later used as the price of coal and coke in the Transport Sector.

Table 17f Transport Sector (1) - United Kingdom and Scotland

a = million therms; b = pence/therm; c = £ million

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
United Kingdom	Consumption	a	3911	3875	3680	3384	3040	2816	2461	2015	1673	1278	866	586	304	123	95	84	57	32	27	24
	Price	b	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	Expenditure	c	62.18	70.53	71.02	69.37	62.32	58.85	53.4	45.34	37.64	28.76	19.49	13.07	6.57	2.61	2.04	2.17	1.76	1.04	0.92	0.89
Scotland	Consumption	a	527	536	506	436	389	355	295	209	169	127	101	56	10	4	4	4	2	2	2	-
	Price	b	1.61	1.87	1.97	2.13	2.11	2.17	2.21	2.48	2.54	2.57	2.54	2.50	2.33	2.33	2.41	2.79	3.26	3.45	3.47	-
	Expenditure	c	8.48	10.02	9.97	9.29	8.21	7.7	6.52	5.18	4.29	3.26	2.57	1.4	0.23	0.09	0.10	0.11	0.07	0.07	0.07	-

(1) Solid Fuel Consumption in the Transport sector constitutes mainly of consumption in the Railways (a small consumption by the Water Transport). The price in the transport sector is taken to be the same as that in the Industrial Sector. See Table 17e above.

Table 17g Public and Commercial Sector (including Agriculture): United Kingdom (1)

Notation: a = million therm; b = pence/therm; c = £million

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal	Consumption	a	2318	2109	2065	1951	1692	1766	1582	1641	1695	1496	1485	1393	1241	1035	1090	1081	924	799	687	669
	Price	b	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	Expenditure	c	36.86	38.38	39.85	40.00	34.69	36.91	34.33	36.92	38.14	33.66	33.41	31.06	26.81	21.94	23.44	27.89	28.46	25.97	23.36	24.75
Coke (2)	Consumption	a	1958	1879	1680	1680	1564	1355	1221	1333	1402	1154	1112	1008	903	917	833	651	321	294	283	373
	Price	b	2.22	2.51	2.63	2.52	2.52	2.74	2.80	2.70	3.05	3.34	3.37	3.45	3.54	3.81	4.22	4.73	5.44	6.03	6.67	10.67
	Expenditure	c	43.47	47.16	44.18	42.34	39.41	37.13	34.19	35.99	42.76	38.54	37.47	34.78	31.97	34.94	35.15	30.79	17.46	17.73	18.88	39.80
Coal & Coke	Consumption	a	4276	3988	3745	3631	3256	3121	2803	2974	3097	2650	2597	2401	2144	1952	1923	1732	1245	1093	970	1042
	Price	b	1.88	2.14	2.24	2.27	2.28	2.37	2.44	2.45	2.61	2.72	2.73	2.74	2.74	2.91	3.05	3.39	3.69	4.00	4.35	6.19
	Expenditure	c	80.33	85.54	84.03	82.34	74.10	74.04	68.52	72.91	80.90	72.20	70.88	65.84	58.78	56.88	58.59	58.68	45.92	43.70	42.24	64.55

(1) Price is assumed to be the same as that in the Industrial Sector. See Table 17c

(2) Includes other solid fuels.

Table 17h Public and Commercial Sector (including Agriculture: Scotland (1)

Notation: a = million therm; b = pence/therm; c = £ million

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Coal	Consumption	a	285	238	229	294	265	303	266	259	235	210	214	195	215	196	151	153	159	168	114	142
	Price	b	1.61	1.87	1.97	2.13	2.11	2.17	2.21	2.48	2.54	2.57	2.54	2.50	2.33	2.33	2.41	2.79	3.26	3.45	3.47	3.70
	Expenditure	c	4.59	4.45	4.51	6.26	5.59	6.58	5.88	6.42	5.97	5.40	5.44	4.88	5.01	4.57	3.64	4.27	5.18	5.8	3.96	5.25
Coke (2)	Consumption	a	109	100	88	90	80	81	77	74	77	69	77	68	56	56	47	34	15	11	16	19
	Price	b	2.73	3.34	3.10	3.15	3.30	3.40	3.47	3.24	3.66	4.01	4.04	4.14	4.25	4.57	5.06	5.68	6.53	7.24	8.00	12.8
	Expenditure	c	2.98	3.34	2.73	2.84	2.64	2.75	2.67	2.40	2.82	2.77	3.11	2.82	2.38	2.56	2.38	1.93	0.98	0.80	1.28	2.43
Coal & Coke	Consumption	a	394	338	317	384	345	384	343	333	312	279	291	263	271	252	198	187	174	179	130	161
	Price	b	1.92	2.30	2.28	2.37	2.39	2.43	2.49	2.65	2.82	2.93	2.94	2.93	2.73	2.83	3.04	3.32	3.54	3.69	4.03	4.77
	Expenditure	c	7.57	7.79	7.24	9.10	8.23	9.33	8.55	8.82	8.79	8.17	8.55	7.70	7.39	7.13	6.02	6.20	6.16	6.60	5.24	7.68

(1) Price is assumed to be the same as that in the Industrial Sector. See Table 17d

(2) Includes other solid fuels

Table 17j Summary Table: United Kingdom

Notations: a = Consumption in million therms
b = Price in pence/therm
c = Expenditure in £ million

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	11948	11983	11387	11713	10825	11294	10771	11037	10972	9805	9729	9222	8547	8310	7823	7137	6136	5397	5320	5032
	b	1.82	2.32	2.46	2.60	2.65	2.86	3.02	3.25	3.45	3.55	3.67	4.01	4.22	4.27	4.54	5.1	5.54	5.97	5.93	7.27
	c	220	280	282	307	288	323	325	359	379	348	357	370	361	355	355	364	340	322	316	366
Industrial	a	16506	16185	15651	13966	13078	13903	13051	12092	11601	11669	11442	10568	9710	9735	9451	8894	7378	6175	6482	5472
	b	1.77	2.02	2.15	2.19	2.19	2.32	2.39	2.40	2.53	2.66	2.68	2.68	2.68	2.79	3.00	3.51	4.14	4.66	5.08	7.16
	c	292.58	328.01	336.13	306.5	286.76	322.15	312.21	290.64	293.54	310.89	306.54	283.19	260.19	271.38	283.49	312.46	305.50	287.65	329.14	410.96
Traction	a	3911	3875	3680	3384	3040	2816	2461	2105	1673	1278	866	586	304	123	95	64	57	32	27	24
	b	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	c	62.18	70.53	71.02	69.37	62.32	58.85	53.40	45.34	37.64	28.76	19.49	13.07	6.57	2.61	2.04	2.17	1.76	1.04	0.92	0.89
Public & Miscellaneous (including Agriculture)	a	4276	3988	3745	3631	3256	3121	2803	2974	3097	2650	2597	2401	2144	1952	1923	1732	1245	1093	970	1042
	b	1.88	2.14	2.24	2.27	2.28	2.37	2.44	2.45	2.61	2.72	2.73	2.74	2.74	2.91	3.05	3.39	3.69	4.00	4.35	6.19
	c	80.33	85.54	84.03	82.34	74.10	74.04	68.52	72.91	80.90	72.20	70.88	65.84	58.78	56.88	58.59	58.68	45.92	43.70	42.24	64.55
All Sectors	a	36641	36031	34463	32694	30199	31134	29086	28118	27343	25402	24634	22777	20705	20120	19292	17847	14816	12697	12807	11840
	b	1.78	2.11	2.24	2.35	2.35	2.50	2.61	2.73	2.89	2.99	3.06	3.21	3.32	3.41	3.62	4.13	4.68	5.15	5.37	7.11
	c	655.09	764.08	773.18	765.21	711.18	778.04	759.13	767.89	791.08	759.85	753.91	732.10	686.54	685.87	699.12	737.31	693.18	654.39	688.30	842.40

Table 17k Summary Table: Scotland

Notations: a = consumption in million therms
b = Price in pence/therm
c = Expenditure in £ million

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	1227	1242	1186	1209	1160	1101	1113	1113	1063	910	885	795	720	704	679	602	508	428	483	440
	b	2.13	2.71	2.88	3.04	3.10	3.35	3.53	3.80	4.04	4.18	4.19	4.58	4.68	4.90	5.09	5.81	6.26	6.67	6.73	8.43
	c	26.14	33.66	34.16	36.75	35.96	36.88	39.29	42.29	42.95	38.04	37.08	36.41	33.70	34.50	34.56	34.98	31.80	28.55	32.51	37.09
Industrial	a	1782	1728	1652	1464	1309	1470	1334	1108	1056	1130	1135	959	828	834	824	792	630	523	540	461
	b	1.84	2.18	2.23	2.36	2.34	2.48	2.54	2.64	2.79	3.03	3.07	3.03	2.99	3.28	3.59	4.15	4.82	5.47	6.18	9.19
	c	32.70	37.67	36.87	34.50	30.64	36.44	33.87	29.26	29.41	34.24	34.81	29.01	24.79	27.34	29.58	32.88	30.39	28.62	33.37	42.35
Traction	a	527	536	506	436	389	355	295	209	169	127	101	56	10	4	4	4	2	2	2	
	b	1.61	1.87	1.97	2.13	2.11	2.17	2.21	2.48	2.54	2.57	2.54	2.50	2.33	2.33	2.41	2.79	3.26	3.45	3.47	
	c	8.48	10.02	9.97	9.29	8.21	7.7	6.52	5.18	4.29	3.26	2.57	1.40	0.23	0.09	0.10	0.11	0.07	0.07	0.07	
Public & Miscellaneous (including Agriculture)	a	394	338	317	384	345	384	343	333	312	279	291	263	271	252	198	187	174	179	130	161
	b	1.92	2.30	2.28	2.37	2.39	2.43	2.49	2.65	2.82	2.93	2.94	2.93	2.73	2.83	3.04	3.32	3.54	3.69	4.03	4.77
	c	7.57	7.79	7.24	9.10	8.23	9.33	8.55	8.82	8.79	8.17	8.55	7.70	7.39	7.13	6.02	6.20	6.16	6.60	5.24	7.68
All Sectors	a	3930	3843	3660	3493	3203	3309	3087	2762	2600	2449	2417	2077	1829	1794	1705	1588	1313	1130	1154	1062
	b	1.91	2.32	2.41	2.57	2.59	2.73	2.86	3.10	3.29	3.42	3.43	3.59	3.61	3.85	4.12	4.67	5.21	5.65	6.17	8.20
	c	74.89	89.14	88.24	89.64	83.04	90.35	88.23	85.55	85.44	83.71	83.01	74.52	66.11	69.06	70.26	74.17	68.42	63.84	71.19	87.12

Table 17j Summary Table: United Kingdom

Notations: a = Consumption in million therms
b = Price in pence/therm
c = Expenditure in £ million

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	11948	11983	11387	11713	10825	11294	10771	11037	10972	9805	9729	9222	8547	8310	7823	7137	6136	5397	5328	5032
	b	1.82	2.32	2.46	2.60	2.65	2.86	3.02	3.25	3.45	3.55	3.67	4.01	4.22	4.27	4.54	5.1	5.54	5.97	5.93	7.27
	c	220	280	282	307	288	323	325	359	379	348	357	370	361	355	355	364	340	322	316	366
Industrial	a	16506	16185	15651	13966	13078	13903	13051	12092	11601	11669	11442	10568	9710	9735	9451	8894	7378	6175	6482	5472
	b	1.77	2.02	2.15	2.19	2.19	2.32	2.39	2.40	2.53	2.66	2.68	2.68	2.68	2.79	3.00	3.51	4.14	4.66	5.08	7.16
	c	292.58	328.01	336.13	306.5	286.76	322.15	312.21	290.64	293.54	310.89	306.54	283.19	260.19	271.38	283.49	312.46	305.50	287.65	329.14	410.96
Traction	a	3911	3875	3680	3384	3040	2816	2461	2105	1673	1278	866	586	304	123	95	64	57	32	27	24
	b	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	c	62.18	70.53	71.02	69.37	62.32	58.85	53.40	45.34	37.64	28.76	19.49	13.07	6.57	2.61	2.04	2.17	1.76	1.04	0.92	0.89
Public & Miscellaneous (including Agriculture)	a	4276	3988	3745	3631	3256	3121	2803	2974	3097	2650	2597	2401	2144	1952	1923	1732	1245	1093	970	1042
	b	1.88	2.14	2.24	2.27	2.28	2.37	2.44	2.45	2.61	2.72	2.73	2.74	2.74	2.91	3.05	3.39	3.69	4.00	4.35	6.19
	c	80.33	85.54	84.03	82.34	74.10	74.04	68.52	72.91	80.90	72.20	70.88	65.84	58.78	56.88	58.59	58.68	45.92	43.70	42.24	64.55
All Sectors	a	36641	36031	34463	32694	30199	31134	29086	28118	27343	25402	24634	22777	20705	20120	19292	17847	14816	12697	12807	11840
	b	1.78	2.11	2.24	2.35	2.35	2.50	2.61	2.73	2.89	2.99	3.06	3.21	3.32	3.41	3.62	4.13	4.68	5.15	5.37	7.11
	c	655.09	764.08	773.18	765.21	711.18	778.04	759.13	767.89	791.08	759.85	753.91	732.10	686.54	685.87	699.12	737.31	693.18	654.39	688.30	842.40

Table 17k Summary Table: Scotland

Notations: a = consumption in million therms
b = Price in pence/therm
c = Expenditure in £ million

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	1227	1242	1186	1209	1160	1101	1113	1113	1063	910	885	795	720	704	679	602	508	428	483	440
	b	2.13	2.71	2.88	3.04	3.10	3.35	3.53	3.80	4.04	4.18	4.19	4.58	4.68	4.90	5.09	5.81	6.26	6.67	6.73	8.43
	c	26.14	33.66	34.16	36.75	35.96	36.88	39.29	42.29	42.95	38.04	37.08	36.41	33.70	34.50	34.56	34.98	31.80	28.55	32.51	37.09
Industrial	a	1782	1728	1652	1464	1309	1470	1334	1108	1056	1130	1135	959	828	834	824	792	630	523	540	461
	b	1.84	2.18	2.23	2.36	2.34	2.48	2.54	2.64	2.79	3.03	3.07	3.03	2.99	3.28	3.59	4.15	4.82	5.47	6.18	9.19
	c	32.70	37.67	36.87	34.50	30.64	36.44	33.87	29.26	29.41	34.24	34.81	29.01	24.79	27.34	29.58	32.88	30.39	28.62	33.37	42.35
Traction	a	527	536	506	436	389	355	295	209	169	127	101	56	10	4	4	4	2	2	2	
	b	1.61	1.87	1.97	2.13	2.11	2.17	2.21	2.48	2.54	2.57	2.54	2.50	2.33	2.33	2.41	2.79	3.26	3.45	3.47	
	c	8.48	10.02	9.97	9.29	8.21	7.7	6.52	5.18	4.29	3.26	2.57	1.40	0.23	0.09	0.10	0.11	0.07	0.07	0.07	
Public & Miscellaneous (including Agriculture)	a	394	338	317	384	345	384	343	333	312	279	291	263	271	252	198	187	174	179	130	161
	b	1.92	2.30	2.28	2.37	2.39	2.43	2.49	2.65	2.82	2.93	2.94	2.93	2.73	2.83	3.04	3.32	3.54	3.69	4.03	4.77
	c	7.57	7.79	7.24	9.10	8.23	9.33	8.55	8.82	8.79	8.17	8.55	7.70	7.39	7.13	6.02	6.20	6.16	6.60	5.24	7.68
All Sectors	a	3930	3843	3660	3493	3203	3309	3087	2762	2600	2449	2417	2077	1829	1794	1705	1588	1313	1130	1154	1062
	b	1.91	2.32	2.41	2.57	2.59	2.73	2.86	3.10	3.29	3.42	3.43	3.59	3.61	3.85	4.12	4.67	5.21	5.65	6.17	8.20
	c	74.89	89.14	88.24	89.64	83.04	90.35	88.23	85.55	85.44	83.71	83.01	74.52	66.11	69.06	70.26	74.17	68.42	63.84	71.19	87.12

TABLE 18 <u>Petroleum Prices in the United Kingdom and Scotland</u>

Table 18a <u>Prices for various petroleum fuels (1) (Zone Basis)</u>

Notation: a = Pence per gallon
b = Pence per therm

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Burning Oil General Zone	Standard Oil	a	7.19	8.65	7.5	7.71	7.71[2]	7.71	8.63	8.54	8.54[2]	8.63[3]	8.63[3]	8.63	9.46	9.55	9.33	9.96	11.09	11.84	15.84	23.42
		b	4.54	5.47	4.74	4.87	4.87	4.87	5.45	5.4	5.4	5.45	5.45	5.45	5.98	6.04	5.9	6.29	7.01	7.48	10.01	14.80
	Premier Oil	a	7.6	9.27	8.02	8.33	8.44[2]	8.44	9.67	9.79	9.79[2]	12.08	12.08	12.08	12.92	12.9	12.9	13.5	15.5	17.0	20.5	25.62
		b	4.8	5.86	5.07	5.26	5.33	5.33	6.11	6.19	6.19	7.63	7.63	7.63	8.17	8.15	8.15	8.53	9.8	10.74	12.96	16.19
	Ratio Standard/Premier		1:6.5[4]	1:6.5[4]	1:6.5[4]	1:6.5[4]	1:6.5[4]	1:6.5	1:4.5	1:3.58	1:3.56	1:2.12	1:1.7	1:1.4	1:1.11	1:0.98	1:0.85	1:0.69	1:0.51	1:0.46	1:0.40	1:0.33
	Weighted Price	b	4.77	5.81	5.02	5.21	5.27	5.27	5.99	6.02	6.02	6.93	6.93	6.93	7.13	7.08	6.93	7.2	7.95	8.51	10.85	15.15
Burning Oil Inner Zone	Standard Oil	a	6.77	8.23	7.08	7.19	7.29[2]	7.29	8.21	8.13	8.13[2]	8.21[3]	8.21[3]	8.21	9.04	9.13	8.92	9.54	10.67	11.42	15.42	23.0
		b	4.28	5.2	4.47	4.54	4.61	4.61	5.19	5.14	5.14	5.19	5.19	5.19	5.71	5.77	5.64	6.03	6.74	7.22	9.75	14.54
	Premier Oil	a	7.4	8.85	7.71	7.92	8.13[2]	8.13	9.25	9.38	9.38[2]	11.67	11.67	11.67	12.5	12.5	12.5	13.1	14.0	16.0	20.0	25.2
		b	4.68	5.59	4.87	5.01	5.14	5.14	5.85	5.93	5.93	7.38	7.38	7.38	7.9	7.9	7.9	8.28	8.85	10.11	12.64	15.93
	Ratio Standard Premier						Same as that for General Zone above															
	Weighted Price	b	4.62	5.54	4.82	4.94	5.06	5.06	5.73	5.75	5.75	6.67	6.67	6.67	6.86	6.82	6.67	6.95	7.46	8.13	10.57	14.88
Fuel Oil (5)		a	4.06	5.94	4.69	4.38	4.69	4.69	5.6	5.52	5.52	5.52[6]	5.6[6]	5.6	6.44	6.32	6.0	7.46	7.96	8.39	10.59	18.84
Inner Zone, Heavy Grade		b	2.27	3.32	2.62	2.45	2.62	2.62	3.13	3.08	3.08	3.08	3.13	3.13	3.67	3.53	3.35	4.17	4.45	4.69	5.92	10.53
Gasoline, Inner Zone, (7)		a	20.41	27.71	21.15	21.25	20.84[8]	20.84	22.09	21.67	21.67	24.38	24.38	26.04	27.09	30.87	31.71	33.6	33.5	34.5	41.5	61.5
Standard Grade (3 star)		b	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.3	22.2	22.9	27.5	40.82
Gas/Diesel Oil		a	5.89	7.46	6.54	6.42	6.63	6.42	7.53	7.45	7.66	7.45	7.45[9]	7.53	8.37	8.46	8.03	9.28	9.78	10.33	15.43	22.93
Inner Zone		b	3.58	4.53	3.98	3.90	4.03	3.9	4.58	4.53	4.66	4.53	4.53	4.58	5.09	5.15	4.88	5.64	5.95	6.28	9.38	13.95

Sources: Institute of Petroleum
Digest of Energy Statistics

(1) For 1964 to 1974 the figures are obtained from the D.E.S. (Refer Table 85 of 1974 Digest and equivalent); for other years from Institute of Petroleum.

(2) Figures for 1959 and 1963 are not available. Figures for 1959 are assumed to be the same as for 1960 and for 1963 same as that for 1962.

(3) For 1964 and 1965 figures for standard oil are not available. 1966 figures are used for both years.

(4) Figures are not available for the years 1955 to 1959. They are assumed to be the same as that for 1960.

(5) There are 3 grades of fuel oil; light, medium and heavy. The price of the light oil tens to be between 7 to 12% higher than for heavy grade and between 4 to 8% higher than for medium grade. For Scotland, consumption of fuel oil into the categories of light/medium/heavy are not given. For U.K. these figures are available since 1967. For 1974 the proportion of light/medium/heavy category for U.K. was 1/4/30. Hence taking the price for the heavy grade will tend to underestimate the fuel oil price by about 3 for later years.

(6) Figures for 1964 and 1965 are not available. 1964 is assumed to be the same as 1963 and 1965 same as 1966.

(7) There are four grades of gasolene; 2 star, 3 star, 4 star and 5 star. The 3 star grade is chosen since this is equivalent to the "standard" grade (the other was "premier" grade) during the years 1953 and 1967.

Inner Zone prices are taken, outer and general zone prices in recent years have tended to be about 0.21 pence and 0.42 pence higher respectively. Derv fuel, on average, is about 5% cheaper than gasolene.

(8) Figure for 1959 assumed to be the same as 1960.

(9) Figure for 1965 assumed to be the same as 1964.

(10) Majority of the price data is for the month of December. For some years the price data is for some other month.

Conversion Factors from pence/gallon to pence/therm. (Source) Digest of Energy Statistics: Ref. page 162 of 1974 DES):

(a) Burning Oil: 283 Imperial gallon per long ton and 448 therms per ton gives 448/283 = 1.583 therms/gallon

(b) Fuel Oil: Above procedure, 418/233 = 1.79 therms/gallon

(c) Gasolene: Above procedure, 452/300 = 1.51 therms/gallon

(d) Gas/Diesel Oil: Above procedure, 439/267 = 1.64 therms/gallon

Table 18b Prices of Petroleum for Sectors

a = Pence/therm b = £/ton

Sector			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
(1) Domestic	U.K.	a	4.69	5.67	4.92	5.08	5.17	5.17	5.86	5.88	5.88	6.8	6.8	6.8	6.99	6.95	6.8	7.08	7.7	8.32	10.7	15.0
	Scotland	a	4.66	5.61	4.87	5.01	5.11	5.11	5.79	5.82	5.82	6.73	6.73	6.73	6.93	6.89	6.73	7.01	7.58	8.22	10.63	14.94
Industrial (2)		b	9.0	10.9	11.3	9.5	8.7	8.3	7.6	8.5	8.0	7.5	7.0	7.4	8.6	9.4	9.3	9.3	13.9	13.3	13.0	30.8
U.K. and Scotland		a	2.16	2.62	2.72	2.29	2.09	.199	1.83	2.05	1.92	1.80	1.68	1.78	2.07	2.26	2.23	2.23	3.34	3.2	3.12	7.38
Transport (3) U.K. and Scotland		a	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.3	22.2	22.9	27.5	40.82
Public & Miscellaneous U.K. & Scotland	Fuel Oil	a	2.27	3.32	2.62	2.45	2.62	2.62	3.13	3.08	3.08	3.08	3.13	3.13	3.6	3.53	3.35	4.17	4.45	4.69	5.92	10.53
	Gas/Diesel Oil	a	3.58	4.53	3.98	3.90	4.03	3.9	4.58	4.53	4.66	4.53	4.53	4.58	5.09	5.15	4.88	5.64	5.95	6.28	9.38	13.95
	Ratio: Fuel Oil to Gas/Diesel Oil		1:0.55	1:0.55	1:0.53	1:0.5	1:0.49	1:0.46	1:0.55	1:0.5	1:0.49	1:0.52	1:0.52	1:0.55	1:0.58	1:0.59	1:0.64	1:0.73	1:0.94	1:1.22	1:1.51	1:1.69
	Weighted Price	a	2.74	3.75	3.09	2.93	3.08	3.02	3.65	3.57	3.60	3.58	3.61	3.65	4.15	4.13	3.95	4.79	5.18	5.56	8.00	12.68

(1) Price for U.K. is obtained by taking weighted average prices; 1 for inner zone, 1 for the general zone. For Scotland the weighting is inner zone 3, general zone 1.

(2) For industrial sector, the price for fuel oil is used. Source, Digest of Energy Statistics (see Table 86 of 1974 Digest and equivalent tables).

(3) For transport sector, the price for gasoline is used.

(4) The ratio used for weighted is that for U.K. Scotland ratio is not much different.

Source: See Table 18a.

Table 18c Summary Table for Petroleum Prices and Expenditure on Petroleum in the United Kingdom and Scotland

Notation: a = pence/therm b = million therms c = £ million

United Kingdom			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic Sector	Average price	a	4.69	5.67	4.92	5.08	5.17	5.17	5.86	5.88	5.88	6.8	6.8	6.8	6.99	6.95	6.8	7.08	7.7	8.32	10.7	15.0
	Consumption	b	289	373	357	529	586	671	731	869	992	911	969	967	1006	1115	1222	1335	1321	1523	1668	1428
	Expenditure	c	13.55	21.15	17.56	26.87	30.3	34.69	42.84	50.4	58.33	61.95	65.89	65.76	70.32	77.49	83.10	94.52	101.72	126.71	178.48	222.3
Industrial Sector	Average price	a	2.16	2.62	2.72	2.29	2.09	1.99	1.83	2.05	1.92	1.80	1.68	1.78	2.07	2.26	2.23	2.23	3.34	3.2	3.12	7.38
	Consumption	b	2449	2762	2798	3293	3835	4516	5175	5991	6815	7540	8406	9044	9609	10091	10790	11426	11265	11455	11464	10131
	Expenditure	c	52.9	72.36	76.11	75.41	80.15	89.87	94.7	122.82	130.95	135.72	141.22	160.98	198.91	228.06	240.60	254.8	376.25	366.56	357.68	747.67
Transport Sector	Average price	a	13.55	18.3[illegible]	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.3	22.2	22.9	27.5	40.82
	Consumption	b	4498	46[illegible]	[illegible]07	4931	5324	5919	6573	6918	7357	7984	8491	8933	9536	10100	10478	11008	11483	11962	12760	12295
	Expenditure	c	609.48	861.[illegible]	[illegible]4.74	695.27	736.31	818.6	963.6	994.81	1057.9	1291.8	1373.8	1543.6	1714.6	2069.5	2205.6	2454.8	2549.2	2739.3	3509.0	5018.82
Public & Commercial Sector	Average price	a	2.74	3.[illegible]	[illegible]09	2.93	3.03	3.02	3.65	3.57	3.6	3.58	3.61	3.65	4.15	4.13	3.95	4.79	5.18	5.56	8.00	12.68
	Consumption	b	788	90[illegible]	[illegible]9	1176	1346	1727	1535	1794	2072	2093	2297	2454	2661	3006	3327	3588	3646	3764	3805	3335
	Expenditure	c	21.59	34.01	[illegible].02	34.46	41.46	52.16	56.03	64.05	74.59	74.93	82.92	89.57	110.43	124.15	131.42	171.87	188.86	209.28	304.4	422.88
All Sectors Total	Average price	a	8.69	11.33	8.72	8.38	8.01	7.75	8.26	7.91	7.67	8.44	8.25	8.69	9.18	10.28	10.31	10.88	11.6	11.99	14.65	23.54
	Consumption	b	8024	8728	8501	9929	11091	12833	14014	15572	17236	18528	20163	21398	22812	24312	25817	27357	27715	28706	29697	27243
	Expenditure	c	697.3	989.1	741.3	831.8	888.1	995.1	1157.1	1232.0	1321.5	1564.3	1663.7	1859.7	2094.2	2499.0	2660.7	2975.9	3215.9	3441.7	4399.4	6411.67

	Scotland		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic Sector	Average price	a	4.66	5.61	4.87	5.01	5.11	5.11	5.79	5.82	5.82	6.73	6.73	6.73	6.97	6.89	6.73	7.01	7.58	8.22	10.63	14.94
	Consumption	b	24	30	28	40	42	50	57	62	71	69	74	75	74	83	93	100	96	114	131	124
	Expenditure	c	1.12	1.68	1.36	2.0	2.15	2.56	3.30	3.61	4.13	4.64	4.98	5.05	5.16	5.72	6.26	7.01	7.28	9.37	13.93	18.53
Industrial Sector	Average Price*	a	2.16	2.62	2.72	2.29	2.09	1.99	1.83	2.05	1.92	1.80	1.68	1.78	2.07	2.26	2.23	2.23	3.34	3.2	3.12	7.38
	Consumption	b	208	241	256	291	319	383	450	519	597	711	808	899	977	1033	1132	1206	1243	1342	1399	1328
	Expenditure	c	4.49	6.31	6.96	6.66	6.67	7.62	8.24	10.64	11.46	12.8	13.57	16.0	20.22	23.35	25.24	26.89	41.52	42.94	43.65	[illegible]
Transport Sector	Average Price*	a	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.3	22.2	22.9	27.5	40.82
	Consumption	b	398	429	401	444	492	521	583	611	653	696	726	750	773	847	886	911	961	982	1073	1038
	Expenditure	c	53.93	78.89	56.3	62.6	68.04	72.05	85.47	87.86	93.9	112.61	117.47	129.6	138.99	173.55	186.5	203.15	213.34	224.88	295.08	423.71
Public & Commercial Sector	Average Price*	a	2.74	3.75	3.09	2.93	3.08	3.02	3.65	3.57	3.6	3.58	3.61	3.65	4.15	4.13	3.95	4.79	5.18	5.56	8.00	12.68
	Consumption	b	86	95	101	121	131	152	143	167	193	204	229	251	267	307	345	371	384	406	420	402
	Expenditure	c	2.36	3.56	3.12	3.55	4.03	4.59	5.22	5.96	6.95	7.3	8.27	9.16	11.08	12.68	13.63	17.77	19.89	22.57	33.6	50.97
Total All Sectors	Average Price	a	8.65	11.38	8.62	8.35	8.21	7.84	8.29	7.95	7.69	8.17	7.85	8.09	8.39	9.48	9.43	9.85	10.5	10.54	12.77	20.44
	Consumption	b	716	795	786	896	985	1107	1233	1360	1514	1681	1837	1975	2091	2270	2456	2588	2685	2844	3024	2692
	Expenditure	c	61.90	90.44	67.64	74.81	80.89	86.82	102.23	108.07	116.44	137.35	144.29	159.81	175.45	215.3	231.63	254.82	282.03	299.76	386.26	591.22

* Same as U.K.

TABLE 19 Gas Prices in the United Kingdom and Scotland
(All price figures are in Pence/therm)

Table 19a Gas price in the United Kingdom

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic (1)	8.14	9.09	9.61	10.22	10.27	10.53	11.06	11.21	11.10	11.17	10.85	10.68	10.57	10.62	10.95	10.64	10.97	11.21	11.06	11.15
Industrial (2)	5.36	5.85	6.14	6.41	6.40	6.39	6.54	6.64	6.61	6.73	6.66	6.63	6.72	6.65	6.07	4.87	3.58	3.04	3.04	3.68
Commercial (1)	7.10	7.79	8.19	8.60	8.58	8.64	8.88	9.00	9.03	9.18	9.10	9.18	9.20	9.34	9.54	9.30	9.04	8.75	8.11	8.5

(1) For Domestic and Commercial sector, the price figures are computed from quarterly statistics supplied by British gas.

(2) For Industrial sector, figures up to and including 1968 are obtained from quarterly statistics supplied by British Gas. From 1969 onwards, the headquarters sell directly to a few large consumers and the prices for these consumptions are not available. Hence the data is constructed since 1969 from financial year figures given in the Annual Reports of British Gas (also given in the U.K. Digest of Energy Statistics, see Table 56 of 1974 Digest for reference). Price of coke oven gas is not available and it is assumed to be the same as that for town and natural gas.

Table 19b Gas price in Scotland

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	8.2	9.47	10.4	10.99	11.99	13.08	13.49	13.69	13.57	12.65	12.4	12.9	13.13	13.25	13.14	13.08	13.78	14.01	14.29	14.19
Industrial (1)	6.17	6.63	6.91	6.76	6.81	6.95	7.04	7.48	7.49	7.42	7.51	7.86	7.86	7.86	7.84	7.59	6.52	4.96	4.17	4.27
Commercial	6.99	7.77	8.24	8.17	8.51	8.8	8.98	9.59	9.71	9.71	10.11	11.19	11.45	11.66	11.65	11.75	11.96	11.70	10.66	11.28

(1) Price of coke oven gas is assumed to be the same as that of town and natural gas.

Source: (1) For years 1955 to 1957, data obtained from U.K. Digest of Energy Statistics (for reference see Table 56 of 1974 Digest).

(2) For 1958, the figures are computed by taking 1/4 of 1957 and 3/4 of 1958-59; Source D.E.S.

(3) For 1959 to 1972, figures are computed from financial year data by taking 1/4 and 3/4 of successive years, source D.E.S., see Check Table 19c below.

(4) For 1973 and 1974, figures are obtained from quarterly statistics supplied by Scottish Gas.

Table 19c Special Check Table (to compare the difference between actual data and data constructed from financial year figures for U.K.

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Actual	8.14	9.09	9.61	10.22	10.27	10.53	11.06	11.21	11.10	11.17	10.85	10.68	10.57	10.62	10.95	10.64	10.97	11.21	11.06	11.15
	Constructed	8.21	9.11	9.63	10.09	10.36	10.69	11.09	11.21	11.24	11.08	10.79	10.69	10.43	10.83	10.72	10.62	10.99	11.17	11.01	11.46
Commercial	Actual	7.10	7.79	8.19	8.60	8.58	8.64	8.88	9.0	9.03	9.18	9.10	9.18	9.20	9.34	9.54	9.30	9.04	8.75	8.11	8.5
	Constructed	6.99	7.64	7.98	8.3	8.46	8.59	8.76	8.89	9.07	9.08	9.1	9.17	9.16	9.48	9.77	9.27	8.89	8.59	8.18	9.06

Table 19d <u>Expenditure on gas in the United Kingdom</u>

Notation: a = million therms
b = price/therm
c = £ million

Sector	Item		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Consumption	a	1389	1371	1326	1339	1290	1298	1300	1401	1537	1614	1869	2177	2473	2829	3211	3542	3930	4509	4815	5380
	Price	b	8.14	9.09	9.61	10.22	10.27	10.53	11.06	11.21	11.10	11.17	10.85	10.68	10.57	10.62	10.95	10.64	10.97	11.21	11.06	11.15
	Expenditure	c	113.06	124.62	127.43	136.85	132.48	136.68	143.68	157.05	170.61	180.28	202.79	232.5	261.40	300.44	351.60	376.87	431.12	505.46	532.54	599.87
Industrial	Consumption	a	1202	1240	1282	1267	1264	1413	1366	1287	1308	1419	1449	1415	1363	1434	1499	1878	2918	4129	5209	5474
	Price	b	5.36	5.85	6.14	6.41	6.40	6.39	6.54	6.64	6.61	6.73	6.66	6.63	6.72	6.65	6.07	4.87	3.58	3.04	3.04	3.68
	Expenditure	c	64.43	72.54	78.71	81.21	80.90	90.29	89.34	85.46	86.46	95.50	96.50	93.81	91.59	95.36	90.99	91.46	104.46	125.52	158.35	201.44
Commercial	Consumption	a	483	488	467	478	464	476	469	503	524	516	550	576	609	654	704	762	866	996	1083	1269
	Price	b	7.10	7.79	8.19	8.60	8.58	8.64	8.88	9.00	9.03	9.18	9.10	9.18	9.20	9.34	9.54	9.30	9.04	8.75	8.11	8.5
	Expenditure	c	34.29	38.02	38.25	41.11	39.81	41.13	41.65	45.27	47.32	47.37	50.05	52.88	56.03	61.08	67.16	70.87	78.29	87.15	87.83	107.87
Total	Consumption	a	3074	3099	3075	3083	3018	3187	3135	3191	3369	3549	3868	4168	4445	4917	5414	6182	7714	9634	11007	12123
	Price	b	6.90	7.59	7.95	8.41	8.39	8.41	8.76	9.02	9.04	9.11	9.03	9.10	9.20	9.29	9.42	8.72	7.96	7.45	7.08	7.50
	Expenditure	c	211.98	235.18	244.39	259.17	25.319	268.10	274.77	287.78	304.39	323.15	349.34	379.19	409.02	456.88	509.75	539.20	613.87	718.13	778.72	909.18

Sources: For consumption see Previous Table No. 9
For prices see previous Table No. 19a

Table 19e <u>Expenditure on gas in Scotland (including coke oven gas)</u>

Sector	Item		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Consumption	a	122	117	114	110	105	99	97	101	108	119	129	153	164	171	183	200	198	217	229	254
	Price	b	8.20	9.47	10.40	10.99	11.99	13.08	13.49	13.89	13.57	12.65	12.40	12.90	13.13	13.25	13.14	13.08	13.78	14.01	14.29	14.19
	Expenditure	c	10.00	11.08	11.86	12.09	12.59	12.95	13.09	14.03	14.66	15.05	16.00	19.74	21.53	22.66	24.05	26.16	27.28	30.4	32.72	36.04
Industrial	Consumption	a	46	46	50	46	46	52	53	53	65	85	102	96	93	102	115	120	118	155	221	258
	Price	b	6.17	6.63	6.91	6.76	6.81	6.95	7.04	7.48	7.49	7.42	7.51	7.66	7.86	7.86	7.84	7.59	6.52	4.96	4.17	4.27
	Expenditure	c	2.84	3.05	3.46	3.11	3.13	3.61	3.73	3.96	4.87	6.31	7.66	7.55	7.31	8.02	9.02	9.11	7.69	7.69	9.22	11.02
Commercial	Consumption	a	37	37	37	36	34	34	35	37	38	38	38	41	43	43	46	48	48	49	59	64
	Price	b	6.99	7.77	8.24	8.17	8.51	8.8	8.98	9.59	9.71	9.71	10.11	11.19	11.45	11.66	11.65	11.75	11.96	11.70	10.66	11.28
	Expenditure	c	2.59	2.87	3.05	2.94	2.89	2.99	3.14	3.55	3.69	3.69	3.84	4.59	4.92	5.01	5.36	5.64	5.74	5.73	6.29	7.22
Total	Consumption	a	205	200	201	192	185	185	185	191	211	242	269	290	299	316	344	368	364	421	509	576
	Price	b	7.53	8.50	9.14	9.45	10.06	10.57	10.79	11.28	11.00	10.35	10.22	10.99	11.29	11.29	11.17	11.12	11.18	10.41	9.48	9.42
	Expenditure	c	15.43	17.00	18.37	18.14	18.61	19.55	19.96	21.54	23.22	25.05	27.50	31.88	33.76	35.69	38.43	40.91	40.71	43.82	48.23	54.28

Sources: For consumption see previous Table 10.
For prices see previous Table 19b

TABLE 20

Electricy in the United Kingdom and Scotland: Prices and Expenditure

Table 20a United Kingdom

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	Sales in million therm	692	775	810	918	992	1149	1305	1559	1785	1787	1953	2041	2128	2275	2464	2629	2754	2966	3114	3157
Domestic	Price in pence/therm	18.41	19.26	19.84	20.84	20.63	.9.93	20.02	20.37	20.84	21.81	22.63	23.3	23.09	25.97	25.15	24.56	26.38	27.99	28.31	33.83
	Expenditure in m	127.40	149.27	160.70	191.31	204.65	229.00	261.26	317.57	371.99	369.74	441.96	475.55	491.36	590.82	619.70	645.68	726.51	830.18	881.57	1069.59
	Sales in million therm	1086	1160	1222	1272	1384	1546	1599	1653	1732	1915	1998	2052	2078	2258	2400	2491	2506	2497	2727	2589
Industrial	Price in pence/therm	14.45	15.39	15.97	16.32	15.62	15.33	16.15	16.47	16.76	16.68	17.44	18.05	18.49	18.87	18.87	19.43	21.81	21.66	21.75	29.89
	Expenditure in m	156.93	178.52	195.15	207.59	216.18	237.00	258.24	272.25	290.28	319.42	348.45	370.39	384.22	426.08	452.88	484.00	546.56	540.85	593.12	773.85
	Sales in million therm	71	71	74	73	76	77	78	82	82	81	80	85	88	90	93	94	94	91	89	92
Traction	Price in pence/therm	13.86	14.77	15.45	15.65	15.36	15.09	15.88	15.04	15.04	16.68	17.12	16.65	16.97	17.09	16.50	16.65	19.58	19.69	20.63	28.37
	Expenditure in m	9.84	10.49	11.43	11.42	11.67	11.62	12.39	12.33	12.33	13.51	13.70	14.15	14.93	15.38	15.35	15.65	18.41	17.92	18.36	26.10
Public +	Sales in million therm	400	437	457	513	545	627	682	781	863	904	991	1044	1097	1197	1288	1353	1403	1449	1562	1444
Misscella-neous +	Price in pence/therm	22.27	23.56	23.59	24.24	24.03	23.53	23.86	23.69	24.18	24.85	25.64	26.26	26.35	28.55	27.75	27.78	28.63	31.74	31.95	38.98
Agriculture (1)	Expenditure in m	89.08	102.96	107.81	124.35	130.96	147.53	162.73	186.58	208.67	224.64	254.09	274.15	289.06	341.74	357.42	375.86	401.68	459.91	499.06	562.87
	Sales in million therm	2249	2443	2563	2776	2997	3399	3664	4075	4462	4687	5022	5222	5391	5820	6245	6567	6757	7003	7492	7282
Total	Price in pence/therm	17.04	18.06	18.54	19.26	18.80	18.39	21.53	19.36	21.23	20.21	21.07	21.72	21.88	23.61	23.14	23.16	25.06	26.40	26.59	33.40
	Expenditure in m	383.25	441.24	475.09	534.67	563.46	625.15	694.62	788.73	883.27	947.31	1058.2	1134.2	1179.5	1374.0	1445.3	1521.1	1693.1	1848.8	1992.1	2432.4

Note: (1) The price figures are obtained from the data for United Kingdom Public Supply from the United Kingdom Digest of Energy Statistics (See for example Table 71 of 1974 Digest). The price of electricity supplied by industry is assumed to be the same as that supplied by Public Authorities and hence the price of public supply is used for the U.K. as a whole.

(2) For consumption see previous Table 11b.

Table 20b North of Scotland Hydro Electric Board

Notation: a = Sales in million therm
b = Total expenditure in £ million
c = Average price in Pence/therm

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	14.4	16.1	17.3	19.4	21.1	23.8	27.4	32.9	38.1	41.1	47.8	53.6	56.7	62.7	70.2	78.4	79.4	83.8	95.2	96.8
	b	2.62	3.18	3.48	4.06	4.39	5.0	5.55	6.48	7.58	8.06	9.34	10.89	11.84	14.02	15.28	16.82	19.48	22.46	24.53	29.96
	c	18.3	19.76	20.14	20.9	20.8	20.96	20.23	19.67	19.89	19.58	19.53	20.32	20.9	22.36	21.78	21.45	24.53	26.79	25.76	30.95
Industrial	a	11.8	12.2	12.6	12.8	13.0	14.6	15.3	16.8	17.2	19.3	19.8	21.3	21.9	25.2	28.8	26.2	39.4	53.2	81.6	82.2
	b	2.03	2.31	2.4	2.54	2.58	2.93	3.08	3.45	3.66	3.97	4.24	4.57	4.62	5.14	5.71	5.56	7.87	10.09	11.86	23.3
	c	17.28	18.93	19.1	19.77	19.82	20.08	20.16	20.58	21.31	20.54	21.44	21.41	21.09	20.4	19.84	21.19	19.99	18.96	14.54	28.34
Total	a	36.2	39.9	42.0	46.0	48.5	54.7	60.8	70.2	78.8	84.8	94.5	103.9	108.6	119.7	134.0	142.9	157.7	177.4	221.8	220.5
	b	6.72	8.03	8.58	9.66	10.29	11.77	12.85	14.75	17.06	18.03	20.18	22.63	23.92	27.32	29.92	31.99	38.28	44.7	49.92	68.11
	c	18.58	20.15	20.42	20.99	21.21	21.53	21.13	21.02	21.65	21.25	21.35	21.79	22.02	22.83	22.33	22.39	24.28	25.2	22.51	30.89
All Other Consumers (By subtraction)	a	10.0	11.6	12.1	13.8	14.4	16.3	18.1	20.5	23.5	24.4	26.9	29.9	30.0	31.8	35.0	38.3	38.9	40.4	45.2	41.5
	b	2.06	2.54	2.7	3.06	3.32	3.84	4.22	4.82	5.82	6.0	6.6	7.17	7.46	8.16	8.93	9.61	10.93	12.15	13.53	14.85
	c	20.46	21.96	22.12	22.25	23.11	23.69	23.29	23.54	24.75	24.66	24.52	24.75	24.82	25.69	25.51	25.15	28.05	30.1	30.04	35.76

Table 20 c South of Scotland Electricity Board

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	a	48.1	53.5	56.8	65.4	72.2	83.6	103.2	131.1	150.7	157.2	177.7	192.1	202.9	218.8	240.1	258.4	265.9	271.7	294.2	292.1
	b	8.18	9.81	10.33	11.47	13.28	15.26	18.2	22.91	27.67	28.59	32.25	36.84	39.47	44.38	47.99	52.03	63.36	70.79	78.12	88.19
	c	17.0	18.33	18.19	17.53	10.39	18.25	17.63	17.48	18.36	18.19	18.15	19.17	19.45	20.28	19.99	20.13	23.83	26.05	26.55	30.19
Industrial	a	87.9	93.8	97.5	98.2	101.0	109.4	115.7	122.1	128.4	140.9	149.9	155.8	158.8	166.2	175.0	178.2	173.8	169.6	185.1	175.1
	b	13.31	15.29	16.42	17.02	17.34	18.67	21.0	22.87	24.22	26.02	27.98	30.03	31.18	32.54	34.20	34.99	34.58	36.33	39.17	47.69
	c	15.13	16.3	16.83	17.33	17.16	17.07	18.15	18.72	18.87	18.47	18.66	19.27	19.64	19.58	19.55	19.64	19.90	21.42	21.16	27.34
Traction (1)	a	0.5	0.2		0.7	3.3	2.9	2.8	3.4	3.3	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.6	2.7	4.3
	b	0.07	0.03		0.1	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.5	0.5	0.5	0.5	0.6	1.1
	c	15.24	16.24		16.38	15.38	15.88	20.72	20.05	20.49	20.4	21.66	22.74	26.96	25.29	19.02	19.31	19.17	20.9	21.86	25.67
Total	a	166.3	180.8	189.8	204.4	219.6	244.1	275.8	318.5	350.8	373.5	411.2	436.7	455.1	485.8	523.4	551.2	556.6	557.0	609.1	587.8
	b	27.54	32.01	34.04	42.89	46.59	44.63	51.41	60.2	68.27	71.7	79.18	97.67	92.97	101.52	108.31	114.85	130.33	141.55	156.57	179.17
	c	16.56	17.7	17.94	17.96	18.31	18.29	18.64	18.85	19.46	19.20	19.26	20.08	20.43	20.9	20.69	20.84	23.42	25.41	25.7	30.48
All Other Consumers (By subtraction)	a	29.8	33.3	35.5	40.1	43.1	48.2	54.1	61.9	68.4	72.2	80.5	85.9	90.5	98.0	105.5	111.8	114.1	113.1	127.1	116.3
	b	6.05	6.91	7.29	8.11	9.15	10.25	11.61	13.54	15.68	16.39	18.25	20.1	21.52	23.9	25.62	27.33	31.89	33.93	38.68	41.99
	c	20.28	20.78	20.57	20.26	21.25	21.27	21.45	21.90	22.92	22.71	22.67	23.41	23.77	24.41	24.27	24.45	27.96	29.98	30.41	36.05

Sources: (Tables 20b and 20c) Digest of Energy Statistics
(Refer Table 71 of 1974 D.E.S.)
South of Scotland Electricity Board
North of Scotland Hydro Electric Board
Previous table of electricity consumption (for obtaining consumption figures in million therms)

Note: (1) Consumption figures are not available for year 1957.

Table 20d Scotland (Total)

Notation: a = Sales in million therms
b = Total expenditure in £million
c = Average price in Pence/Therm

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
	a	62.5	69.6	74.1	84.8	93.3	107.4	130.6	164.0	188.8	198.3	225.5	245.7	259.6	281.5	310.3	336.8	345.3	355.8	389.4	388.9
Domestic	b	10.81	12.99	13.81	15.53	17.67	20.26	23.75	29.39	35.25	36.65	41.59	47.73	51.31	58.40	63.27	68.85	82.84	93.25	102.65	118.15
	c	17.29	18.64	18.64	18.29	18.93	18.85	18.17	17.91	18.67	18.46	18.43	19.43	19.78	20.75	20.40	20.43	24.00	26.23	26.35	30.35
	a	99.7	106.0	110.1	110.0	114.0	124.0	131.0	138.9	145.6	160.2	169.7	177.1	180.7	191.4	203.8	204.4	213.2	222.8	266.7	257.3
Industrial	b	15.34	17.6	18.62	19.56	19.92	21.6	24.08	26.32	27.88	29.99	32.22	34.60	35.8	37.68	39.91	40.55	42.45	46.42	51.03	71.19
	c	15.39	16.62	17.09	17.61	17.47	17.44	18.38	18.93	19.17	18.73	18.99	19.55	19.81	19.69	19.58	19.84	19.93	20.84	19.14	27.67
	a	0.5	0.2		0.7	3.3	2.9	2.8	3.4	3.3	3.2	3.1	2.9	2.9	2.8	2.8	2.8	2.8	2.6	2.7	4.3
Traction	b	0.07	0.03		0.1	0.5	0.5	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.5	0.5	0.5	0.5	0.6	1.1
	c	15.24	16.24		16.38	15.38	15.88	20.72	20.05	20.49	20.40	21.66	22.74	26.96	25.29	19.02	19.31	19.17	20.90	21.88	25.67
	a	39.8	44.9	47.6	53.9	57.5	64.5	72.2	82.4	91.9	96.6	107.4	114.9	120.5	129.8	140.5	150.1	153.0	153.5	172.3	157.8
All Other Consumers	b	8.11	9.45	9.99	11.17	12.45	14.04	15.93	18.36	21.5	22.39	24.85	27.27	28.98	32.06	34.55	36.76	42.82	46.08	52.21	56.84
	c	20.34	21.07	21.01	20.97	21.68	21.81	22.05	22.31	23.39	23.20	23.14	23.75	24.03	24.72	24.58	24.51	27.98	30.01	30.32	37.81
	a	202.5	220.7	231.8	250.4	268.1	298.8	336.6	388.7	429.6	458.3	505.7	540.9	563.7	605.5	657.4	694.1	714.3	734.4	831.1	808.3
Total	b	34.26	40.04	42.62	46.37	50.49	56.4	64.26	74.77	85.33	89.73	99.36	110.3	116.89	128.84	138.23	146.84	168.61	186.25	206.49	247.28
	c	16.91	18.14	18.38	18.52	18.85	18.87	19.08	19.23	19.87	19.58	19.64	20.40	20.72	21.28	21.01	21.16	23.59	25.35	24.85	30.60

Compiled from figures for South of Scotland Electricity Board and North of Scotland Hydro-Electricity Board, quarterly statistics. See previous Table 12c

TABLE 21 Summary Tables: Prices and Expenditure on Energy: United Kingdom

Table 21a Prices (1)

All prices in Pence/Therm

United Kingdom		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Coal & Other Solid	1.82	2.32	2.46	2.60	2.65	2.86	3.02	3.25	3.45	3.55	3.67	4.01	4.22	4.27	4.54	5.1	5.54	5.97	5.93	7.27
	Petroleum & Other Liquid	4.69	5.67	4.92	5.08	5.17	5.17	5.86	5.88	5.88	6.8	6.8	6.8	6.99	6.95	6.8	7.08	7.7	8.32	10.7	15.0
	Gas	8.14	9.09	9.61	10.22	10.27	10.53	11.06	11.21	11.10	11.17	10.85	10.68	10.57	10.62	10.95	10.64	10.97	11.21	11.06	11.15
	Electricity	18.41	19.26	19.84	20.84	20.63	19.93	20.02	20.37	20.84	21.81	22.63	23.3	23.09	25.97	25.15	24.56	26.38	27.99	28.31	33.88
	All Energy	3.28	3.94	4.21	4.54	4.76	5.02	5.48	5.95	6.41	6.94	7.36	7.95	8.36	9.11	9.58	10.12	11.31	12.39	12.79	15.00
Industrial	Coal & Other Solid	1.77	2.02	2.15	2.19	2.19	2.32	2.39	2.40	2.53	2.66	2.68	2.68	2.68	2.79	3.00	3.51	4.14	4.66	5.08	7.16
	Petroleum & Other Liquid	2.16	2.62	2.72	2.29	2.09	1.99	1.83	2.05	1.92	1.80	1.68	1.78	2.07	2.26	2.23	2.23	3.34	3.2	3.12	7.38
	Gas	5.36	5.85	6.14	6.41	6.40	6.39	6.54	6.64	6.61	6.73	6.66	6.63	6.72	6.65	6.07	4.87	3.58	3.04	3.04	3.68
	Electricity	14.45	15.39	15.97	16.32	15.62	15.33	16.15	16.47	16.76	16.68	17.44	18.05	18.49	18.87	18.87	19.43	21.81	21.66	21.75	29.89
	All Energy	2.67	3.05	3.28	3.39	3.40	3.46	3.56	3.67	3.73	3.82	3.83	3.93	4.11	4.34	4.42	4.63	5.54	5.45	5.58	8.92
Transport	Coal & Other Solid	1.59	1.82	1.93	2.05	2.05	2.09	2.17	2.25	2.25	2.25	2.25	2.23	2.16	2.12	2.15	2.58	3.08	3.25	3.40	3.70
	Petroleum & Other Liquid	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.3	22.2	22.9	27.5	40.82
	Gas																				
	Electricity	13.86	14.77	15.45	15.65	15.36	15.09	15.88	15.04	15.04	16.68	17.12	16.65	16.97	17.09	16.50	16.65	19.58	19.69	20.63	28.37
	All Energy	8.03	10.92	8.59	9.24	9.60	10.10	11.29	11.67	12.16	14.29	14.91	16.36	17.50	20.25	20.84	22.11	22.08	22.82	27.40	40.66
Public and Commercial (including Agriculture)	Coal & Other Solid	1.88	2.14	2.24	2.27	2.28	2.37	2.44	2.45	2.61	2.72	2.73	2.74	2.74	2.91	3.05	3.39	3.69	4.00	4.35	6.19
	Petroleum & Other Liquid	2.74	3.75	3.09	2.93	3.08	3.02	3.65	3.57	3.60	3.58	3.61	3.65	4.15	4.13	3.95	4.79	5.18	5.56	8.00	12.68
	Gas	7.10	7.79	8.19	8.60	8.58	8.64	8.88	9.00	9.03	9.18	9.10	9.18	9.20	9.34	9.54	9.30	9.04	8.75	8.11	8.5
	Electricity	22.27	23.56	23.59	24.24	24.03	23.53	23.86	23.89	24.18	24.85	25.64	26.26	26.35	28.55	27.75	27.78	28.63	31.74	31.95	38.98
	All Energy	3.78	4.48	4.62	4.85	5.10	5.29	6.01	6.08	6.28	6.80	7.12	7.46	7.89	8.58	8.48	9.12	9.99	10.96	12.57	16.35
All Sectors	Coal & Other Solid	1.78	2.11	2.24	2.35	2.35	2.50	2.61	2.73	2.89	2.99	3.06	3.21	3.32	3.41	3.62	4.13	4.68	5.15	5.37	7.11
	Petroleum & Other Liquid	8.69	11.33	8.72	8.38	8.01	7.75	8.26	7.91	7.67	8.44	8.25	8.69	9.18	10.28	10.31	10.88	11.60	11.99	14.65	23.54
	Gas	6.90	7.59	7.95	8.41	8.39	8.41	8.76	9.02	9.04	9.11	9.03	9.10	9.20	9.29	9.42	8.72	7.96	7.45	7.08	7.50
	Electricity	17.04	18.06	18.54	19.26	18.80	18.39	21.53	19.36	21.23	20.21	21.07	21.72	21.88	23.61	23.14	23.16	25.06	26.40	26.59	33.40
	All Energy	3.89	4.83	4.59	4.92	5.10	5.28	5.78	6.03	6.30	6.89	7.13	7.67	8.19	9.09	9.36	9.96	10.91	11.48	12.80	18.12

(1) Prices for "All Energy are computed from expenditure and consumption figures (for consumption - see Table 13c)

Table 21b <u>Expenditure</u> All expenditure in £ million

UNITED KINGDOM		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Coal & Other Solid	220	280	282	307	288	323	325	359	379	348	357	370	361	355	355	364	340	322	316	366
	Petroleum & Other Liquid	14	21	18	27	30	35	43	50	58	62	66	66	70	77	83	95	102	127	178	222
	Gas	113	125	127	137	132	137	144	157	171	180	203	233	261	300	352	377	431	505	533	600
	Electricity	127	149	161	191	205	229	261	318	372	390	442	476	491	591	620	646	727	830	882	1070
	All Energy	474	575	588	662	655	724	773	884	980	980	1068	1145	1183	1323	1410	1482	1600	1784	1909	2258
Industrial	Coal & Other Solid	293	328	336	307	287	322	312	291	294	311	307	283	260	271	283	312	306	288	329	411
	Petroleum & Other Liquid	53	72	76	75	80	90	95	123	131	136	141	161	199	228	241	255	376	366	358	748
	Gas	64	73	79	81	81	90	89	85	86	96	97	94	92	95	91	91	104	126	158	201
	Electricity	157	178	195	208	216	237	258	272	290	319	348	370	384	426	453	484	547	541	593	774
	All Energy	567	651	686	671	664	739	754	771	801	862	893	908	935	1020	1068	1142	1333	1321	1438	2134
Transport	Coal & Other Solid	62	71	71	69	62	59	53	45	38	29	19	13	7	3	2	2	2	1	1	1
	Petroleum & Other Liquid	609	862	619	695	736	819	964	995	1058	1292	1374	1544	1715	2070	2206	2455	2549	2739	3509	5019
	Gas																				
	Electricity	10	10	11	11	12	12	12	12	12	14	14	14	15	15	15	16	18	18	18	26
	All Energy	681	943	791	775	810	890	1029	1052	1108	1335	1407	1571	1737	2088	2223	2473	2569	2758	3528	5046
Public and Commercial (including Agriculture)	Coal & Other Solid	80	86	84	82	74	74	69	73	81	72	71	66	59	57	59	59	46	44	42	65
	Petroleum & Other Liquid	22	34	29	34	41	52	56	64	75	75	83	90	110	124	131	172	189	209	304	423
	Gas	34	38	38	41	40	41	42	45	47	47	50	53	56	61	67	71	78	87	88	108
	Electricity	89	103	108	124	131	148	163	186	209	225	254	274	289	342	357	376	402	460	499	563
	All Energy	225	261	259	281	286	315	330	368	412	419	458	483	514	584	614	678	715	800	933	1159
All Sectors	Coal & Other Solid	655	765	773	765	711	778	759	768	792	760	754	732	687	686	699	737	694	655	688	843
	Petroleum & Other Liquid	698	989	742	831	887	996	1158	1322	1322	1565	1664	1861	2094	2499	2661	2977	3216	3441	4349	6412
	Gas	211	236	244	259	253	268	275	287	304	323	350	360	409	456	510	539	613	718	779	909
	Electricity	383	440	475	534	564	626	694	788	883	948	1058	1134	1179	1374	1445	1522	1694	1849	1992	2433
	All Energy	1947	2430	2234	2389	2415	2668	2886	3075	3301	3596	3826	4107	4369	5015	5315	5775	6217	6663	7808	10597

TABLE 22 Summary Tables: Prices and Expenditure: Scotland

Table 22a Prices[1]

Scotland		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Coal & Other Solid	2.13	2.71	2.88	3.04	3.10	3.35	3.53	3.80	4.04	4.18	4.19	4.58	4.68	4.90	5.09	5.81	6.26	6.67	6.73	8.43
	Petroleum & Other Liquid	4.66	5.61	4.87	5.01	5.11	5.11	5.79	5.82	5.82	6.73	6.73	6.73	6.97	6.89	6.73	7.01	7.58	8.22	10.63	14.94
	Gas	8.20	9.47	10.40	10.99	11.99	13.08	13.49	13.89	13.57	12.65	12.40	12.90	13.13	13.25	13.14	13.08	13.78	14.01	14.29	14.19
	Electricity	17.29	18.64	18.64	18.29	18.93	18.85	18.17	17.91	18.67	18.46	18.43	19.43	19.78	20.75	20.40	20.43	24.00	26.23	26.35	30.36
	All Energy	3.34	4.11	4.35	4.64	4.93	5.38	5.65	6.18	6.78	7.25	7.60	8.60	9.20	9.84	10.12	11.06	12.99	14.44	14.91	17.40
Industrial	Coal & Other Solid	1.84	2.18	2.23	2.36	2.34	2.48	2.54	2.64	2.79	3.03	3.07	3.03	2.99	3.28	3.59	4.15	4.82	5.47	6.18	9.19
	Petroleum & Other Liquid	2.16	2.62	2.72	2.29	2.09	1.99	1.83	2.05	1.92	1.80	1.68	1.78	2.07	2.26	2.23	2.23	3.34	3.20	3.12	7.38
	Gas	6.17	6.63	6.91	6.76	6.81	6.95	7.04	7.48	7.49	7.42	7.51	7.86	7.86	7.86	7.84	7.59	6.52	4.96	4.17	4.27
	Electricity	15.39	16.62	17.09	17.61	17.47	17.44	18.38	18.93	19.17	18.73	18.99	19.55	19.81	19.69	19.58	19.84	19.93	20.84	19.14	27.67
	All Energy	2.62	3.07	3.19	3.40	3.41	3.45	3.56	3.85	3.92	3.98	4.02	4.13	4.28	4.44	4.57	4.74	5.58	5.57	5.64	9.64
Traction	Coal & Other Solid	1.61	1.87	1.97	2.13	2.11	2.17	2.21	2.48	2.54	2.57	2.54	2.50	2.33	2.33	2.41	2.79	3.26	3.45	3.47	
	Petroleum & Other Liquid	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.30	22.20	22.90	27.50	40.82
	Gas																				
	Electricity	15.24	16.24		16.38	15.38	15.88	20.72	20.05	20.49	20.40	21.66	22.74	26.96	25.29	19.02	19.31	19.17	20.90	21.88	25.67
	All Energy	6.70	9.22	7.28	8.17	8.71	9.22	10.57	11.42	12.00	14.16	14.58	16.32	17.81	20.49	21.05	22.22	22.15	22.90	27.46	40.79
Public and Commercial (including Agriculture)	Coal & Other Solid	1.92	2.30	2.28	2.37	2.39	2.43	2.49	2.65	2.82	2.93	2.94	2.93	2.73	2.83	3.04	3.32	3.54	3.69	4.03	4.77
	Petroleum & Other Liquid	2.74	3.75	3.09	2.93	3.08	3.02	3.65	3.57	3.60	3.58	3.61	3.65	4.15	4.13	3.95	4.79	5.18	5.56	8.00	12.68
	Gas	6.99	7.77	8.24	8.17	8.51	8.8	8.98	9.59	9.71	9.71	10.11	11.19	11.45	11.66	11.65	11.75	11.96	11.70	10.66	11.28
	Electricity	20.34	21.07	21.01	20.97	21.68	21.81	22.05	22.31	23.39	23.20	23.14	23.75	24.03	25.72	24.58	24.51	27.98	30.01	30.32	37.81
	All Energy	3.77	4.65	4.56	4.70	4.75	4.88	5.22	5.97	6.61	6.63	6.92	7.30	7.41	7.79	8.22	8.86	9.88	10.41	12.32	15.67
All Sectors	Coal & Other Solid	1.91	2.32	2.41	2.57	2.59	2.73	2.86	3.10	3.29	3.42	3.42	3.59	3.61	3.85	4.12	4.67	5.21	5.65	6.17	8.20
	Petroleum & Other Liquid	8.65	11.38	8.62	8.35	8.21	7.84	8.29	7.95	7.69	8.17	7.85	8.09	8.39	9.48	9.43	9.85	10.50	10.54	12.77	20.44
	Gas	7.53	8.50	9.14	9.45	10.06	10.57	10.79	11.28	11.00	10.35	10.22	10.99	11.29	11.29	11.17	11.12	11.18	10.41	9.48	9.42
	Electricity	16.91	18.14	18.38	18.52	18.85	18.87	19.08	19.23	19.87	19.58	19.64	20.40	20.72	21.28	21.01	21.16	23.59	25.35	24.85	30.60
	All Energy	3.70	4.70	4.43	4.80	5.04	5.21	5.68	6.17	6.54	6.94	7.08	7.75	8.21	9.03	9.30	9.89	11.05	11.57	12.94	16.71

(1) Price of "All Energy" is computed from expenditure and consumption figures (for consumption see Table 14a)

Table 22b Expenditure

All expenditure figures in £million

Scotland		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Coal & Other Solid	26	34	34	37	36	37	39	42	43	38	37	36	34	35	35	35	32	29	33	37
	Petroleum & Other Liquid	1	2	1	2	2	3	3	4	4	4	5	5	5	6	6	7	7	9	14	19
	Gas	10	11	12	12	13	13	13	14	15	15	16	20	22	23	24	26	27	30	33	36
	Electricity	11	13	14	16	18	20	24	29	35	37	42	48	51	58	63	69	83	93	103	118
	All Energy	48	60	61	67	69	73	79	89	97	94	100	109	112	122	128	137	149	161	183	210
Industrial	Coal & Other Solid	33	38	37	35	31	36	34	29	29	34	35	29	25	27	30	33	30	28	33	42
	Petroleum & Other Liquid	5	6	7	7	7	8	8	11	11	13	14	16	20	23	25	27	42	43	44	98
	Gas	3	3	3	3	3	4	4	4	5	6	8	8	8	8	9	9	8	8	9	11
	Electricity	15	18	19	20	20	22	24	26	28	30	32	35	36	38	40	41	43	46	51	71
	All Energy	56	65	66	65	61	70	70	70	73	83	89	88	89	96	104	110	123	125	137	222
Transport	Coal & Other Solid	8	10	10	9	8	8	7	5	4	3	3	1								
	Petroleum & Other Liquid	54	79	56	63	68	72	85	88	94	113	117	130	139	174	187	203	213	225	295	424
	Gas																				
	Electricity					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	All Energy	62	89	66	72	77	81	93	94	99	117	121	132	140	175	188	204	214	226	296	425
Public and Commercial (including Agriculture)	Coal & Other Solid	8	8	7	10	8	9	9	9	9	8	9	8	7	7	6	6	6	7	5	8
	Petroleum & Other Liquid	2	4	3	4	4	5	5	6	7	7	8	9	11	13	14	18	20	23	34	51
	Gas	3	3	3	3	3	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7
	Electricity	8	9	10	11	12	14	16	18	22	22	25	27	29	32	35	37	43	46	52	57
	All Energy	21	24	23	28	27	31	31	37	42	41	46	49	52	57	60	67	75	82	96	123
All Sectors	Coal & Other Solid	75	90	88	91	83	90	89	85	85	83	84	74	66	69	71	74	68	64	71	87
	Petroleum & Other Liquid	62	91	67	76	81	88	101	109	116	137	144	160	175	216	232	255	282	300	387	591
	Gas	16	17	18	18	19	20	20	22	24	25	28	33	35	36	38	41	41	44	48	54
	Electricity	34	40	43	47	51	57	65	74	86	90	100	111	117	129	139	148	170	186	207	247
	All Energy	187	238	216	232	234	255	275	290	311	335	356	378	393	450	480	518	561	594	713	892

TABLE 23

Prices of Effective Energy: United Kingdom (current prices)

All prices in pence/therm

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Domestic	Coal (1)	7.28	9.01	9.28	9.54	9.46	9.95	10.24	10.74	11.13	11.18	11.29	12.06	12.41	12.29	12.79	14.07	14.97	15.91	15.40	18.52
	Petroleum (2)	7.82	9.37	8.07	8.26	8.34	8.27	9.30	9.26	9.19	10.54	10.46	10.38	10.59	10.45	10.15	10.49	11.32	12.15	15.51	21.58
	Gas	13.57	15.02	15.75	16.62	16.56	16.85	17.56	17.65	17.34	17.32	16.69	16.31	16.02	15.97	16.34	15.76	16.13	16.36	16.03	16.04
	Electricity	25.22	26.39	27.18	28.55	28.26	27.30	27.43	27.91	28.55	29.88	31.00	31.92	31.63	35.58	34.46	33.65	36.14	38.35	38.78	46.42
	All Energy	10.45	12.16	12.60	13.16	13.26	13.60	14.27	14.95	15.48	16.18	16.61	17.32	17.53	18.44	18.67	18.99	20.56	21.40	21.71	24.96
Industrial	Coal (1)	2.96	3.37	3.59	3.66	3.66	3.87	3.99	4.01	4.23	4.44	4.48	4.48	4.48	4.66	5.01	5.66	6.91	7.78	8.48	11.96
	Petroleum (2)	3.09	3.75	3.89	3.27	2.99	2.85	2.62	2.93	2.75	2.57	2.40	2.55	2.96	3.23	3.19	3.19	4.79	4.58	4.46	10.55
	Gas	7.66	8.37	8.78	9.17	9.15	9.14	9.35	9.50	9.45	9.62	9.52	9.48	9.61	9.51	8.68	6.96	5.12	4.35	4.35	5.26
	Electricity	18.06	19.24	19.96	20.40	19.53	19.16	20.19	20.59	20.95	20.85	21.80	22.56	23.11	23.59	23.59	24.29	27.26	27.08	27.19	37.36
	All Energy	4.25	4.84	5.20	5.33	5.31	5.39	5.51	5.65	5.70	5.81	5.81	5.93	6.17	6.50	6.59	6.87	8.15	7.96	8.15	13.12
Transport	Coal (1)	19.88	22.75	24.13	25.63	25.63	26.13	27.13	28.13	28.13	28.13	28.13	27.88	27.00	26.50	26.88	32.35	38.50	40.63	42.50	46.25
	Petroleum (2)	58.91	76.91	60.26	61.04	59.61	59.36	62.12	60.93	60.93	68.85	68.85	73.53	76.84	87.56	89.96	95.30	94.87	98.28	118.13	175.95
	Gas																				
	Electricity	23.15	24.67	25.80	26.14	25.65	25.20	26.52	25.12	25.12	27.86	28.59	27.81	28.34	28.54	27.56	27.81	32.70	32.88	34.45	47.38
	All Energy	48.96	65.78	51.44	53.10	53.30	54.01	57.31	57.21	57.63	65.85	66.56	71.75	75.11	85.81	88.31	93.69	92.77	97.11	116.60	173.02
Public and Commercial (including Agriculture)	Coal (1)	3.76	4.24	4.39	4.41	4.38	4.51	4.60	4.58	4.83	4.99	4.96	4.94	4.69	5.15	5.35	5.90	6.36	6.04	7.37	10.40
	Petroleum (2)	4.22	5.75	4.72	4.46	4.67	4.56	5.49	5.35	5.37	5.32	5.35	5.39	6.10	6.05	5.77	6.97	7.51	8.03	11.51	18.18
	Gas	10.92	11.94	12.50	13.08	13.00	13.04	13.35	13.48	13.48	13.65	13.48	13.55	13.53	13.68	13.93	13.53	13.10	12.64	11.67	12.19
	Electricity	35.85	37.93	37.98	39.03	36.69	37.88	38.41	38.46	38.93	40.01	41.28	42.28	42.42	45.97	44.68	44.73	46.09	51.10	51.44	62.76
	All Energy	7.00	8.16	8.32	8.58	8.87	9.03	10.17	10.20	10.43	11.15	11.56	11.97	12.52	13.45	13.19	14.05	15.21	16.56	18.90	24.51
All Sectors	All Energy	8.68	10.69	10.00	10.70	10.87	11.05	11.94	12.28	12.60	13.48	13.74	14.61	15.42	16.90	17.17	18.08	19.66	20.43	22.70	32.13

(1) Includes other solid fuels

(2) Includes other liquid fuels

TABLE 24

United Kingdom: Consumption of and Expenditure on Domestic Energy and Private Transport Energy

All consumption is in million therms
All expenditure is in £ million

Table 24a Domestic

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Final Energy Consumption	(a)	14318	14502	13880	14499	13693	14425	14071	14880	15261	14095	14520	14407	14154	14529	14720	14643	14141	14395	14925	15051
Effective Energy Consump.	(b)	4498	4707	4636	5010	4918	5316	5410	5919	6323	6047	6433	6615	6755	7171	7546	7798	7850	8334	8797	9049
Expenditure	(c)	474	575	588	662	655	724	773	884	980	980	1068	1145	1183	1323	1410	1482	1600	1784	1909	2258

Table 24b Private Cars and Motor Cycles

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Consumer expenditure on Petrol and Oil (1)	(d)	122	136	144	172	197	226	260	302	330	382	470	539	608	714	809	859	942	1093	1250	1718
Price of petrol, pence/therm (2)	(e)	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.38	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.30	22.20	22.90	27.50	40.82
Final Energy Consumption (3)	(f)	900	740	1026	1220	1424	1624	1774	2100	2295	2361	2905	3119	3382	3485	3842	3852	4243	4773	4545	4209
Effective Energy Consumption @ 20% of (f)	(g)	180	148	205	244	285	327	355	420	459	472	581	624	676	697	769	770	849	955	909	842
Assume 50% Private: Effective Energy	(h)	90	74	103	122	143	164	178	210	230	236	291	312	338	349	385	385	425	478	455	421
Assume 50% Private: Expenditure	(i)	61	68	72	86	99	113	130	151	165	191	235	270	304	357	405	430	471	547	625	859

Table 24c Public Service Vehicles (Buses etc.) and Taxis

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Final Energy Consumption (5) (Thousand Ton)	(j)	1045	1015	945	950	944	948	952	967	993	1023	1037	1030	1036	1045	1055	1048	1015	1015	995	974
Final Energy (million therms) (6)	(k)	460	446	414	414	414	416	418	424	436	450	456	452	452	460	464	460	446	446	438	428
Effective Energy @ 28% of k	(l)	129	125	116	116	116	116	117	119	122	126	128	127	127	129	130	129	125	125	123	120
Price of DERV fuel (7) pence/therm	(m)	11.38	15.45	11.70	11.77	12.02	11.89	12.66	11.89	12.78	14.18	14.18	15.20	15.71	17.93	18.89	18.89	19.15	21.10	24.40	36.45
Expenditure	(n)	52	68	48	48	50	50	52	50	56	64	64	68	72	82	88	86	86	94	106	156
Assume 50% Private: Effective Energy	(o)	65	63	58	58	58	58	59	60	61	63	64	64	64	65	65	65	63	63	62	60
Assume 50% Private: Expenditure	(p)	26	34	24	24	25	25	26	25	28	32	32	34	36	41	44	43	43	47	53	78

Table 24d Railways[8]

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Solid Fuel	Final energy (q)	3912	3876	3680	3384	3040	2816	2462	2016	1674	1278	866	586	304	124	96	84	58	32	28	24
	Effective Energy (9) (r)	313	310	294	271	243	225	197	161	134	102	69	47	24	10	8	7	5	3	2	2
	Expenditure (s)	62	71	71	69	62	59	53	45	38	29	19	13	7	3	2	2	2	1	1	1
Gas/ Diesel Oil	Final Energy (t)			18	33	59	105	223	279	328	369	402	410	420	452	470	498	471	445	446	416
	(Price, pence/therm)	3.58	4.53	3.98	3.90	4.03	3.90	4.58	4.53	4.66	4.53	4.53	4.58	5.09	5.15	4.88	5.64	5.95	6.28	9.38	13.98
	Effective Energy (10) (u)			5	9	17	29	62	78	92	103	113	115	118	127	132	139	132	125	125	116
	Expenditure (v)				1	3	4	10	13	15	17	18	19	21	23	23	28	28	28	42	58
Elec-tricity	Final Energy (w)	72	72	74	74	76	78	78	82	82	82	80	86	88	90	94	94	94	92	90	92
	Effective Energy (11) (x)	44	44	44	44	46	46	46	50	50	50	48	52	52	54	56	56	56	56	54	55
	Expenditure (y)	10	10	11	11	12	12	12	12	12	14	14	14	15	15	15	16	18	18	18	26
Total Railways	Effective Energy (z)	357	354	343	324	306	300	305	289	276	255	230	167	194	191	196	202	193	164	181	173
	Expenditure (ab)	72	81	82	81	77	75	75	70	65	60	51	46	43	41	40	46	48	47	61	85
Assume 25% Private	Effective Energy (ac)	179	177	172	162	153	150	153	145	138	128	115	84	97	96	98	101	97	92	91	87
	Expenditure (ad)	18	20	21	20	19	19	19	18	16	15	13	12	11	10	10	12	12	12	15	21

Table 24e Aviation

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Final Energy (12)	(ae)	771	796	740	710	739	801	977	954	1011	1038	1077	1163	1309	1421	1484	1533	1684	1793	1910	1675
Price of Aviation Fuel, pence/therm (13)	(af)	4.20	5.44	4.61	4.40	4.54	4.40	4.54	4.96	4.96	4.82	4.82	4.87	5.42	5.48	5.20	5.62	6.36	6.78	8.57	16.16
Expenditure	(ag)	32	43	34	31	34	35	44	47	50	50	52	57	71	78	77	86	107	122	164	271
Effective Energy @ 28%	(ah)	216	223	207	199	207	224	274	267	283	291	302	326	367	398	416	429	472	502	535	469
Assume 50% Private: Effective Energy	(ai)	108	112	104	100	104	112	137	134	142	146	151	163	184	199	208	215	236	251	268	235
Assume 50% Private: Expenditure	(aj)	16	22	17	16	17	18	22	24	25	25	26	29	36	39	39	43	54	61	82	136

Table 24f Total of Domestic and Private Transport

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total Effective Energy b + h + 0 + ac + ai	(ak)	4940	5133	5073	5452	5376	5800	5937	6468	6894	6620	7054	7238	7438	7880	8302	8564	8671	9218	9673	9852
Total expenditure c + i + p + ad + aj	(al)	595	719	722	808	815	899	970	1102	1214	1243	1374	1490	1570	1770	1908	2010	2180	2451	2684	3352

(1) Source: National Income and Expenditure Blue Book, see Table 29 of 1975 publication; Consumers' expenditure on petrol and oil was available for the years 1964 to 1974. Prior to 1964 thé information available was for the category "running cost of motor vehicles". Since the expenditure under the heading "expenditure on petrol and oil" is about half that under the heading "running cost of motor vehicles" during the years 1964 to 1974, the expenditure under the former headings was assumed to be half of that of the second category during the years 1955 to 1963.

(2) See Table 21a

(3) Obtained by column (d) and (e)

(4) See P.G. Gray, Private Motoring in England and Wales, H.M.S.O. 1969, page 35.

(5) Source: Digest of Energy Statistics. See Table 37 of 1974 Digest. Figures obtained by addition of consumption figures for both Motor Spirit and Derv Fuel.

(6) See Table 1b for converstion to therms from tons.

(7) Source: Institute of Petroleum

(8) Source: for consumption, Digest of Energy Statistics, see Table 10 of 1974 Digest. Source: for prices: Table 21a and Institute of Petroleum. The proportion of private transport is assumed to be 25% for two reasons. Passenger Transport 50% of total and private consumption of passenger transport is again 50%. See Chapter 8 for details.

(9) Efficiency of steam engine @ 8%

(10) Efficiency of diesel engine @ 28%

(11) Efficiency of electric engine @ 60%

(12) Source: Digest of Energy Statistics, see Table 10 of 1974 Digest

(13) Sooure: Institute of Petroleum.

TABLE 25

Scotland: Consumption of and Expenditure on Domestic Energy and Private Transport Energy

All consumption in million therms
All expenditure in £million

Table 25a Domestic

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Effective Energy	(a)	437	465	454	482	482	486	518	556	578	552	581	588	588	614	646	660	633	642	708	710
Expenditure	(b)	48	60	61	67	69	73	79	89	97	94	100	109	112	122	128	137	149	161	183	210

Table 25b Private Cars and Motor Cycles

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
United Kingdom	Total Motor Spirit Consumption (1)	(c)	2821	2858	2597	2494	3220	3447	3616	3815	4032	4466	4809	5071	5420	5759	5971	6328	6658	7040	7530	7331
	Of which consumption by the consumer (2)	(d)	900	740	1026	1220	1424	1634	1774	2100	2295	2361	2905	3119	3382	3485	3843	3852	4243	4773	4545	4209
	Ratio of d:c	(e)	.32	.26	.39	.41	.44	.47	.49	.55	.57	.53	.60	.61	.62	.60	.64	.61	.64	.67	.60	.57
	50% of (e) used as Private Transport	(f)	.16	.13	.195	.205	.22	.235	.245	.275	.285	.265	.30	.305	.31	.30	.32	.305	.32	.335	.30	.285
Scotland	Total Motor Spirit Consumption (1)	(g)	231	232	211	239	255	269	287	302	320	350	367	381	397	429	450	465	503	534	583	562
	Private Transport Consumption = g × f	(h)	37.0	30.2	41.1	49.0	56.1	63.2	70.3	83.1	91.2	92.8	110.1	116.2	123.1	128.7	144.0	141.8	161.0	178.9	174.9	160.5
	Effective Energy at 20% of (h)	(i)	7.4	6.0	8.2	9.8	11.2	12.6	14.1	16.6	18.2	18.6	22.0	23.2	24.6	25.7	28.8	28.4	32.2	35.8	35.0	32.1
	Price, pence/therm	(j)	13.55	18.39	14.04	14.10	13.83	13.83	14.66	14.39	14.38	16.18	16.18	17.28	17.98	20.49	21.05	22.3	22.2	22.9	27.5	40.82
	Expenditure £m = h × j	(k)	5.0	5.6	5.8	6.9	7.8	8.7	10.3	11.9	13.1	15.0	17.8	20.1	22.1	26.4	30.3	31.6	35.7	41.0	48.1	65.5

Table 25c Public Service Vehicles (Buses etc) and Taxis

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
United Kingdom	Total Derv Consumption (3) (l)	700	785	784	895	995	1128	1241	1329	1447	1591	1683	1766	1879	2006	2098	2173	2243	2270	2445	2378
	Of which consumption by PS Vehicle (4) (m)	460	446	414	414	414	416	418	424	436	450	456	452	452	460	464	460	446	446	438	428
	Ratio of m : l (n)	.65	.56	.53	.46	.41	.37	.34	.32	.30	.28	.27	.25	.24	.23	.22	.21	.20	.20	.18	.18
	50% of m used as Private Transport (o)	.325	.28	.265	.23	.205	.185	.17	.16	.15	.14	.135	.125	.12	.115	.11	.105	.10	.10	.09	.09
Scotland	Total Derv consumption (3) (p)	81	90	91	104	112	122	132	144	152	163	168	172	174	198	210	209	213	223	239	225
	Private consumption of PSV = p × o (q)	26.6	25.5	24.3	23.9	23.1	22.6	22.5	23.1	22.9	22.9	22.8	21.6	20.9	22.8	23.2	22.0	21.8	22.3	21.5	20.3
	Effective Energy at 28% of(q) (r)	7.4	7.1	6.8	6.7	6.5	6.3	6.3	6.5	6.4	6.4	6.4	6.0	5.9	6.4	6.5	6.2	6.1	6.2	6.0	5.7
	Price, pence/therm (s)	11.38	15.45	11.70	11.77	12.02	11.89	12.66	11.89	12.78	14.18	14.18	15.20	15.71	17.93	18.89	18.89	19.15	21.1	24.4	36.45
	Expenditure £m = q × s (t)	3.0	3.9	2.8	2.8	2.8	2.7	2.8	2.7	2.9	3.2	3.2	3.3	3.3	4.1	4.4	4.2	4.2	4.7	5.2	7.4

Table 25d Railways

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Solid Fuel (5)	Final energy (u)	527	536	506	436	389	355	295	209	169	127	101	56	10	4	4	4	2	2	2	-
	Effective energy (v)	42	43	40	35	31	28	24	17	14	10	8	4	1							
	Expenditure (w)	8.4	10.0	10.0	9.4	8.2	7.8	6.6	5.2	4.8	3.4	2.6	1.4	0.2							
Gas/ Diesel Oil (6)	Final energy (x)	-	-	2	3	6	11	22	28	33	37	40	41	42	45	47	50	47	45	45	42
	Effective Energy (y)	-	-	0.6	0.8	1.7	3.1	6.2	7.8	9.2	10.4	11.2	11.5	11.8	12.6	13.2	14.0	13.2	12.6	12.6	11.8
	Expenditure (z)	-	-	-	0.1	0.3	0.4	1.0	1.3	1.5	1.7	1.8	1.9	2.1	2.3	2.3	2.8	2.8	2.8	4.2	5.8
Electricity	Final Energy (aa)	1	-	-	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	Effective Energy (ab)	1	-	-	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	Expenditure (ac)	0.6	-	-	-	0.6	0.6	0.6	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.6	0.6	0.6	0.6	0.6	0.6
Total Railways	Effective Energy (ad)	43	43	41	37	35	33	32	27	25	22	21	18	15	15	15	16	15	15	15	14
	Expenditure (ae)	9.0	10.0	10.0	9.5	9.1	8.8	8.2	7.3	7.1	5.9	5.2	4.1	3.1	3.1	2.9	3.4	3.4	3.4	4.8	6.4
Assume 25% Private	Effective Energy (af)	10.8	10.8	10.3	9.3	8.8	8.3	8.0	6.8	6.3	5.5	5.3	4.5	3.8	3.8	3.8	4.0	3.8	3.8	3.8	3.5
	Expenditure (ag)	2.3	2.5	2.5	2.4	2.3	2.2	2.1	1.8	1.8	1.5	1.3	1.0	0.8	0.8	0.7	0.9	0.9	0.9	1.2	1.6

Table 25e Aviation

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Final Energy	(ah)	59.8	77.5	62.3	60.6	60.2	79.5	96.5	87.0	98.4	96.1	96.7	103.5	116.4	129.4	133.2	140.6	155.1	143.7	162.3	151.4
Price of Aviation, Fuel, pence/therm	(ai)	4.20	5.44	4.61	4.40	4.54	4.40	4.54	4.96	4.96	4.82	4.82	4.87	5.42	5.40	5.20	5.62	6.36	6.78	8.57	16.16
Expenditure	(aj)	2.5	4.2	2.9	2.7	3.6	3.5	4.4	4.3	4.9	4.6	4.7	5.0	6.3	7.1	6.9	7.9	9.9	9.7	13.5	24.46
Effective Energy @ 28%	(ak)	16.7	21.7	17.4	17.0	22.5	22.3	27.0	24.4	27.6	26.9	27.1	29.0	32.6	36.2	37.3	39.4	43.4	40.2	45.4	42.4
Assume 50% Private { Effective Energy	(al)	8.4	10.9	8.7	8.5	11.3	11.2	13.5	12.2	13.8	13.5	13.6	14.5	16.3	18.1	18.7	19.7	21.7	20.1	22.7	21.2
Expenditure	(am)	1.3	2.1	1.5	1.4	1.3	1.8	2.2	2.2	2.5	2.3	2.4	2.5	3.2	3.6	3.5	4.0	5.0	4.9	7.0	12.2

Table 25f Total of Domestic and Private Transport

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Total Effective Energy a + i + r + af + ak	(an)	479.3	510.6	496.7	524.8	531.0	535.5	573.4	610.3	636.5	609.4	641.8	650.7	654.9	686.1	722.4	738.0	718.5	728.0	797.2	793.7
Total Expenditure b + k + t + ag + am	(ao)	59.6	74.1	73.5	80.5	83.7	88.4	96.4	107.6	117.3	116.0	124.7	135.9	141.4	156.9	166.9	177.7	195.0	212.5	244.5	296.7

(1) See Table 7b for U.K. and Table 8b for Scotland

(2) See Table 24b

(3) See Table 7b for U.K. and Table 8b for Scotland

(4) See Table 24c

(5) See Table 14a. Efficiency used for effective energy is 8 per cent

(6) Consumption in Scotland is taken to be 10% of U.K. consumption.
See Table 24d for U.K. Efficiency used for effective energy is 28%.

Note: Prices for all petroleum produces (i.e. motor spirit, Derv fuel etc) are the same as that for the U.K. - See Table 24.

TABLE 26 United Kingdom: Consumer demand for energy and non-energy

Table 26(a) Energy measured in effective energy unit

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Retail price index RPI(t)		(a)	81.33	83.64	86.76	89.38	89.87	90.77	94.06	98.07	100.00	103.28	108.20	112.45	115.45	120.66	127.22	135.33	148.07	158.59	173.17	200.97
Total consumers' expenditure £m	Current prices	(b)	13088	13744	14509	15296	16117	16923	17835	18923	20118	21477	22864	24246	25447	27375	29033	31472	35075	39635	45141	51670
	Constant 1963	(c)	16093	16433	16723	17113	17933	18644	18961	19295	20118	20795	21132	21562	22041	22688	22821	23256	23688	24992	26068	25710
Consumers' expenditure on energy £m	Current prices	(d)	595	719	722	808	815	899	970	1102	1214	1243	1374	1490	1570	1770	1908	2010	2180	2451	2684	3352
	Constant 1963	(e)	732	860	832	904	907	990	1031	1124	1214	1204	1270	1325	1360	1467	1500	1485	1472	1545	1550	1668
Consumption of effective energy QE(t) in million therm		(f)	4940	5133	5073	5452	5376	5800	5937	6468	6894	6620	7054	7238	7438	7880	8302	8564	8671	9218	9673	9852
Price of effective energy PE £/therm	Constant prices PE(t)	(g)	0.1204	0.1401	0.1423	0.1482	0.1516	0.1550	0.1634	0.1704	0.1761	0.1878	0.1948	0.2059	0.2111	0.2246	0.2298	0.2347	0.2514	0.2659	0.2775	0.3402
	Constant 1963	(h)	0.1482	0.1675	0.1640	0.1658	0.1687	0.1707	0.1737	0.1738	0.1761	0.1819	0.1800	0.1831	0.1828	0.1662	0.1807	0.1734	0.1698	0.1676	0.1602	0.1693
$\frac{PE(t)}{PE(0)} = \frac{g}{0.1761}$		(i)	0.6837	0.7956	0.8081	0.8416	0.8609	0.8802	0.9279	0.9676	1.00	1.0664	1.1062	1.1692	1.1988	1.2754	1.3049	1.3328	1.4276	1.5099	1.5788	1.9319
$\frac{\alpha(0).PE(t).100}{PE(0)} = i \times 6.034$		(j)	4.1227	4.7975	4.8728	5.0748	5.1912	5.3076	5.5952	5.8346	6.034	6.4303	6.6704	7.0503	7.2288	7.6907	7.8685	8.0368	8.6084	9.1047	9.5021	11.649
$1-\frac{\alpha(0).PE(t).100}{PE(0).RPI(t)} = 1-\frac{i}{RPI(t)}$		(k)	0.9493	0.9426	0.9438	0.9432	0.9422	0.9415	0.9405	0.9405	0.9397	0.9397	0.9384	0.9373	0.9374	0.9363	0.9382	0.9406	0.9419	0.9426	0.9451	0.0420
$\tilde{P}c(t) = \frac{k}{1-\alpha(0)} = \frac{k}{1-0.9397}$		(l)	101.0	100.3	100.4	100.4	100.3	100.2	100.1	100.1	100.0	99.8	99.9	99.8	99.8	99.6	99.8	100.1	100.2	100.3	100.6	100.3
Consumers' expenditure on non-energy at 1963 prices £m = c − e		(m)	15361	15573	15891	16209	17026	17654	17930	18171	18904	19561	19862	20237	20681	21221	21321	21771	22216	23447	24518	24042
Quantity of non-energy Qc(t) = m/l		(n)	152.1	155.3	158.3	161.4	169.8	176.2	179.1	181.5	189.0	196.0	198.8	202.8	207.2	213.1	213.6	217.5	221.7	233.8	243.7	239.7

The basic equation is

$$\tilde{P}c(t) = \frac{RPI(t) - \alpha(0)\frac{PE(t)}{PE(0)}.100}{[1-\alpha(0)].RPI(t)} = \frac{1 - \frac{\alpha(0).PE(t).100}{PE(0).RPI(t)}}{1-\alpha(0)}$$

where $\tilde{P}c(t)$ **is the price of non energy at constant 1963 prices**

$\alpha(0)$ **is the weight of energy expenditure to total consumers' expenditure (0.0634)**

PE(t) is price of energy

PE(0) is price of energy in 1963

RPI(t) is retail price index

Table 26(b) Energy measured in final energy unit

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
Retail price index RPI(t)		(a)	81.33	83.64	86.76	89.38	89.87	90.77	94.06	98.07	100.00	103.28
Total consumers' expenditure £m	Current prices	(b)	13088	13744	14509	15296	15117	16923	17835	18923	20118	21477
	Constant 1963	(c)	16093	16433	16723	17113	17933	18644	18961	19295	20118	20795
Consumers' expenditure on energy £m	Current prices	(d)	595	719	722	808	815	899	970	1102	1214	1243
	Constant 1963	(e)	732	860	832	904	907	990	1031	1124	1214	1204
Consumption of final energy QE(t) in million therm		(f)	17376	17467	16858	17379	16569	17349	17037	17808	18181	16909
Price of final energy PE £/therm	Current prices PE(t)	(g)	0.0342	0.0412	0.0429	0.0465	0.0492	0.0518	0.0569	0.0619	0.0668	0.0735
	Constant 1963	(h)	0.0421	0.0492	0.0492	0.0520	0.0547	0.0571	0.0605	0.0631	0.0668	0.0712
$\frac{PE(t)}{PE(0)} = \frac{g}{0.0668}$		(i)	0.5120	0.6168	0.6422	0.6961	0.7365	0.7755	0.8518	0.9266	1.00	1.1033
$\frac{a(0).PE(t).100}{PE(0)} = i \times 6.034$		(j)	3.0894	3.7218	3.8750	4.2003	4.4440	4.6794	5.1398	5.5911	6.034	6.6573
$1-\frac{a(0).PE(t).100}{PE(0).RPI(t)} = 1-\frac{i}{RPI(t)}$		(k)	0.9620	0.9555	0.9533	0.9530	0.9506	0.9484	0.9454	0.9430	0.9397	0.9355
$\tilde{P}c(t) = \frac{k}{1-a(0)} = \frac{k}{1-0.9397}$		(l)	102.4	101.7	101.7	101.4	101.2	100.9	100.6	100.4	100.0	99.6
Consumers' expenditure on non-energy at 1963 prices £m = c − e		(m)	15361	15573	15891	16209	17026	17654	17930	18171	18904	19561
Quantity of non-energy Qc(t) = m/l		(n)	150.1	153.2	156.3	159.8	167.9	174.9	178.2	181.1	189.0	196.5

			1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Retail price index RPI(t)		(a)	108.20	112.45	115.45	120.66	127.22	135.33	148.07	158.59	173.17	200.97
Total consumers' expenditure £m	Current prices	(b)	22864	24246	25447	273'5	29033	31472	35075	39635	45141	51670
	Constant 1963	(c)	21132	21562	22041	22688	22821	23256	23688	24992	26068	25710
Consumers' expenditure on energy £m	Current prices	(d)	1374	1490	1570	1770	1908	2010	2180	2451	2684	3352
	Constant 1963	(e)	1270	1325	1360	1467	1500	1485	1472	1545	1550	1668
Consumption of final energy QE(t) in million therm		(f)	17413	17314	17132	17546	17946	17904	17640	18187	18653	18534
Price of final energy PE £/therm	Current prices PE(t)	(g)	0.0789	0.0860	0.0917	0.1009	0.1064	0.1122	0.1235	0.1348	0.1439	0.1809
	Constant 1963	(h)	0.0729	0.0765	0.0794	0.0836	0.0836	0.0829	0.0834	0.0850	0.0831	0.0900
$\frac{PE(t)}{PE(0)} = \frac{g}{0.0668}$		(i)	1.1811	1.2874	1.3728	1.5105	1.5928	1.6796	1.8488	2.0180	2.1542	2.7081
$\frac{a(0).PE(t).100}{PE(0)} = i \times 6.034$		(j)	7.1268	7.7682	8.2835	9.1144	9.6110	10.1347	11.156	12.177	12.998	16.341
$1-\frac{a(0).PE(t).100}{PE(0).RPI(t)} = 1-\frac{i}{RPI(t)}$		(k)	0.9341	0.9309	0.9283	0.9245	0.9245	0.9251	0.9247	0.9232	0.9249	0.9187
$\tilde{P}c(t) = \frac{k}{1-a(0)} = \frac{k}{1-0.9397}$		(l)	99.4	99.1	98.8	98.4	98.4	98.4	98.4	98.2	98.4	97.8
Consumers' expenditure on non-energy at 1963 prices £m = c − e		(m)	19862	20237	20681	21221	21321	21771	22216	23447	24518	24042
Quantity of non-energy Qc(t) = m/l		(n)	199.8	204.3	209.4	215.7	216.7	221.2	225.8	238.7	249.1	245.9

Notes: **Row (f) is obtained from Table 24**

For the basic equation see Table 26(a)

TABLE 27 Consumers' Expenditure in Scotland

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Consumers' expenditure at current prices - Begg's estimate (1) £m	(a)							1586.4	1638.8	1718.3	1895.3	2031.0	2137.3	2236.5	2375.6	2503.9	2748.3	3047.8			
Average weekly household expenditure - Family expenditure survey (2) £	(b)							16.765	17.321	17.877	19.640	20.831	22.382	22.59	24.20	24.69	29.00	28.84	33.01	39.22	45.92
Average number of persons per household (3)	(c)							3.26	3.26	3.27	3.24	3.22	3.23	3.15	3.08	3.13	3.04	2.861	30.84	2.964	2.855
Population (mid-year estimate) (4) million	(d)	5.113	5.1119	5.1247	5.1412	5.1626	5.1777	5.1838	5.1975	5.2051	5.2085	5.2099	5.2066	5.1983	5.2002	5.2085	5.2137	5.2174	5.2104	5.2117	5.226
Consumers' expenditure constructed from F.E.S. £m = b × 52 × d/c	(e)							1386.3	1436.0	1479.7	1641.8	1752.6	1876.2	1938.5	2124.6	2136.5	2586.3	2734.9	2900.0	3589.9	4334.4
F.E.S. constructed data as ratio of Begg's Estimate = e/b (5)	(f)							.87	.88	.86	.87	.86	.88	.87	.89	.85	.94	.90			
For U.K. average weekly household expenditure from F.E.S. £	(g)			14.27	14.75	15.50	16.51	17.19	17.60	19.14	19.50	21.25	22.28	23.32	24.93	26.37	28.568	30.99	35.06	39.43	46.13
For U.K. average number of persons per houshold	(h)			3.08	3.14	3.08	3.04	3.03	3.03	3.02	3.06	2.96	3.03	3.00	2.96	2.96	2.946	2.899	2.917	2.824	2.834
U.K. - Polulation - million	(i)	50.946	51.184	51.430	51.652	51.956	52.372	52.807	53.273	53.552	53.886	54.219	54.503	54.802	55.048	55.262	55.418	55.610	55.793	55.933	55.968
U.K. - Consumers' expenditure as constructed from F.E.S. = g × 52 × i/h £ million	(j)			12382	12623	13590	14769	15578	16088	17672	17836	20224	20820	22140	24128	25603	27931	30919	34892	40612	
U.K. Consumers' expenditure - Blue Book £million	(k)	13088	13744	14509	15296	16117	16923	17835	18923	20118	21474	22864	24246	25447	27375	29033	31472	35075	39635	45141	51670
U.K., F.E.S. constructed data as ratio of Blue Book j/k(@(l)	(l)			.85	.83	.84	.87	.87	.85	.88	.83	.88	.86	.87	.88	.88	.89	.88	.88	.90	
Ratio of average expenditure Scotland: U.K. (Begg for Scotland, Blue Book for UK	(m)							.91	.89	.88	.91	.92	.92	.93	.92	.92.	.93	.93			
Assume Ratio of average expenditure per person between Scotland/U.K.	(n)	.90	.90	.90	.90	.90	.90	.91	.89	.88	.91	.92	.92	.93	.92	.92	.93	.93	.95	.95	.95
Consumers' expenditure in Scotland using ratio of (n) above and population ratio £ million	(o)	1182.1	1235.5	1301.2	1370.1	1441.4	1505.7												3516.4	3972.4	4583.4
Consumers' expenditure in Scotland (complete series)	(p)	1182.1	1235.5	1301.2	1370.1	1441.4	1505.7	1586.4	1638.4	1718.3	1895.3	2031.0	2137.3	2236.5	2375.6	2503.9	2748.3	3047.8	3516.4	3972.4	4583.4

(1) See Table 1, page 21 in "Expenditure in Scotland 1961-1971" by H.M. Begg et al.

(2) Source. Family Expenditure Survey. For the years 1962 to 1966 inclusive the F.E.S. gives the average expenditure figures for 3 years cumulative. The average for the 3 year period is assumed (in this table) to be the expenditure for the middle year. For 1961 the estimate is obtained by subtracting 1962 and 1963 estimated figures from the average figures for the 3 year period 1961 to 1963 multiplied by 3.

(3) Source: F.E.S.

(4) Source: Annual Abstract of Statistics

(5) The expenditure figures for 1969 and 1970 was constructed from 2 year estimate. This may have resulted in some error, due to the unweighting of the averages.

(6) As can be seen from column (f), both for the United Kingdom and Scotland, the data constructed from Family Expenditure Survey roughly equals to between 86 to 90% of that of the Blue Book and Begg's estimate respectively. This would imply that the complete series (column (p)) as obtained by using U.K. ratio for some years would be consistent with that of Begg's estimate which is used for the years 1961 to 1971 inclusive.

TABLE 28

Scotland: Consumer demand of energy and non-energy

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Retail price index RPI (t)		(a)	81.33	83.64	86.76	89.38	89.87	90.77	94.06	98.07	100.00	103.28	108.20	112.45	115.45	120.66	127.22	135.33	148.07	158.59	173.17	200.97
Total consumers' expenditure £m	Current prices	(b)	1182	1236	1301	1370	1441	1506	1586	1638	1718	1895	2031	2137	2237	2376	2504	2748	3048	3516	3972	4583
	Constant 1963	(c)	1453	1478	1500	1533	1603	1659	1686	1670	1718	1835	1877	1900	1938	1969	1968	2031	2058	2217	2294	2280
Consumers' expenditure on energy £m	Current prices	(d)	59.6	74.1	73.5	80.5	83.7	88.4	96.4	107.6	117.3	116.0	124.7	135.9	141.4	156.9	166.9	177.9	195.0	212.5	244.5	296.7
	Constant 1963	(e)	73.3	88.6	84.7	90.1	93.1	97.4	102.5	109.7	117.3	112.3	115.2	120.9	122.5	130.0	131.2	131.5	131.7	134.0	141.2	147.6
Consumption of effective energy Qe(t) in million therm		(f)	479.3	510.6	496.7	524.8	531.0	535.5	573.4	610.3	636.5	609.4	641.8	650.7	654.9	686.1	722.4	738.0	718.5	728.0	797.2	793.2
Price of effective energy PE £/therm	Current prices PE(t)	(g)	0.1243	0.1451	0.1480	0.1534	0.1576	0.1651	0.1681	0.1763	0.1843	0.1904	0.1943	0.2089	0.2159	0.2287	0.2310	0.2411	0.2714	0.2919	0.3067	0.3741
	Constant 1963	(h)	0.1529	0.1735	0.1705	0.1717	0.1753	0.1819	0.1788	0.1797	0.0843	0.1843	0.1795	0.1858	0.1871	0.1895	0.1816	0.1782	0.1833	0.1841	0.1771	0.1861
$\frac{PE(t)}{PE(0)} = \frac{g}{0.1843}$		(i)	0.6744	0.7873	0.8030	0.8323	0.8551	0.8958	0.9121	0.9566	1.00	1.0331	1.0543	1.1335	1.1715	1.2409	1.2534	1.3082	1.4726	1.5838	1.6641	2.0298
$\frac{\alpha(0).PE(t).100}{PE(0)} = i \times 6.828$		(j)	4.6048	5.3757	5.4829	5.6829	5.8386	6.1165	6.2278	6.5317	6.828	7.054	7.1988	7.7395	7.999	8.4729	8.5582	8.9324	10.054	10.814	11.362	13.860
$1 - \frac{\alpha(0).PE(t).100}{PE(0).RPI(t)} = 1 - \frac{i}{RPI(t)}$		(k)	0.9434	0.9357	0.9368	0.9364	0.9350	0.9326	0.9338	0.9334	0.9317	0.9317	0.9335	0.9312	0.9307	0.9298	0.9327	0.9340	0.9321	0.9318	0.9344	0.9310
$\tilde{P}c(t) = \frac{k}{1-\alpha(0)} = \frac{k}{0.9317}$		(l)	101.3	100.4	100.5	100.5	100.4	100.1	100.2	100.2	100.0	100.0	100.2	99.9	99.9	99.8	100.1	100.2	100.0	100.0	100.3	99.9
Consumers' expenditure on non-energy at 1963 prices £m = c - e		(m)	1380	1389	1415	1443	1510	1562	1584	1560	1601	1723	1762	1779	1816	1839	1837	1900	1926	2083	2153	2132
Quantity of non-energy Qc(t) = m/l		(n)	13.62	13.83	14.08	14.36	15.04	15.60	15.81	15.57	16.01	17.23	17.58	17.81	18.18	18.43	18.35	18.96	19.26	20.83	20.47	21.34

Note: For the basic equation see Table 26(a)

TABLE 29

United Kingdom: Derived demand of energy

Consumption in million therms (of effective energy)
Expenditure in £m

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Industry (1)		Consumption	13328	13440	13225	12590	12524	13729	13689	13672	14034	14804	15361	15305	15168	15715	16193	16642	16361	16619	17672	16278
		Expenditure	567	651	686	671	664	739	754	771	801	862	893	908	935	1020	1068	1142	1333	1321	1438	2134
Trans-port	Total (1)	Consumption	1390	1437	1364	1456	1522	1652	1795	1842	1920	2029	2110	2193	2313	2431	2520	2639	2744	2842	3025	2913
		Expenditure	681	943	701	775	810	890	1029	1052	1108	1335	1407	1571	1737	2088	2223	2473	2569	2758	3528	5046
	Private (2)	Consumption	442	426	437	442	458	484	527	549	571	573	621	623	683	709	756	766	821	884	876	803
		Expenditure	121	144	134	146	160	175	197	218	234	263	306	345	387	447	498	528	580	667	775	1094
	Industry & Commerce	Consumption	948	1011	927	1014	1064	1168	1268	1293	1349	1456	1489	1579	1630	1722	1764	1873	1923	1958	2149	2110
		Expenditure	560	799	567	629	650	715	832	834	874	1072	1101	1226	1350	1641	1725	1945	1989	2091	2753	3952
Public & miscellaneous (1)		Consumption	3212	3195	3114	3275	3225	3487	3242	3608	3946	3759	3963	4033	4104	4343	4656	4826	4706	4834	4935	4726
		Expenditure	225	261	259	281	286	315	330	368	412	419	458	483	514	584	614	678	715	800	933	1159
Total		Consumption	17488	17646	17266	16879	16813	18384	18199	18573	19329	20019	20813	20908	20902	21780	22613	23341	22990	23411	24756	23114
		Expenditure	1351	1717	1512	1581	1600	1769	1916	1973	2087	2353	2452	2617	2799	3245	3407	3765	4037	4212	5124	7245
		Average price (pence/therm)	7.73	9.70	8.76	9.37	9.52	9.62	10.53	10.62	10.80	11.75	11.78	12.52	13.39	14.90	15.07	16.13	17.56	17.99	20.70	31.34

(1) For consumption see Table 15
For expenditure see Table 21b

(2) For consumption see Table 24. The figures are obtained by adding effective energy consumption in Tables 24b, 24c, 24d and 24e.
For expenditure see Table 21b.

TABLE 30

United Kingdom: Labour, Capital and Energy in the production and distribution sector (derived demand)

Table 30(a) Labour (all industries)

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Employees in employment, million, new classifications (1)	(a)																	22.121	22.118	22.662	22.790
(a) with old classification (1)	(b)																	22.509			
Ratio (a)/(b)	(c)																	0.983			
Employee and unemployed (2) million	(d)	21.933	22.173	22.333	22.288	22.426	22.815	23.110	23.430	23.556	23.705	23.920	24.065	23.807	23.667	23.603					
Unemployed, million (2)	(e)	0.243	0.250	0.297	0.473	0.449	0.334	0.299	0.432	0.516	0.354	0.305	0.292	0.539	0.552	0.534					
Employed, million, (2) old classification	(f)	21.690	21.923	22.036	21.815	21.977	22.481	22.811	22.998	23.040	23.351	23.615	23.773	23.268	23.115	23.069	22.891				
Employed, million, new (3) classification = (f)×(c)	(g)	21.321	21.550	21.661	21.444	21.603	22.099	22.423	22.607	22.648	22.954	23.214	23.369	22.872	22.722	22.677	22.502	22.121	22.118	22.662	22.790
Average weekly hours worked index	(h)	100.0	99.5	99.0	98.3	99.1	98.3	97.2	96.3	96.5	97.4	96.3	94.3	94.3	94.7	94.7	93.4	91.6	91.2	92.9	90.4
Actual weekly hours	(i)	47.0	46.8	46.5	46.2	46.6	46.2	45.7	45.3	45.4	45.8	45.3	44.3	44.3	44.5	44.5	43.9	43.1	42.9	43.7	42.5
Total man-hours thousand million = (g)×(i)×52.143	(j)	52.25	52.59	52.52	51.66	52.49	53.24	53.43	53.40	53.61	54.82	54.83	53.98	52.83	52.72	52.62	51.51	49.71	49.48	51.55	50.50
Average hourly earnings index	(k)	100.0	108.4	114.0	118.9	123.2	132.5	141.9	148.4	154.3	166.1	181.6	196.2	204.1	219.8	236.5	(268.0)	(301.5)	(350.5)	(393.3)	(480.5)
Average weekly earnings, manufacturing & other industries £	(l)											19.59	20.3	21.38	23.00	24.82	28.05	30.93	35.82	40.92	48.63
Index of (l) with 1965 = 100	(m)											100.0	103.6	109.1	117.4	126.7	143.2	157.9	182.8	208.9	248.2
Average hourly earnings adjusted for weekly hours worked (4)	(n)											100.0	105.8	111.4	119.4	128.9	147.6	166.0	193.0	216.6	264.3
Adjusted average hourly earnings	(o)											(181.6)	(192.1)	(202.3)	(216.8)	(234.1)	268.0	301.5	350.5	393.3	480.0
Compare with (k)	(p)											181.6	196.2	204.1	219.8	236.5					
Average hourly earnings (5)	(q)	0.238	0.258	0.271	0.283	0.293	0.315	0.338	0.353	0.367	0.395	0.432	0.467	0.486	0.523	0.563	0.638	0.718	0.834	0.936	1.142

Notes:

(1) Until 1971 annual employment statistics were derived mainly from counts of national insurance cards. In 1971 a new system was introduced because of proposals to abolish the national insurance cards for employees within the next few years. The new systems relies on returns from employers. In order to provide a link between the old system and the new system, both a card count and a census of employment under the new system were taken in 1971.

(2) In the old classification system, owing to the use of national insurance card count, the figures from employment also included those who were unemployed but were holding national insurance cards.

Sources for:

(a) Table 144 of 1974 Annual Abstract of Statistics and Table 146 of 1975 AAS.
(b) Table 141 of 1973 AAS
(d) Table 129 of 1965 AAS for the years 1955-1956, Table 130 of 1968 AAS for the years 1957 to 1967 and Table 147 of 1972 AAS for the years 1968 to 1970
(e) Table 140 of 1965 AAS and its equivalents for earlier and later years.
(h) & (i) Table 226 of the Department of Employment Gazette, Feb. 1971 and Table 121 of Jan 1976 D.E. Gazette
(k) Table 226 of D.E. Gazette of Feb. 1971 for the years 1955 to 1969 and row (0) of Table 30a for estimation of data for the years 1970 to 1974
(l) Table 163 of 1975 AAS

TABLE 30(b)

Employment in the energy sector as proportion of total employment

			1955	1956	1957	1958	1959	1960
Total employment, million		(a)	21.933	22.173	22.376	22.290	22.346	22.702
Total employment in energy industries, million	Coal mining, million	(b)	0.787	0.785	0.795	0.786	0.768	0.703
	Coal and petroleum products, million	(c)	0.058	0.060	0.061	0.063	0.060	0.059
	Gas, million	(d)	0.147	0.145	0.142	0.140	0.136	0.130
	Electricity, million	(e)	0.203	0.205	0.211	0.211	0.212	0.214
	Total, million	(f)	1.195	1.195	1.209	1.200	1.176	1.106
Ratio of employment in energy industries = f/a		(g)	0.0545	0.0539	0.0540	0.0538	0.0526	0.0487
Correction factor = 1 - g		(h)	0.9455	0.9461	0.9460	0.9462	0.9474	0.9513

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
(a)	22.037	23.354	23.470	23.616	23.920	24.065	23.807	23.667	23.603	23.446	23.234	22.120	22.662	22.790
(b)	0.668	0.649	0.625	0.596	0.565	0.518	0.496	0.446	0.407	0.382	0.368	0.379	0.363	0.349
(c)	0.059	0.050	0.049	0.047	0.047	0.045	0.046	0.051	0.050	0.056	0.051	0.034	0.033	0.032
(d)	0.128	0.128	0.129	0.126	0.124	0.126	0.129	0.130	0.127	0.127	0.123	0.112	0.108	0.10[illegible]
(e)	0.222	0.230	0.237	0.242	0.251	0.261	0.260	0.249	0.238	0.226	0.218	0.198	0.192	0.192
(f)	1.077	1.057	1.040	1.011	0.987	0.950	0.931	0.876	0.822	0.791	0.760	0.723	0.696	0.67[illegible]
(g)	0.0468	0.0453	0.0443	0.0428	0.0413	0.0395	0.0391	0.0370	0.0348	0.0337	0.0327	0.0327	0.0307	0.029[illegible]
(h)	0.9532	0.9547	0.9557	0.9572	0.9587	0.9605	0.9609	0.9630	0.9652	0.9663	0.9673	0.9673	0.9693	0.970[illegible]

Sources: (1) For 1955 to 1958, Table 135, page 106 of 1960 AAS
(2) For 1959 to 1960, Table 134, page 106 of 1962 AAS
(3) For 1961 to 1964, Table 130, page 110 of 1965 AAS
(4) For 1965 to 1968, Table 136, page 124 of 1969 AAS
(5) For 1969 to 1971, Table 148, page 133 of 1972 AAS
(6) For 1972 to 1974, Table 146, page 145 of 1975 AAS

TABLE 30(c)

Labour (excluding energy industries)

		1955	1956	1957	1958	1959	1960
Labour, thousand million man-hours (unadjusted)	(a)	52.25	52.59	52.52	51.66	52.49	53.24
Correction factor	(b)	0.9455	0.9461	0.9460	0.9462	0.9474	0.9513
Corrected labour = a × b	(c)	49.43	49.75	49.68	48.87	49.71	50.63

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
(a)	53.43	53.40	53.61	54.82	54.83	53.98	52.83	52.72	52.62	51.51	49.71	49.48	51.55	50.50
(b)	0.9532	0.9547	0.9557	0.9572	0.9587	0.9605	0.9609	0.9630	0.9652	0.9663	0.9673	0.9673	0.9693	0.970[illegible]
(c)	50.92	51.0	51.25	52.46	52.58	51.87	50.77	50.77	50.78	49.76	48.07	47.85	49.95	49.04

Note: For row (a) see row (d) of Table 30(a)

TABLE 30(d)

Capital (all industries)

		1955	1956	1957	1958	1959	1960
Net capital stock (excluding personal sector), £000m	(a)	29.8	32.3	35.1	36.9	37.5	40.2
GDFCF at current prices £m	(b)	2829	3103	3381	3485	3736	4120
GDFCF at 1970 prices £m	(c)	4379	4581	4825	4844	5238	5743
$q(t) = \frac{\text{GDFCF (current)}}{\text{GDFCF (1970)}} \times 100$	(d)	64.6	67.7	70.1	71.9	71.3	71.7
r(t) = Yield on industrial ordinary shares	(e)	5.43	6.25	6.27	6.23	4.83	4.60
Price of capital services P(t) = q(t).r(t) = d × e	(f)	350.8	423.1	439.5	447.9	344.4	329.8
Quantity of capital = $\frac{a}{d}$	(g)	461.3	477.1	500.7	513.2	525.9	560.7

	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
(a)	43.3	46.4	49.5	55.0	59.9	64.2	69.3	76.3	84.6	95.8	[illegible]	126.2	[illegible]	[illegible]
(b)	4615	4726	4899	6041	6502	6917	7520	8168	8564	9360	10378	[illegible]	[illegible]	[illegible]
(c)	6288	6254	6359	7541	7899	8092	8771	9175	9191	9380	9544	9754	[illegible]	[illegible]
(d)	73.4	75.6	77.0	80.1	82.3	85.5	85.7	89.2	93.2	100.0	108.7	118.4	133.0	165.7
(e)	5.12	5.57	4.40	4.63	5.54	5.67	5.16	3.69	3.90	4.52	3.96	3.31	4.10	8.0
(f)	375.8	421.1	338.8	370.9	455.9	484.8	442.2	329.1	363.5	452.0	430.5	391.9	565.8	1325.
(g)	589.9	613.8	642.9	686.6	727.8	750.9	808.6	855.4	907.7	958.0	993.6	1065.9	1137.0	1191.

Sources: (a) Table 72 of National Income and Expenditure statistics 1975 and its equivalent for earlier years.

(b) & (c) Table 63 of N.I.E. and its equivalent for earlier years.

(e) Table 400 of 1975 AAS and its equivalent for earlier years.

* Figures for 1974 are subject to errors, particularly for r(t).

TABLE 30(e) Capital in the energy sector

Table 30(e)/1 Coal mining

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Gross capital in mining and quarrying, £'000m	(a)	1.15	1.20	1.25	1.30	1.4	1.4	1.5	1.5	1.5	2.1	2.1	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.5	2.8
Total output in mining and quarrying £m (net)	(b)									771					727						
Output in mining £m	(c)									655					546						
Ratio of mining output to total of mining and quarrying = $\frac{c}{b}$	(d)									0.85					0.75						
Ratio for all years (assume)	(e)	0.85	[illegible]	[illegible]	0.85	0.85	0.85	0.85	0.85	0.85	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75
Gross capital estimated for coal mining = e × a	(f)	1.0	[illegible]	[illegible]	1.1	1.2	1.2	1.3	1.3	1.3	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.9	2.1

Notes:

(1) Gross capital stocks for 1955 to 1963 were obtained from Table 66, p.80 of 1967 N.I.E. statistics. The figures relate to capital stock at 1958 replacement cost. Figures for the years 1955, 1956, 1957, 1959, 1960 were not available. Figures were estimated by linear interpolation of figures for 1954, 1958 and 1961. For the years 1964 to 1974 figures were obtained from Table 73, page 82 of 1975 N.I.E.. The figures refer to stock at 1970 replacement prices.

For rows (b) and (c) figures were obtained from 1963 Census and 1968 Census of Production.

Table 30(e)/2 Coal products and petroleum refining

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Gross capital stock in petroleum and chemical sector £'000m	(a)	2.3	2.4	2.6	2.7	2.8	2.9	3.1	3.3	3.4	5.3	5.6	5.9	6.2	6.6	6.9	7.3	7.7	8.0	8.1	8.4
Output in the petroleum sector £m (net)	(b)														155						
Index of output in the petroleum sector	(c)	45.9	48.9	48.2	51.9	55.5	60.8	63.4	62.2	64.2	70.4	75.0	79.7	76.4	84.0	92.1	100.0	103.4	102.6	110.0	106.1
Output in the petroleum sector = b × c	(d)	85	91	89	96	103	112	117	115	119	130	139	147	141	155	171	185	191	190	204	196
Output in the chemical and allied sector £m (net)	(e)														1334						
Index of output in the chemical & allied sector	(f)	39.4	42.0	44.4	45.7	50.6	55.9	56.7	58.9	63.3	69.7	74.6	78.8	83.4	89.9	95.0	100.0	102.2	108.1	121.6	128.0
Output in the chemical and allied sector = e × f	(g)	585	623	659	678	751	830	841	874	939	1034	1107	1169	1238	1334	1410	1484	1517	1604	1805	1900
Total output, petroleum refining + chemical = d + g	(h)	670	714	748	774	854	942	958	989	1058	1164	1246	1316	1379	1489	1581	1669	1708	1794	2009	2096
Ratio $\frac{d}{h}$	(i)	0.13	0.13	0.12	0.12	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.11	0.11	0.11	0.11	0.10	0.09
Capital in the coal products & petroleum sector = a × i	(j)	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.6	0.6	0.6	0.6	0.7	0.8	0.8	0.8	0.9	0.8	0.8

Notes:

(1) See general comment under note (1) for Table 30(e)/1 above.

For rows (b) and (e) figures were obtained from 1963 Census and 1968 Census of Production.
For rows (c) and (f) figures were obtained from Table 15, page 18 of 1975 N.I.E.

TABLE 30(e)/3 Gas Industry

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Gross capital £'000 m	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.7	1.7	1.9	2.2	2.4	2.6	2.7	2.8	2.9	2.9	3.0

Note: (1) See general comment under note (1) for Table 30(e)/1

TABLE 30(e)/4 Electricity industry

	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Gross capital £'000m	3.5	3.7	3.9	4.1	4.3	4.6	4.9	5.2	5.5	8.3	9.0	9.8	10.5	11.0	11.4	11.7	12.0	12.2	12.4	12.5

Note: (1) See general comment under note (1) for Table 30(e)/1

TABLE 30(e)/5

Capital in the energy industry sector as proportion of total capital

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Gross capital all industries £'000m	(a)	76.9	78.9	80.9	82.9	85.5	88.1	90.8	93.8	96.7	140.9	146.6	152.6	159.1	165.9	172.6	179.5	186.4	193.4	200.6	207.7
Gross capital energy sector £'000m	(b)	5.7	5.9	6.3	6.5	6.8	7.1	7.6	8.0	8.3	12.2	12.9	14.0	15.0	15.8	16.5	16.9	17.4	17.8	18.0	18.4
Ratio $\frac{a}{b}$	(c)	0.10	0.10	0.10	0.10	0.10	0.10	0.11	0.11	0.11	0.11	0.11	0.11	0.12	0.12	0.12	0.12	0.11	0.11	0.11	0.11
Correction factor 1 - c	(d)	0.90	0.90	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.89

For row (a), regarding the source, see general comment under note (1) for Table 30(e)/1

TABLE 30(f) Capital (excluding energy industries)

		1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Quantity of capital	(a)	461.3	477.1	500.7	513.2	525.9	560.7	589.9	613.8	642.9	686.6	727.8	750.9	808.6	855.4	907.7	958.0	993.6	1065.9	1137.0	1191.9
Correction factor	(b)	0.90	0.90	0.90	0.90	0.90	0.90	0.89	0.89	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.89
Corrected capital = a × b	(c)	415.2	429.4	450.6	461.9	473.3	504.6	525.0	546.3	572.2	611.1	647.7	668.3	711.6	752.8	798.8	843.0	884.3	948.7	1011.9	1060.8

For row (a), see row (g) of Table 30(d)
For row (b), see row (d) of Table 30(e)/5

TABLE 30(g)

Summary Table

			1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974
Energy	Quantity, m.th	(a)	17488	17646	17266	16879	16813	18384	18199	18573	19329	20019	20813	20908	20902	21780	22613	23341	22990	23411	24756	23114
	Price, £/th	(b)	0.0773	0.097	0.0876	0.0937	0.0952	0.0962	0.1053	0.1062	0.108	0.1175	0.1178	0.1252	0.1339	0.149	0.1507	0.1613	0.1756	0.1799	0.207	0.3134
	Expenditure £m	(c)	1351	1711	1512	1581	1600	1769	1916	1973	2087	2353	2452	2617	2799	3245	3407	3765	4037	4212	5124	7245
Labour	Q = th.m. man-hours	(d)	49.43	49.75	49.68	48.87	49.71	50.63	50.92	51.0	51.25	52.46	52.58	51.87	50.77	50.77	50.78	49.76	48.07	47.85	49.95	49.04
	P = £/man-hour	(e)	0.238	0.258	0.271	0.283	0.293	0.315	0.338	0.353	0.367	0.395	0.432	0.467	0.486	0.523	0.563	0.638	0.718	0.834	0.936	1.142
	Expenditure £m	(f)	11764	12836	13463	13830	14565	15948	17211	18003	18809	20722	22715	24223	24674	26553	28589	31747	34515	39907	46753	56004
Capital	Q	(g)	415.2	429.4	450.6	461.9	473.3	504.6	525.0	546.3	572.2	611.1	647.7	668.3	711.6	752.8	798.8	843.0	884.3	948.7	1011.9	1060.8
	P	(h)	350.8	423.1	439.5	447.9	344.4	329.8	375.8	421.1	338.8	370.9	455.9	484.8	442.2	329.1	363.5	452.0	430.5	391.9	565.8	1325.6
	E = Q × P	(i)	1457	1817	1980	2069	1630	1664	1973	2300	1939	2267	2953	3240	3147	2477	2904	3810	3807	3718	5725	14062
Total expenditure = c + f + i		(j)	14572	16364	16955	17480	17795	19381	21100	22276	22835	25342	28120	30080	30620	32275	34900	39322	42358	47837	57602	77311

For energy, see Table 29