

FINAL REPORT

ELECTRICITY SATURATION IN SOUTH AFRICA

R K DUTKIEWICZ

T C STOFFBERG

Energy Research Institute
University of Cape Town
P.O. Box 33
Plumstead 7800
South Africa

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**National Energy Council
Private Bag X 03
LYNNWOOD RIDGE
0040**

**Nasionale Energieraad
Privaatsak X03
LYNNWOODRIF
0040**

**Tel: (012) 348-9564/5/6
Fax: (012) 348-9676
Telegr: ENERGOS
Telex: 320063 SA**

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EXECUTIVE SUMMARY

This report describes a method of determining the saturation levels of electricity in a country's energy balance. Use is made of the mathematical properties of S-curves, and a range of curves have been used to produce a fit for historical data. A comparison has been made between the various curves, using regression techniques, to select the best fit curve in each case. The Gompertz, Logistic, and Middelhoek equations have been used and it has been found that in most cases the Middelhoek expression gives the best correlation.

A novel approach to saturation determination has been introduced by considering the relationship between the percentage utilization of electricity and the usage of the other energy forms. Together all the separate energy forms in the final energy demand must add up to 100%. Where there have been changes in the orderly progression to an asymptote for a particular energy form, such as the changes in the shape of the oil curve following the 1970's energy crises, then it has been found possible to combine energy forms or to determine the shape of one of the components by finding the difference between the total energy demand and the energy demand of the other components.

Besides fitting an S-curve to the electricity usage, a similar exercise has been adopted to determine the long-term asymptotic values for the other energy forms. It has been found that following the energy crises of the 1970's the use of oil has dropped significantly with, in some cases, gas taking over the role of oil. Such substitution has normally not affected the electricity saturation curve.

The saturation or long-term equilibrium values for the energy components of each country are shown in Table A below.

Table A Asymptotic values from the saturation curves for the selected countries

Country	Long-term equilibrium values %		
	Electricity	Coal	Oil & Gas
Australia	25,9	14,2	59,9
Germany	23,0	12,0	65,0
South Africa	33,0	34,0	33,0
United Kingdom	15,9	10,5	73,6
USA	22,0	9,5	68,5

It has been determined that the time when the electricity saturation curve reaches 99% of its saturation value varies from 1988 to 2016. Details are given in the Table below.

Table B Years taken off the electricity saturation curves for the selected countries

Country	Year for inflection	Year for 99% saturation
Australia	1985	2012
Germany	1977	1993
South Africa	1980	2000
United Kingdom	1963	1988
U S A	1974	2016

It is easy to understand that the electricity saturation level in South Africa is higher than that of the northern hemisphere countries because of the differences in the percentage use of energy for heating purposes. It is more difficult, however, to understand why there is such a difference between Australia and South Africa. Without detailed statistics for energy usage in each sector, it is not possible to investigate this further in this report.

The South African electricity saturation curve shows that electricity will continue to grow at the expense of other energy forms, especially coal, until the end of the century. Thereafter electricity will grow at the same annual rate as the total final energy demand. The high rate of electricity growth which was being experienced in the 1960's and 1970's will therefore not be repeated and the growth, by the turn of the century, will be linked to the required energy growth to sustain economic growth.

CONTENTS

	<u>Page</u>
EXECUTIVE SUMMARY	i
CONTENTS	iv
1. INTRODUCTION	1
2. ELECTRICITY IN SOUTH AFRICA	3
3. ANALYSIS	3
4. METHODOLOGY	6
4.1 Introduction	6
4.2 Choice between possible sigmoidal equations	7
4.3 Detailed procedure	9
4.4 Difficulties arising from a limited span of the data	10
4.5 "Two-cycle" growth curves	11
5. SOUTH AFRICA	11
5.1 Introduction	11
5.2 Results	12
6. AUSTRALIA	13
6.1 Introduction	13
6.2 Results	15
7. GERMANY	16
7.1 Introduction	16
7.2 Results	16
8. UNITED KINGDOM	17
8.1 Introduction	17
8.2 Results	20
9. UNITED STATES OF AMERICA	21
9.1 Introduction	21
9.2 Results	21
10. DISCUSSION	22
11. REFERENCES	26
12. APPENDICES	29

LIST OF TABLES

	<u>Page</u>
Table A Asymptotic values from the saturation curves for the selected countries	ii
Table B Years taken off the electricity saturation curves for the selected countries	ii
Table 1 South Africa - values from saturation curves	13
Table 2 Curve fitting to Australian Electricity saturation	14
Table 3 Australia - values from saturation curves	15
Table 4 Germany - values from saturation curves	17
Table 5 United Kingdom - values from saturation curves	20
Table 6 United States - values from saturation curves	21
Table 7 Electricity saturation values for selected countries	22
Table 8 Coal - saturation values for selected countries	23
Table 9 Saturation values for selected countries	24
Table 10 Percentages of electricity and coal, and oil and gas, in the final energy demand of the selected countries	25

APPENDICES - TABLES

AUSTRALIA

TABLES 1 - 5 29 - 33

GERMANY

TABLES 6 - 10 35 - 39

SOUTH AFRICA

TABLES 11 - 13 42 - 44

UNITED KINGDOM

TABLES 14 - 25 46 - 61

UNITED STATES

TABLES 26 - 38 63 - 76

LIST OF FIGURES

	<u>Page</u>
Figure 1	South Africa - Final energy demand 73
Figure 2	Contribution of energy sources to final energy demand in South Africa 74
Figure 3	South Africa - Role of electricity in final energy demand 75
Figure 4	Difference between annual growth rate (Electricity - Energy) 76
Figure 5	South Africa - Coal 77
Figure 6	South Africa - Electricity 78
Figure 7	South Africa - Oil 79
Figure 8	South Africa - Total 80
Figure 10	Australia - Electricity 83
Figure 11	Australia - Oil 84
Figure 12	Australia - Gas 85
Figure 13	Australia - Oil & gas 86
Figure 14	Australia - Total energy 87
Figure 15	Germany - Coal 88
Figure 16	Germany - Electricity 89
Figure 17	Germany - Oil 90
Figure 18	Germany - Gas 91
Figure 19	Germany - (Coal & oil) 92
Figure 20	Germany - Final energy 93
Figure 21	United Kingdom - Coal 94
Figure 22	United Kingdom - Electricity 95
Figure 23	United Kingdom - Oil 96
Figure 24	United Kingdom - Gas 97
Figure 25	United Kingdom - Total 98
Figure 26	United Kingdom - Coal 99
Figure 27	United Kingdom - Electricity 100
Figure 28	United Kingdom - (Gas & oil) 101
Figure 29	United Kingdom - (Oil & gas) 102
Figure 30	United Kingdom - Final demand 103
Figure 31	United Kingdom - (Gas & oil) 104
Figure 32	USA - Coal 105
Figure 33	USA - Electricity 106
Figure 34	USA - Electricity 107
Figure 35	USA - (Oil and gas) 108
Figure 36	USA - (Oil and gas) 109
Figure 37	USA - Total energy 110
Figure 38	Comparison of curves 111

1. INTRODUCTION

The development of electricity as an energy form has significantly changed the rate of industrial development and hence the economy of countries. The use of electricity can be divided into two historical divisions - that period when electricity was being used as an alternative to other forms of energy, and especially to the use of coal, and the more recent period when manufacturing and information systems were changing because of the potential introduced by electricity. Thus in the pre-electricity times machine tools were driven from a central lay-shaft which served a number of machines and which was driven by a prime mover such as a steam engine.

When electricity was introduced, it started off as a straight replacement for the prime mover, and the steam engine was replaced by a central electric motor. Subsequently, with the growing use of electricity, individual machines were driven by their own electric motor. This process allowed for greater flexibility in the layout of factories and in the efficiency of energy utilization since individual motors could be sized to drive a machine at the optimum operating point of the electric motor.

Schurr et al⁽¹⁾ claim that the special attribute of electricity which has made it occupy a growing role in the total energy scene is the fact that it can be supplied with exceptional precision - in space, in time, and in scale. Thus using wires electricity can be supplied anywhere and in any quantity. Fairly simple switches or rheostats allow for the accurate control of voltage and current, a control process which has been greatly enhanced by modern electronic technology.

In addition to these attributes, electricity is a clean energy source without the safety and environmental constraints imposed by other fuels such as coal and oil, and there is no disposal problem with the wastes associated with the other fuels. That there is waste and hazards associated with the generation of electricity is not the problem of the user of electricity.

For these reasons and because of the decreasing cost of electricity as generation became progressively more efficient, the use of electricity became more widespread. The main expansion was originally in the area of machine drives, but electricity has been expanding into other areas such as heating and chemical

processing. Thus in the USA 80% of machine drives were steam powered in 1890, and 90% were electrically driven by 1940⁽¹⁾. In sympathy with the use of electricity, the energy intensity - the ratio of energy use per unit of GDP produced - fell by 60% in the same period. Electricity also became more cost-competitive with other energy sources. For example, in the USA⁽¹⁾ the ratio of electricity cost to gas cost fell from a value of 45 in 1935 to approximately parity in 1980.

However, there are areas in which electricity has made few inroads. For instance, in the transport sector liquid fuels have a tremendous advantage because of their energy density, and the internal combustion engine has been developed over many years to satisfy consumer needs in terms of speed and range. Electric vehicles did play a role in the early days of transport with 1575 electric vehicles in service in the USA in 1899, compared with 936 internal combustion engined vehicles. In 1900 an electric vehicle won an 80 km race in Long Island. However, by 1904 more than 85% of vehicles in the USA were gasoline driven⁽¹⁾.

Also in many other areas other forms of energy are cheaper. Thus for large-scale heat production it is not sensible to convert coal - to electricity - to heat, at an efficiency of 35% and with a large capital expenditure, when coal burnt in a boiler at 85% efficiency and with a lower capital expenditure will do the same job.

It is therefore evident that electricity will play an increasing role in the total energy scene as a country becomes more developed, as its energy demand shifts to manufacturing requirements, and as electricity becomes more available in the country as a whole. However, there must remain some area of the energy scene which will not be taken over by electricity.

The total percentage of the energy supply market which will be satisfied by electricity is a function of the state of economic development of the country, on the sectorial mix of the country's economy, on the climatic conditions in the country, on the source of the various forms of energy, on the relative prices of the various energy forms, and on government policies.

The purpose of the work reported here is to determine the level of electricity supply in the overall energy scene which may be expected to be satisfied by electricity in the medium to long term.

2. ELECTRICITY IN SOUTH AFRICA

The growth of electricity usage in South Africa has been exponential, as shown in Figure 1. There was a general slowing down in supply during the 1940 to 1947 war years, but otherwise the growth has been steady. Figure 2 compares the growth of electricity with that of the various other forms of energy, whilst Figure 3 shows how electricity has increased its share of the total final energy consumption.

It is not easy to determine from these figures what the general trend is likely to be for electricity in the future. Figure 4 has been drawn to show the difference between the annual growth rate of electricity consumption and the growth of total final energy demand (i.e. electricity growth rate per annum minus total energy growth rate). Apart from a short period during the war years 1940 to 1947, the growth of electricity has always been greater than that of energy. Discounting the war year period, the growth rate difference appears to have been gradually decreasing over the 60-year period illustrated. However, this perception is possibly influenced by the two or three high years in the mid 1930's and the low years after 1980.

It can be assumed that if there is a saturation level for electricity in the total energy market, as discussed above, then the curve of electricity demand as a percent of the total market will be some form of S-curve. Figure 3 should indicate whether there is an S-curve and if so, how far South Africa is along the curve. It is evident that the growth of electricity up to now has exhibited a general exponential form. However it is not possible on the basis of Figure 3 to find out whether the curve is an S-curve shape and if so, whether electricity consumption has passed the inflection point. However, if the growth rate difference, as shown in Figure 4, is declining, then the inflection point on the S-curve has already passed.

3. ANALYSIS

There are two possible methods for the determination of the role of electricity in total energy supply in the future. The first method may be termed the synthesis method and involves a bottom-up approach to the determination of how electricity will be used in the future in each sector of the economy and to determine which of

the energy needs will not be satisfied by electricity. This method needs an in-depth analysis of the technology in each sector and an aggregation of the total contribution that will be made by electricity. This method requires a large amount of knowledge in each sector and an assessment of the probable developments in technology which would affect energy consumption patterns.

The second method is to assume that in the time scale to be considered there will not be any large changes in energy consumption patterns. This assumption is based on the fact that large changes in the application of new or radically improved energy consumption methods would take a long time to permeate through industry because of the large capital investment in energy-using equipment, and in particular the slow roll-over of capital goods in the larger energy-using industries. Therefore the trends of the past may be projected to the future if that future is not too far away. In addition, future trends in a developing country such as South Africa should follow past trends in other countries further along the line of industrial development.

It is this second method which will be adopted here, and a comparison will be made with a number of other countries to determine whether there is likely to be a common trend in the role of electricity in the total energy picture. The countries which have been chosen for comparison are Australia, Germany, United Kingdom, and the USA. It is assumed that the industrial base of each of these countries is similar to that in South Africa and that most of them are most probably further down the line in terms of electricity penetration into the energy market than South Africa. The United Kingdom has also been selected because there is a longer available series of energy statistics than is possible for any other country, with records going back to 1923. Australia has been selected because it is similar to South Africa in terms of climate and industrial methods and is possibly in more or less the same situation as South Africa in electricity penetration.

It is assumed in the analysis that the role of electricity in the overall energy market follows some type of S-shaped curve which varies from zero percent in the past to a maximum which is the final penetration of electricity in the energy scene in the future. If there is a dramatic change in energy use or supply situation in the future, then the S-curve asymptote could well be the first plateau of a series of such plateaus, but it is unlikely that this would occur in the time scale of this investigation, bearing in mind the fact that such apparently large-scale disruptions in the energy scene as the energy crises of the 1979's and the Gulf War do not

appear to have changed the energy picture in any large-scale manner when viewed against the historical background.

There are an infinite number of possible S-curves that could be used in the analysis of the role of electricity. The most common ones in use statistically are the Gompertz and Logistic. However, the common exponential curve could be considered for the first part of the S-curve. Another S-curve which will be considered is that of Middelhoek⁽²⁾.

Middelhoek carried out work on the modelling of energy on a long-term basis. The model is based on a final consumption section and on an energy conversion section. The model for final consumption uses a series of equations based on relevant indices of activity and relations describing the possible substitution of one energy form for another. In the work described here the form of Middelhoek's equation for substitution has been adapted as an S-curve for the penetration of electricity into the total energy market, and also for the reverse - the decrease of an energy form such as coal in the total energy picture. It is obvious that an increase in the share of electricity must be at the expense of some other form of energy.

The concept of using an S-curve for a decreasing and for an increasing market share of each component of the energy market introduces a possible method of decreasing the inaccuracies in forecasting the role of a single energy component. Because of scatter in the historical results, it is useful to look at the total energy picture in terms of the fractional parts of the energy scene in any one year. Thus the fractional part of electricity in the overall energy scene, together with the fractional parts of all the other energy forms, must add up to one.

The "best fit" to the historical data for each energy component has been selected in a manner described in the next section, using the three main types of S-curve. The best fit curve has then been used for extrapolation to determine the asymptotic value, i.e. the percentage penetration, and the year at which this is achieved. Because of the nature of an asymptotic curve, the point at which 100% of the penetration values is achieved is impossible to define and therefore the year at which penetration is achieved is defined as that year in which 99% of the final penetration value is achieved.

4. METHODOLOGY

4.1 Introduction

The following four major energy forms can be identified as the main carriers of Total Final Energy Consumption in the economy of developed countries:

- electricity,
- oil (or liquid fuel),
- gas, and
- coal (and other solid fuel).

The concept "Final" energy points to the consumption by the ultimate or final user. It excludes (and does not identify) the coal or oil, or hydro- or other energy resource used for the generation of electricity, for example; or the coal or gas "liquefied" to produce oil, or the coal used to produce gas, etc.

The market shares of the above four major carriers of Total Final Energy Consumption have, in all countries, showed continuous change during the past century, with the Coal share dropping from a value close to 100% at the turn of the century, and the shares of Oil, Gas, and Electricity increasing from starting points close to zero. The reasons for these changes are varied, complex, and difficult to quantify. One major cause can be found in technological (and infrastructural) developments which enabled the economical substitution of one energy carrier for another. The move away from coal-fired steam to diesel and electricity for rail traction is a typical example.

Other technological developments created new needs which could be met only by one specific energy carrier. This applies to oil as the only practical energy carrier for air transport, and to electricity as the only energy carrier for television and other electronic applications. Thirdly, there have been changes in the mix of the total national economic activity, such as that away from agriculture towards mining or industry. The mix may also change away from heavy "smoke stack" industries to service industries. Such changes obviously affect not only the energy intensiveness of the total economy, but also the market shares of the different carriers of final energy consumption.

The objective in this report is to derive a reliable model of the market share of Electricity, as carrier of the South African Total Final Energy Consumption. The model must not only fit the historical data, but must especially also be credible in the area of extrapolation in order to provide a dependable indication of the future ultimate ceiling or saturation value of this Electricity market share.

The following observations were found to be of use in the search of this objective:

- ** The sum of the components shares of the total market of course remains at 100% despite the changes in the shares of individual carriers of the Final Energy Consumption. This makes it possible to define one selected component as the complement of the sum of all the others, or provides a check against the total of the independently derived models of the separate components of this total market.

- ** Despite the apparently inexorable growth of the market shares of one or more energy carriers (and the ongoing decline of another), the total range of each of the market shares is defined by an upper asymptote below 100% and a lower asymptote more than zero. Suitable models must therefore be sought amongst the family of sigmoidal curves which each exhibit an upper and a lower asymptote.

- ** The analysis of the changing market shares of the similar energy carriers in other countries adds credibility to the results of the models derived for South Africa.

4.2 Choice between possible sigmoidal equations

There is in principle no limit to the number of "sigmoidal" equations which can simulate the progress of growth (or decay) in a range restricted between a lower and an upper asymptote, and we have no prior indication of the particular equation which can best define the changing market share of a given carrier of part of the Total Final Energy Consumption in a particular country. In this study we have in every case tested the suitability of three equations which respectively typify a symmetrical curve (Logistic), a growth curve skewed to the right (Gompertz), and a sigmoidal curve skewed to the left (Middelhoek).

The Logistic curve has come to be known as "the growth curve" and it is sometimes incorrectly and glibly adopted as the only feasible sigmoidal model. It was popularized by Pearl⁽⁹⁾ in his book "Studies in Human Biology", and by Lotka⁽¹⁰⁾ in his "Elements of Mathematical Biology", both published in 1924. These authors demonstrated the remarkably good fit of the Logistic curve to diverse examples of biological growth ranging from the increasing number of fruit flies (*Drosophila*) confined in a glass bottle, the growth of unicellular bacterial cultures, the increasing height of growing sunflower plants, and the growth of the human population of the United States of America.

The Logistic curve has a point of inflection halfway between its upper and lower asymptotes, and its slope changes symmetrically around this point. This inflexible symmetry, which apparently suits the processes of biological growth, also renders the Logistic equation suspect for universal application in other fields.

The Gompertz Curve is used in actuarial work and also has application in business forecasting⁽¹¹⁾. It is asymmetrical and skewed to the right, having a point of inflection at $1/e$ (or 36,788%) of the upper asymptote value.

The "Middelhoek" curve can be seen as a modification of the Gompertz curve. This asymmetric curve is skewed to the left, having a point of inflection at $1-1/e$ or 63,212% of the upper asymptote. An early application of this curve, in the field of energy studies, is found in a paper "Een Sectormodel van het Energieverbruik" by A.J. Middelhoek⁽²⁾ published in 1962. It was then found to be the correct model to simulate the changing share of electricity in the energy supply to The Netherlands' residential sector. This modification of the Gompertz equation is herein referred to as the "Middelhoek" equation, not only as a matter of convenience, but also in recognition of its early application in energy research.

The following are the three equations, each given first in the standard form, and then also with simple transformations which render the equations amenable to linear regression when the upper asymptote or saturation value "A" is taken as a known value. In this study the independent variable "x" is time, measured from a chosen datum calendar year.

Logistic:

$$Y = A / (1 + B * (C ^ X))$$

$$\ln (A - Y) = \ln B + x * \ln C$$

Gompertz:

$$Y = A * B ^ (C ^ x)$$

$$\ln(-\ln(y / A)) = \ln(-\ln B) + x * \ln C$$

Middelhoek:

$$Y = A * (1 - B ^ (C ^ x))$$

$$\ln(-\ln(1 - Y / A)) = \ln(-\ln B) = X * \ln C$$

Obvious minor modifications of the equations are needed to model a decreasing market share, such as the Coal component, which is decreasing from a historical upper ceiling value, close to 100%, to an unknown future floor value. (In the equations concerned, this lower asymptote is indicated by the parameter "Z").

4.3 Detailed procedure

For the component Market Shares of the Total Final Energy Consumption of a given country, the Logistic model is tested for a range of postulated "A" asymptote values. For each postulated "A" value, the parameters "B" and "C" are determined by the linear regression analysis of the data. The resulting derived growth equation can now be used to provide calculated yearly values (Y) for comparison with the actual historical values (y) of Market Share concerned. The size of the sum of the squares of the differences between the yearly actual and calculated values (SUM(y-Y)²) is used as the measure of goodness of fit, and identifies the best Logistic asymptote "A" value.

For the same component Market Share, the iterative procedure is repeated to find the best fitting Gompertz, and the best fitting Middelhoek equations. The final selection between the three sigmoidal equations is again based on the criterion of the least (SUM(y-Y)²) figure.

The sigmoidal equations for the component market shares of the other carriers of the Total Final Energy Consumption of the country concerned are derived in the same manner. This is a very important step. A test of the derived equations is that the sum of the set of all the component market shares must yield a calculated total close to 100%, not only during the span of the data but especially in the extrapolated future region.

4.4 Difficulties arising from a limited span of the data

Figure 28 shows three sigmoidal curves, namely, the symmetrical Logistic model, together with the "skewed" Gompertz and Middelhoek equations. The parameters of the three equations were chosen so that the three curves have equal slopes at a common point of inflection located at the ordinates of $Y = 50\%$; $x = 0$.

It is important to note the very close agreement of the three curves over the range up to, and even slightly beyond, this common point of inflection. Only in the range well beyond the common point of inflection do the three curves diverge, to approach the appreciably different asymptotes of $(50/0,36788) = 135,9\%$ for the Gompertz curve, $(50/0,5) = 100\%$ for the Logistic, and $(50/0,63212) = 79,1\%$ for the Middelhoek equation.

It is immediately clear that no statistical curve-fitting technique could reliably distinguish between the three different equations (or reliably discover any other valid sigmoidal model) if the historical series of the empirical data available for the analysis do not extend into the range beyond that of the point of inflection. In such circumstances the algorithm described above leads to very similar (and equally acceptably small) $(\text{SUM}(y-Y)^2)$ values for the three alternative models, despite a wide disparity in the "A" asymptote values. The dilemma is compounded by the fact that inaccuracies of the empirical data may be of the same, or higher, order than the failures of fit, so that the small differences between the $(\text{SUM}(y-Y)^2)$ values become even less significant.

With an "open-ended" problem, when there is no other independent indication of the value or even the existence of an upper asymptote, such an inadequate range of the data will render meaningless any statistical curve-fitting attempt of a growth equation. Dorn⁽¹³⁾ recognised this in his paper "Pitfalls in Population Forecasts

and Projections". He noted that "there are many statistical difficulties with the Logistic such as the fact that a population must be past the point of inflection of the curve before future growth can be described with even rough accuracy".

In the present study of the saturation curves of the several (more than two) component shares of a Total Final Energy Consumption, we fortunately do not encounter such an insoluble "open-ended" problem. In the cases where the range of the data up to the present does not as yet straddle the point of inflection of the curve of Electricity component share for example, the same period of the available data was found to extend adequately beyond the points of inflection of the component shares of the other carriers. The growth equation of the Electricity share, with its indicated upper asymptote, could therefore adequately and legitimately be defined as the required complement of the sum of the equations of the other components, to give the total of 100%.

4.5 "Two-cycle" growth curves

In each of our three alternative sigmoidal models we find only one point of inflection and no reversal in the direction of growth (or decay). In several instances, however, the historical data of the Oil share of the Final Energy Consumption shows an initial increase to a maximum and a subsequent decline towards a new lower asymptote above zero. Such a curve has two points of inflection and cannot be modelled by one "single cycle" growth equation such as the Logistic, Gompertz, or Middelhoek.

Here again a legitimate and adequate solution is found by defining the complex growth curve as the complement or counterpart of two or more other component shares. The analysis of the energy component shares in Germany provides a good example of the use of this stratagem.

5. SOUTH AFRICA

5.1 Introduction

The data for South Africa for the years 1971 to 1988 have been taken from the International Energy Statistics⁽³⁾. Coal data for the earlier years are taken from

the statistics collected by the Fuel Research Institute of South Africa and summarized by Krueger⁽⁴⁾. Oil results have been taken from IEA statistics for the period 1971 to 1988 and from United Nations statistics⁽⁵⁾ for the period 1950 to 1970. Electricity statistics have been taken from the ESKOM Statistical Year Book⁽⁶⁾.

The energy forms considered in this analysis are electricity, coal and oil. Only the commercial forms of energy have been considered mainly because there is no historical data on the use of traditional fuels. Some non-conventional energy forms were used earlier in the Century for commercial purposes and an estimate has been made of this. This mainly relates to the use of animal power and of wind. However, cognizance must be taken of the possible increase in electricity use of those households which presently use traditional forms of energy, especially fuelwood and dung.

At present approximately 10% of South Africa's energy is estimated to come from traditional fuels, mainly wood. In time it is likely that all this component will be satisfied by electricity, but because of the capital requirements for electrification, this will take a long time. This time may be shortened however due to the increasing rate of urbanization.

The efficiency of energy conversion of fuelwood in cooking is around 5%. If fuelwood were replaced by electricity, the efficiency would be around 60%. Thus the 10% traditional fuel consumption, when translated into electricity use, would mean an increase of electricity usage by less than 1% of total energy. Some of this traditional energy would however, in the first place, be taken up by coal and only in the longer term would it be taken over by electricity. It has therefore been decided to ignore the traditional fuel component since it makes only a marginal effect to the final penetration figure.

5.2 Results

Regression analysis was carried out using the various curves described above. The results of the calculations are given in Tables 11 to 13 in the Appendix, and in Figures 1 to 4.

Gas is only a small contributor to the total energy scene as shown in Table 11. Since increased gas production or imports, e.g. from Mozambique, could well

change this component, it was decided to model gas and coal together since it is most probable that any increase in the share of gas would be at the cost of coal.

The contributions of coal, electricity, and oil to the total energy market are shown in Figures 5 to 7. These figures also show the best fit calculated curve. Good fits are evident for all three components. It is noteworthy in Figure 7 that large perturbations in the supply situation, such as the 1970's energy crises, are noticeable in the comparison between actual and calculated values, but over time these local temporal effects are smoothed out with the long-term trend following the predicted values.

The total energy component picture is shown in Figure 8 in which is an assumed contribution from animal, wind, etc. at the beginning of the century.

The steady state final situation shows the main fuel components as follows:

Table 1 South Africa - values from saturation curves

Component	Final Contribution %	Year for 99% of final	Inflection
Coal + Gas	34,0	2000	1972
Oil	33,0	1984	1984
Electricity	33,0	2002	1980

In the longer term the contribution of oil must decrease because of resource considerations, but this is out of the time-scale of this determination and will depend on world oil scenarios.

6. AUSTRALIA

6.1 Introduction

The data for Australia have been taken from the International Energy Agency statistics and from those of the United Nations.

The results are given in Tables 1 to 5 and shown as graphs in Figures 9 to 14.

Figure 12 shows that Australia started to use an increasing amount of gas from 1968 onwards. Gas replaced oil and the oil values in Figure 11 show a flattening of demand. The energy crises of the 1970's further reduced oil consumption to give the bell-shaped form typical of the other countries with the exception of South Africa. The oil and gas components were added together, but the resulting graph (Figure 13) shows a sharp rise to a maximum of 67% in the late 1970's followed by a slight decrease in consumption from 1978 to 1985. The (oil + gas) component cannot therefore be modelled by a simple three-parameter saturation curve but requires a compound equation. It was decided therefore that the (oil + gas) values could be calculated from the difference between 100% and the values obtained from the coal and electricity curves, which could be accurately fitted by an S-curve.

From the Tables it can be seen that for electricity all three sigmoidal models (as also the Exponential model) fit the data almost equally well. This is a clear indication that the range of the data does not yet straddle the point of inflection of the curve. It is not possible to distinguish between the Gompertz, Middelhoek, Logistic (or even the Exponential) model if the data of the growth curve do not extend beyond the point of inflection.

In the case of the Australian Electricity market share (with data for the years from 1960 to 1985), the following summary can be made:

Table 2 Curve fitting to Australian Electricity saturation

Best fit	Exponential	Gompertz	Middelhoek	Logistic
Asymptote	Infinity	110	26	37
"R squared" Regression coefficient	0.994	0.997	0.997	0.997
Sum of squared differences from 1960 to 1985	1,49	0,64	0,70	0,68
Point of inflection at % :- and Year :-	none -	40.5 2025	16.4 1985	18.5 1989

The Gompertz must in this case be discarded as absurd. Like the Exponential, it postulates a market share more than 100 %. Note however that, on the criterion of the lowest sum of the squared differences between the model and the data (or on the grounds of the highest "R squared " value), it would be the first choice.

The Logistic model "anticipates" a point of inflection in 1989, beyond the span of the data, and only in the Middelhoek model is the point of inflection discovered in the region of interpolation.

While the range of the data relating to the Australian Electricity market share did not, in 1985, clearly straddle a recognizable point of inflection, the fitting of a sigmoidal growth model remains uncertain.

In the case of Australia it is also not readily possible, at this stage, to confirm the electricity share as the complement of two or more sigmoidal models of the other components of the Total Final Energy Consumption.

The Middelhoek model, with its asymptote at 26% and with the point of inflection at 16,4% in 1985, seems quite feasible however, and is adopted in this study.

6.2 Results

The results of the determination of the saturation level for electricity is given in the Table below. The steady state conditions for coal and (oil + gas) are also given. However, it can be observed that the (oil + gas) curve (Figure 13) shows that the (oil + gas) component peaked in about 1984 and appears to be dropping to a possible steady condition sometime in the next century. The coal and electricity components fit the Middelhoek model accurately.

Table 3 Australia - values from saturation curves

Component	Final Contribution %	Year for 99% of final	Inflection
Coal	14,2	2000	
Electricity	25,9	2012	
(Coal + Oil)	59,9	-	

7. GERMANY

7.1 Introduction

Data for Germany have been obtained from International Energy Agency statistics as well as from the United Nations. The figures are shown in Table 6. The values quoted exclude oil and gas feedstock, and other non-energy uses. The "coal" figures given in the tables include other solid fuels.

7.2 Results

It will be seen from Table 7 that the "Oil %" share rose to a maximum of about 60% in 1972/73 and has since declined towards a new floor value. This curve therefore has two points of inflection and cannot be modelled by a "simple" single cycle equation such as the Logistic, or Gompertz, or Middelhoek.

In all the other columns of the Table including especially the one headed "Oil + Coal", there is no apparent reversal in the direction of growth or decline.

A desirable (though not essential) condition for the successful application of the curve-fitting methodology is that the range of the data adequately straddles the single point of inflection. This was found to be the case in all the columns of Table 8, and independent sigmoidal equations were found to model the separate shares of Electricity, Gas, and Coal. The "simple" equation for (Coal + Oil) also leads to the "complex" but similarly independent model for the Oil share.

The sum of component shares will in practice of course equal 100%, and this stringent test is successfully applied to the derived models. Of the five countries investigated, the results of the analysis of Germany showed the best results.

In Table 8 the upper asymptote in the "Coal" equation is not 100% but only 95%. The 95% assumption results in a better fit between the model and the actual figures. Early in the century, animal, wind and water energy undoubtedly contributed (about 5%) to the "formal" final energy consumption. These "primitive" energy forms were then the only supplement to Coal energy and were later replaced by electricity, oil, and gas.

The results of the best-fit determination are shown in Figures 15 to 20. Figure 17 shows the maximum value for oil mentioned above. A means of overcoming the difficulty of trying to fit an S-curve to a curve having two points of inflection was overcome by assuming that during the energy crises of the 1970's there was a substantial substitution of oil by coal, mainly in thermal power stations where short-term changes could be made. Therefore it would be expected that, whilst the oil curve would show a maximum, the combination of "oil and coal" would show a better behaved relationship. Figure 15 shows that there was a pick-up in the contribution of coal to the total energy demand at the end of the 1970's. Figure 19 has been drawn for this combination of oil and coal and does show the typical S-curve relationship. Since the purpose of this project is the determination of electricity penetration, the other energy forms may be combined in any form that may be required.

Figure 20 shows the combined energy demand picture and shows the assumed contribution to "primitive" forms of energy at the turn of the century.

The results of the calculations give the following results:

Table 4 Germany - values from saturation curves

Component	Final Contribution %	Year for 99% of final	Inflection
Coal	12,0	1974	1967
Gas	18,0	1985	1974
Oil	47,0	?	-
Electricity	23,0	1993	1977
(Coal + Oil)	59,1	1999	1975

8. UNITED KINGDOM

8.1 Introduction

It is always satisfying to work with a long-term series of statistical data and the United Kingdom data which stretches from 1923 to 1988 provide the best available statistical information. This data has been obtained from the United Kingdom Energy Digest⁽⁷⁾. The only significant data which were missing from the series were

the electricity figures for the war years 1940 to 1945. Interpolation has been used to estimate this missing section, but the amount missing is so small and during a period when no large swings were expected, that the reliability of the data has not been compromised.

The Oil and Gas components of the final energy demand data, shown in Figures 23 and 24 respectively, pose a problem due to the shape of the curves. The United Kingdom in the 1970's had serious economic problems and the oil price increases in the 1970's caused it to decrease energy consumption drastically, especially that based on petroleum. Figure 23 shows the decrease in oil consumption which started in the early 1970's. On the other hand, gas had been found in the North Sea and growing use was made of this form of energy which displaced some electricity (especially in the late 1970's - see Figure 22) and some oil. The combined (oil + gas) curve shown in Figure 29 shows the S-curve of Middelhoek curve and the actual values. Whilst the fit is not as good as that for other components and for other countries, the shape conforms to prediction. For comparison, Figure 31 has been drawn as the complement to the coal and electricity S-curves. This latter procedure gives a better fit than the straight (oil + gas) regression.

The use of the independent electricity, coal and (oil + gas) regression curves gives rise to an anomaly in that the sum of the three is at times greater than 100%, as shown in Figure 30. However, the difference is not great and should not unduly affect the analysis of electricity penetration.

Looking at Figure 31, one expects that a successful sigmoidal model should readily be found. The data obviously straddle the point of inflection. The actual data are "smooth" enough. The curve is skewed away from the Logistic toward the Middelhoek shape.

It was found indeed that the Middelhoek is indeed the better of our three sigmoids for this purpose, but the fit, as shown in Figure 29, remains poor in comparison with the graph in Figure 31. Similarly, Figure 30 shows a sum of the component parts, disturbingly more than 100% over the period from 1950 to 1980. This problem of the sum of the parts can be negated, as described above, by using the difference between 100% and the two components coal and electricity, as shown in Figure 25.

The changing slopes of the % market share curves of the different components of the Total Final Energy Consumption are shown in Figures 26, 27, and 28.

Figure 28 shows the slope of the (Oil + Gas) component. It is skewed to the right, and the position of its maximum implies a point of inflection in about 1970 in the corresponding % market share curve.

We then know the following of the (Oil + Gas) component:

Year of point of inflection	1970
Market share in this year	say, 55%
Expected asymptote	73.5
Ratio (value at point of inflection)/(asymptote) = 55/73.5	
= 0.75	

For our three alternative models, the above ratio are as follows:

- Gompertz: 0.36788
- Logistic: 0.50
- Middelhoek: 0.63212

Note that the above (Oil + Gas) component would require a model even more skewed to the left than the Middelhoek.

Similarly, we know the following of the Electricity component of the UK Final Energy Consumption:

Year of the point of inflection (indicated by the maximum slope of the % Market Share curve in Figure 27	about 1963
Market Share in this year	8.1%
Expected asymptote	16%

The "Asymptote Ratio", defined as the ratio of the "Value at point of inflection" over the "Asymptote value", is 8.1/16 or 0.506. This ratio is very close indeed to the Logistic ratio of 0.50 and the good fit of the Logistic model to the UK - Electricity - data is apparent in Figure 22.

For the sigmoidal decay models, with an upper asymptote of 95% and a lower asymptote of Z%, the point is given by:

$$(95 + Z*(\$-1))/\$$$

Where \$ is = 2.0, for the Logistic -,

and = e = 2.71828, for the Gompertz -,

and = e/(e-1) = 1.581977, for the Middelhoek model.

Figure 21 shows a Gompertz model with lower asymptote of 10.50% fitted to the UK Coal component. This model has the point of inflection at $(95 + 10.5*(e-1))/e = 41.59\%$. This occurs roughly in the year 1967. The slope of the UK Coal - Market - Share - curve, shown in Figure 26, also has its minimum value in about 1967, indicating the point of inflection in that year. In respect of the "Asymptote Ratio", the Gompertz model is confirmed as suitable for the UK Coal - data.

The relatively small imperfection of the fit, which is nevertheless apparent in Figure 21, can be ascribed to the large degree of kurtosis, seen in Figure 26, where kurtosis is the degree to which a distribution is flattened at its centre.

The problem remains that the UK (Oil + Gas) component requires a model even more skewed to the right than the Middelhoek. There is no solution readily available for this problem, but the differences expected are so small that it is not considered necessary to investigate this at this point.

8.2 Results

The results of the calculations of the relative shares of the various energy components are shown in Tables 14 to 25. The final share of the energy forms are:

Table 5 United Kingdom - values from saturation curves

Component	Final Contribution %	Year for 99% of final	Inflection
Coal	10,5	1988	1968
Electricity	15,9	2010	1963
(Oil + Gas)	73,5	(1984)	1968

9. UNITED STATES OF AMERICA

9.1 Introduction

The USA was selected as being possibly furthest along the line to the asymptotic value for electricity penetration. Data have been obtained from two main sources - the Department of the Interior⁽⁸⁾ for the period 1947 to 1971, and the International Energy Agency for the period 1972 to 1985. The analysis of the data is shown in Tables 26 to 38.

It is interesting to note that the Gompertz, Middelhoek, and Logistic models all fit the Electricity data almost equally well, so that it is difficult to use the sums of the squared differences between the model and the data as the criterion to select the best model for extrapolation. The reason lies in the fact that the data up to 1985 only barely extend beyond the point of inflection. The position is very well illustrated in Figure 34.

As shown in Figure 35, the USA Gas- and Oil - market shares reached maxima in the seventies, but then again decreased, thus exhibiting plural points of inflection. The sum of the Oil - and the Gas - components can however be adequately modelled as the complement of the Electricity - and the Coal - models. This is illustrated in Figure 36. The final results and conclusions are then as shown in Figures 33, 32, and 36, whilst the final demand picture is shown in Figure 37.

9.2 Results

The results of the calculations show that the steady state contribution of the various energy forms are as shown in the Table below. It has not been possible to differentiate between oil and gas for the reasons discussed above and the strong substitution possibilities between these two fuels.

Table 6 United States - values from saturation curves

Component	Final Contribution %	Year for 99% of final	Inflection
Coal	9,5	1975	--
Electricity	23,0	1986	1974
(Oil + Gas)	67,5	--	--

10. DISCUSSION

The method adopted for the determination shows good results between the assumed shape of the S-curve and the actual values for the various countries.

For all the countries considered, with the exception of South Africa, the oil consumption pattern shows a declining one following the 1970's energy crises. For South Africa oil consumption has tended to flatten out but has not decreased. It has therefore not been possible to fit an S-curve to the oil components. However, it has been argued that gas is substituting for oil and the combination of oil plus gas should show an S-curve relationship. This has been found to be true for the UK, but the USA, Australia, and Germany show a bell-shape curve for this component. It has however been possible to fit adequate curves to the electricity and coal figures.

The saturation values for electricity in the various countries are summarized in the Table below:

Table 7 Electricity saturation values for selected countries

Country	Saturation %	Year for Inflection	Year for 99% of saturation
Australia	26,0	1985	2015
Germany	23,0	1977	2000
South Africa	33,0	1980	2002
United Kingdom	16,0	1963	2010
United States	23,0	1974	1986

Whilst the countries have been selected to give a wide spread of industrial development and thus a large spread in progress along the electricity saturation curve, it is remarkable how little variation there is in terms of when the 99% of saturation will occur. The spread in years between the various countries is only +/- 11 years. It is also noteworthy that the USA is expected to reach saturation last and that the UK appears to be already past the 99% saturation point.

The two countries with the highest electricity saturation levels are Australia and South Africa, with the UK the lowest. Part of the reason for this is the difference in climatic conditions and the larger proportion of energy used in the domestic sector in the other three countries. In the three countries with the lowest saturation levels a

significant portion of the domestic and industrial heating load has been taken over by gas. In Australia and South Africa there is only a small environmental heating component and therefore there is less call for gas or oil firing. South Africa also has a much higher coal component than the other countries. In part this has to do with the large and inexpensive coal resources in South Africa. It is strange however that Australia, with similar resources and costs, does not have a larger coal contribution. This is possibly due to Australia's gas resources. The steady state coal component of the various countries' demand is shown in the Table below

Table 8 Coal - saturation values for selected countries

Country	Asymptote level %	Year for Inflection	Year for 99% of saturation
Australia	14,0	--	2003
Germany	12,0	1962	1981
South Africa	34,0	1972	2000
United Kingdom	10,5	1968	1988
United States	9,5	--	1975

The analysis carried out assumes that there are no dramatic changes in the energy resource base, in conversion technology, nor in utilization technology. It has already been pointed out that events such as the 1970's energy crises do not affect the utilization of electricity, but had an effect of changing from oil to gas. For South Africa no abrupt changes in the picture are anticipated in the next one or two decades. The only significant event that would increase the saturation level of electricity would be the production of a vehicle battery which could cause large inroads into oil consumption. However, improved batteries would have an effect on vehicles used for urban deliveries and are thus not expected to make very large changes in the mix of fuel utilization.

The Table below summarizes the details of the various energy components for the selected countries.

Table 9 Saturation values for selected countries

	Germany	United Kingdom	USA	Australia	South Africa
Electricity					
Actual 1985	18,3	14,2	15,7	16,5	26,2
Forecast 2000	22,7	15,6	19,5	23,0	33,0
Asymptote	23,0	16,0	23,0	26,0	33,0
Year-inflec.	1977	1963	1974	2015	2002
Year-99% Asymp.	2000	2010	1986	2015	2002
Coal					
Actual 1985	13,6	13,6	10,6	18,2	40,2
Forecast 2000	12,0	10,5	9,5	15,1	34,5
Asymptote	12,0	10,5	9,5	14,0	34,0
Year-inflec.	1962	1968	--	--	1972
Year-99% Asymp.	1981	1988	1975	2003	2000
Oil					
Actual 1985	50,5	39,8	50,1	51,1	32,8
Forecast 2000	47,5	(42)	(23)	(46)	33,0
Asymptote	47,0				33,0
Year-inflec.					1960
Year-99% Asymp.					1984
Gas					
Actual 1985	17,6	32,4	23,6	14,3	0,8
Forecast 2000	18,0	(32)	(23)	(15)	(0,5)
Asymptote	18,0				
Year-inflec.	1976				
Year-99% Asymp.	1985				
(Oil + Gas)					
Actual 1985	68,1	72,2	73,7	65,5	33,6
Forecast 2000	65,5	73,9	73,7	65,5	33,0
Asymptote	65,0	73,5	67,5	60,0	33,0
Year-inflec.	1968				
Year-99% Asymp.	(1984)			1967	

The Table above is incomplete due mainly to the shape of the oil demand curves which do not lend themselves to a strict interpretation of what is a point of inflection or an asymptote. Also, the German and Australian coal curves, in the area of available data, are exponential curves and therefore do not have a point of inflection, though they do have an asymptotic value.

All the countries considered have an inflection point in the electricity curve and therefore the curve fitting, especially when using the multi-component procedure

described, produces acceptable results. Of the five countries, three have very similar asymptotic values of 23% to 26%. It is to be expected therefore that other developed countries with industrial components similar to these three countries would also have an asymptotic value of approximately 23%. The United Kingdom has a low asymptotic value of 16% due principally to the large component of energy used for heating for comfort purposes and to the large use that is being made to this demand by gas.

The country that has the highest electricity asymptotic value is South Africa with a 33% electricity penetration. Whilst it is not possible to carry out a full investigation into the reasons for this large value because of lack of adequate data, there are possibly some comments that can be made. South Africa, because of its cheap coal, has concentrated on using coal and electricity made from coal. The proportion of final demand energy from the two sources: oil and gas, and coal and electricity, in the five countries and at the asymptotic values is summarized below.

Table 10 Percentages of electricity and coal, and oil and gas, in the final energy demand of the selected countries

Country	Electricity and coal	Oil & Gas
Australia	40,0	60,0
Germany	35,0	65,0
South Africa	67,0	33,0
United Kingdom	26,5	73,5
USA	32,5	67,5

It is apparent that countries with large and inexpensive coal sources would use more coal. However, Australia and South Africa should therefore be very similar in their energy proportional usage, instead of having the large difference shown. It could be postulated that the South African reliance on coal has been engendered by the need to be self-reliant in energy for strategic reasons. However, inspection of the coal curve, Figure 5, does not show any discontinuity which could be expected as a result of a policy decision. The main difference between the Australian and South African scenes is the cost of electricity which is higher in Australia because of the higher coal cost and the higher capital cost for those stations using brown coal. If coal is more expensive in Australia than in South Africa and if oil or gas is readily available, then it is conceivable that the energy proportions in the two countries

would be very different. It is easy to see that oil or gas as a heating source would substitute for coal, but it is more difficult to see how it could substitute for electricity other than on a limited scale.

There is no obvious reason why the electricity usage in South Africa and in Australia should be so different from each other. The difference between South Africa and the northern hemisphere countries is more easily explained by the difference in the heating requirements between the two groups.

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12 APPENDIX

DATA FOR :-

**AUSTRALIA
GERMANY
SOUTH AFRICA
UNITED KINGDOM
UNITED STATES**

AUSTRALIA

TABLE 1

AUSTRALIA

(File: AUSDATA Page 1)

Australia Final Energy Consumption. IEA Statistics. Unit: Mtoe.

Year	Coal	other Solid fuel	Oil	Gas	Elec	Total Mtoe	GDP billion '80 US\$	Popu- lation Million
1960	6.27	4.05	11.61	0.50	1.51	23.94	62.82	10.55
1961	6.31	4.05	12.42	0.48	1.64	24.90	62.61	10.77
1962	6.24	3.94	12.84	0.49	1.74	25.25	66.62	10.99
1963	6.17	4.02	14.65	0.50	1.95	27.29	71.00	11.20
1964	6.47	3.87	15.33	0.52	2.18	28.37	75.45	11.42
1965	6.69	3.96	16.38	0.52	2.42	29.97	79.65	11.65
1966	6.11	3.80	17.44	0.56	2.59	30.50	81.87	11.86
1967	6.24	3.88	18.67	0.55	2.82	32.16	87.48	12.07
1968	6.28	3.78	20.43	0.53	2.99	34.01	92.92	12.30
1969	6.60	3.77	21.49	0.68	3.29	35.83	98.69	12.55
1970	6.65	3.50	22.12	0.98	3.61	36.86	104.66	12.82
1971	6.58	3.52	22.76	1.31	3.89	38.06	110.81	13.07
1972	6.31	3.59	22.64	2.00	4.11	38.65	115.23	13.30
1973	6.76	3.49	24.69	2.42	4.51	41.87	121.59	13.50
1974	6.93	3.55	24.67	2.91	5.00	43.06	123.76	13.72
1975	7.28	3.55	24.87	3.20	5.29	44.19	127.18	13.89
1976	6.85	3.57	25.18	3.45	5.49	44.54	131.49	14.03
1977	6.70	3.59	26.66	3.90	5.89	46.74	132.80	14.19
1978	6.02	3.56	27.32	4.29	6.14	47.33	136.57	14.36
1979	6.40	3.43	27.69	4.73	6.49	48.74	142.87	14.51
1980	6.29	3.50	27.69	5.44	6.81	49.73	145.26	14.69
1981	5.84	3.71	26.69	5.92	7.21	49.37	150.07	14.92
1982	6.02	3.83	26.65	6.15	7.47	50.12	149.99	15.18
1983	5.14	3.80	25.12	6.41	7.54	48.01	151.03	15.38
1984	5.24	3.70	26.24	6.63	8.04	49.85	161.70	15.56
1985	5.57	3.81	26.54	7.43	8.54	51.89	168.46	15.75

TABLE 2

AUSTRALIA

(File: AUSDATA page 2)

Total Final Energy Consumption [TFC]

% Market Share of Total Final Consumption %

Year	Coal+ Other Solid	Gas	Oil	Elec	Coal+ Solids +Gas	Oil+ Gas	RATIOS		
							[TFC]/ GDP	[TFC]/ CAPITA	Elec/ GDP
1960	43.11	2.09	48.50	6.31	45.20	50.58	0.38	2.27	2.40
1961	41.61	1.93	49.88	6.59	43.53	51.81	0.40	2.31	2.62
1962	40.32	1.94	50.85	6.89	42.26	52.79	0.38	2.30	2.61
1963	37.34	1.83	53.68	7.15	39.17	55.51	0.38	2.44	2.75
1964	36.45	1.83	54.04	7.68	38.28	55.87	0.38	2.48	2.89
1965	35.54	1.74	54.65	8.07	37.27	56.39	0.38	2.57	3.04
1966	32.49	1.84	57.18	8.49	34.33	59.02	0.37	2.57	3.16
1967	31.47	1.71	58.05	8.77	33.18	59.76	0.37	2.66	3.22
1968	29.58	1.56	60.07	8.79	31.14	61.63	0.37	2.77	3.22
1969	28.94	1.90	59.98	9.18	30.84	61.88	0.36	2.85	3.33
1970	27.54	2.66	60.01	9.79	30.20	62.67	0.35	2.88	3.45
1971	26.54	3.44	59.80	10.22	29.98	63.24	0.34	2.91	3.51
1972	25.61	5.17	58.58	10.63	30.79	63.75	0.34	2.91	3.57
1973	24.48	5.78	58.97	10.77	30.26	64.75	0.34	3.10	3.71
1974	24.34	6.76	57.29	11.61	31.10	64.05	0.35	3.14	4.04
1975	24.51	7.24	56.28	11.97	31.75	63.52	0.35	3.18	4.16
1976	23.39	7.75	56.53	12.33	31.14	64.28	0.34	3.17	4.18
1977	22.02	8.34	57.04	12.60	30.36	65.38	0.35	3.29	4.44
1978	20.24	9.06	57.72	12.97	29.30	66.79	0.35	3.30	4.50
1979	20.17	9.70	56.81	13.32	29.87	66.52	0.34	3.36	4.54
1980	19.69	10.94	55.68	13.69	30.63	66.62	0.34	3.39	4.69
1981	19.34	11.99	54.06	14.60	31.33	66.05	0.33	3.31	4.80
1982	19.65	12.27	53.17	14.90	31.92	65.44	0.33	3.30	4.98
1983	18.62	13.35	52.32	15.71	31.97	65.67	0.32	3.12	4.99
1984	17.93	13.30	52.64	16.13	31.23	65.94	0.31	3.20	4.97
1985	18.08	14.32	51.15	16.46	32.40	65.47	0.31	3.29	5.07

TABLE 3

AUSTRALIA

(File: AUSDATA page 3)

% Market Share of Total Final Energy Consumption

Year	Calc. Market Shares %			Actual Market Shares %		
	Elec	Coal+ Solids	Oil+ Gas	Elec	Coal+ Solids	Oil+ Gas
1960	6.38	43.71	49.91	6.31	43.11	50.58
1961	6.67	41.65	51.68	6.59	41.61	51.81
1962	6.97	39.71	53.33	6.89	40.32	52.79
1963	7.27	37.87	54.86	7.15	37.34	55.51
1964	7.59	36.14	56.27	7.68	36.45	55.87
1965	7.92	34.51	57.57	8.07	35.54	56.39
1966	8.26	32.98	58.76	8.49	32.49	59.02
1967	8.61	31.55	59.84	8.77	31.47	59.76
1968	8.97	30.22	60.81	8.79	29.58	61.63
1969	9.34	28.98	61.68	9.18	28.94	61.88
1970	9.72	27.82	62.46	9.79	27.54	62.67
1971	10.12	26.74	63.14	10.22	26.54	63.24
1972	10.52	25.74	63.74	10.63	25.61	63.75
1973	10.93	24.81	64.26	10.77	24.48	64.75
1974	11.35	23.95	64.69	11.61	24.34	64.05
1975	11.79	23.16	65.06	11.97	24.51	63.52
1976	12.23	22.42	65.35	12.33	23.39	64.28
1977	12.67	21.74	65.58	12.60	22.02	65.38
1978	13.13	21.12	65.75	12.97	20.24	66.79
1979	13.59	20.54	65.87	13.32	20.17	66.52
1980	14.06	20.01	65.93	13.69	19.69	66.62
1981	14.54	19.51	65.95	14.60	19.34	66.05
1982	15.02	19.06	65.92	14.90	19.65	65.44
1983	15.50	18.65	65.85	15.71	18.62	65.67
1984	15.98	18.26	65.75	16.13	17.93	65.94
1985	16.47	17.91	65.62	16.46	18.08	65.47
1987	17.44	17.29	65.27			
1990	18.87	16.53	64.59			
1995	21.10	15.64	63.26			
2000	22.97	15.06	61.97			
2005	24.38	14.68	60.94			
2010	25.27	14.44	60.29			
2015	25.74	14.28	59.98			
2020	25.93	14.18	59.89			
1930	1.55	99.79	-1.33			
1940	2.52	92.81	4.67			
1950	4.05	69.16	26.79			

Calculated Electricity Share % = $Y[e] = A*(1-(B^{(C^x)}))$

$B = 0.3665$; $C = 1.0521$; $A = 26$

Calculated Share of (Coal + other solid fuels) % = $Y[c]$

= $Z + (100-Z)*(1-B^{(c^x)})$

$B = 0.95453$; $C = 0.91543$; $Z = 14$

$x = (Year - 1985)$

Calculated share of (Oil + Gas) % = $Y[o+g]$

= $(100 - Y[e] - Y[c])$ %

TABLE 4

AUSTRALIA

(File: AUSDATA page 4)

% Market Share of Total Final Energy Consumption

Differences between Calculated, and Actual % Market Shares

Year	(Calculated % - Actual %)			Squares of the Diffs.		
	Elec	Coal+ Solids	Oil+ Gas	Elec	Coal+ Solids	Oil+ Gas
1960	0.08	0.60	-0.68	0.01	0.36	0.46
1961	0.08	0.05	-0.13	0.01	0.00	0.02
1962	0.08	-0.61	0.53	0.01	0.37	0.28
1963	0.13	0.53	-0.66	0.02	0.28	0.43
1964	-0.09	-0.31	0.40	0.01	0.10	0.16
1965	-0.15	-1.03	1.18	0.02	1.05	1.39
1966	-0.23	0.49	-0.26	0.05	0.24	0.07
1967	-0.16	0.09	0.07	0.03	0.01	0.01
1968	0.18	0.64	-0.82	0.03	0.41	0.67
1969	0.16	0.03	-0.19	0.03	0.00	0.04
1970	-0.07	0.28	-0.21	0.00	0.08	0.04
1971	-0.10	0.20	-0.10	0.01	0.04	0.01
1972	-0.12	0.13	-0.01	0.01	0.02	0.00
1973	0.16	0.33	-0.49	0.03	0.11	0.24
1974	-0.26	-0.38	0.64	0.07	0.15	0.41
1975	-0.19	-1.35	1.53	0.03	1.82	2.36
1976	-0.10	-0.97	1.07	0.01	0.94	1.15
1977	0.07	-0.27	0.20	0.01	0.07	0.04
1978	0.16	0.88	-1.03	0.03	0.77	1.07
1979	0.28	0.37	-0.65	0.08	0.14	0.42
1980	0.37	0.32	-0.69	0.14	0.10	0.47
1981	-0.07	0.17	-0.10	0.00	0.03	0.01
1982	0.11	-0.59	0.48	0.01	0.35	0.23
1983	-0.21	0.02	0.18	0.04	0.00	0.03
1984	-0.14	0.33	-0.19	0.02	0.11	0.03
1985	0.01	-0.17	0.15	0.00	0.03	0.02
avg =				sum =	sum =	sum =
	-0.001	-0.008	0.009	0.695	7.577	10.077
std =						
	0.163	0.540	0.622	0.029	0.416	0.544

TABLE 5

AUSTRALIA

(File: AUSDATA page 5)

% Market Share of Total Final Energy Consumption

Calculated Market Shares %

Year	Elec	Coal+ Solids	Oil+ Gas	Oil+ Gas+ Coal+ Solids	Oil+ Gas+ Coal+ Solids Elec
1940	2.52	92.81	4.67	97.48	100
1942	2.78	89.25	7.98	97.22	100
1944	3.05	84.94	12.00	96.95	100
1946	3.36	80.03	16.61	96.64	100
1948	3.69	74.70	21.61	96.31	100
1950	4.05	69.16	26.79	95.95	100
1952	4.45	63.58	31.97	95.55	100
1954	4.88	58.14	36.98	95.12	100
1956	5.34	52.97	41.69	94.66	100
1958	5.84	48.14	46.02	94.16	100
1960	6.38	43.71	49.91	93.62	100
1962	6.97	39.71	53.33	93.03	100
1964	7.59	36.14	56.27	92.41	100
1966	8.26	32.98	58.76	91.74	100
1968	8.97	30.22	60.81	91.03	100
1970	9.72	27.82	62.46	90.28	100
1972	10.52	25.74	63.74	89.48	100
1974	11.35	23.95	64.69	88.65	100
1976	12.23	22.42	65.35	87.77	100
1978	13.13	21.12	65.75	86.87	100
1980	14.06	20.01	65.93	85.94	100
1982	15.02	19.06	65.92	84.98	100
1984	15.98	18.26	65.75	84.02	100
1986	16.96	17.59	65.46	83.04	100
1988	17.92	17.02	65.06	82.08	100
1990	18.87	16.53	64.59	81.13	100
1992	19.79	16.13	64.08	80.21	100
1994	20.67	15.79	63.54	79.33	100
1996	21.51	15.50	62.99	78.49	100
1998	22.28	15.26	62.47	77.72	100
2000	22.97	15.06	61.97	77.03	100
2002	23.60	14.89	61.52	76.40	100
2004	24.14	14.74	61.12	75.86	100
2006	24.59	14.62	60.78	75.41	100
2008	24.97	14.52	60.51	75.03	100
2010	25.27	14.44	60.29	74.73	100
2012	25.50	14.37	60.13	74.50	100
2014	25.67	14.31	60.02	74.33	100
2016	25.80	14.26	59.95	74.20	100
2018	25.88	14.22	59.90	74.12	100
2020	25.93	14.18	59.89	74.07	100

GERMANY

TABLE 6

GERMANY

(File: GERDATA Page 1)

Final Energy Consumption : IEA Statistics. Unit: Mtoe

Year	Coal	Oil	Gas	Elec	Total Mtoe	GDP billion '80 US\$	Popu- lation 10 ⁶
1960	65.24	28.11	2.57	8.30	104.22	401.03	55.58
1961	62.00	34.46	2.62	8.88	107.96	419.61	56.17
1962	63.05	42.73	2.94	9.52	118.24	439.47	56.84
1963	65.16	50.88	3.05	10.30	129.39	451.65	57.39
1964	60.22	58.16	3.34	11.21	132.93	481.77	57.97
1965	55.56	66.14	3.57	12.11	137.38	508.18	58.62
1966	48.23	74.76	6.52	12.89	142.40	523.13	59.15
1967	45.79	76.89	7.28	13.39	143.35	522.50	59.29
1968	44.97	85.55	9.44	14.80	154.76	551.55	59.50
1969	45.78	96.08	11.23	16.34	169.43	592.71	60.07
1970	42.05	92.82	9.17	17.74	161.78	623.23	60.65
1971	32.98	97.43	12.07	18.96	161.44	641.26	61.30
1972	29.52	102.63	15.50	20.69	168.34	668.27	61.67
1973	29.29	108.56	18.26	22.11	178.22	699.60	61.98
1974	31.10	97.56	19.71	22.93	171.30	701.50	62.05
1975	24.59	97.82	19.83	24.73	166.97	690.35	61.83
1976	24.00	102.96	23.07	26.83	176.86	727.71	61.53
1977	22.14	102.17	25.52	27.48	177.31	749.20	61.40
1978	21.45	107.99	26.02	29.16	184.62	770.71	61.33
1979	23.85	110.19	28.16	30.41	192.61	802.70	61.36
1980	24.33	99.59	28.48	30.38	182.78	813.65	61.57
1981	24.22	90.80	28.90	30.63	174.55	814.99	61.68
1982	22.43	87.25	27.18	30.48	167.34	809.73	61.64
1983	21.95	87.56	28.33	31.20	169.04	821.89	61.42
1984	23.85	88.87	30.47	32.27	175.46	844.42	61.17
1985	24.39	90.52	31.65	32.82	179.38	866.41	61.02

The figures exclude oil- and gas feedstocks, and other non-energy use, in the years from 1970 onwards.

COAL includes "Other Solid Fuels"

The source of the data is the International Energy Agency Statistics [available for the years 1960 to 1985 only.]

TABLE 7

GERMANY

(File: GERDATA Page 2)

Year	% Share of Total Final Energy Consumption						energy/ economy ratio toe/k\$
	Coal %	Oil %	Gas %	Elec %	Elec+ Gas %	Oil+ Coal %	
1960	62.60	26.97	2.47	7.96	10.43	89.57	0.26
1961	57.43	31.92	2.43	8.23	10.65	89.35	0.26
1962	53.32	36.14	2.49	8.05	10.54	89.46	0.27
1963	50.36	39.32	2.36	7.96	10.32	89.68	0.29
1964	45.30	43.75	2.51	8.43	10.95	89.05	0.28
1965	40.44	48.14	2.60	8.81	11.41	88.59	0.27
1966	33.87	52.50	4.58	9.05	13.63	86.37	0.27
1967	31.94	53.64	5.08	9.34	14.42	85.58	0.27
1968	29.06	55.28	6.10	9.56	15.66	84.34	0.28
1969	27.02	56.71	6.63	9.64	16.27	83.73	0.29
1970	25.99	57.37	5.67	10.97	16.63	83.37	0.26
1971	20.43	60.35	7.48	11.74	19.22	80.78	0.25
1972	17.54	60.97	9.21	12.29	21.50	78.50	0.25
1973	16.43	60.91	10.25	12.41	22.65	77.35	0.25
1974	18.16	56.95	11.51	13.39	24.89	75.11	0.24
1975	14.73	58.59	11.88	14.81	26.69	73.31	0.24
1976	13.57	58.22	13.04	15.17	28.21	71.79	0.24
1977	12.49	57.62	14.39	15.50	29.89	70.11	0.24
1978	11.62	58.49	14.09	15.79	29.89	70.11	0.24
1979	12.38	57.21	14.62	15.79	30.41	69.59	0.24
1980	13.31	54.49	15.58	16.62	32.20	67.80	0.22
1981	13.88	52.02	16.56	17.55	34.10	65.90	0.21
1982	13.40	52.14	16.24	18.21	34.46	65.54	0.21
1983	12.99	51.80	16.76	18.46	35.22	64.78	0.21
1984	13.59	50.65	17.37	18.39	35.76	64.24	0.21
1985	13.60	50.46	17.64	18.30	35.94	64.06	0.21

TABLE 8

GERMANY

(File: GERDATA Page 3)

% Market Shares of Total Final Energy Consumption in Germany

Year	Calculated Shares %					Actual Shares %			
	Elec	Gas	Coal	Coal + Oil	Oil	Elec	Gas	Coal	Oil
1960	7.02	1.93	63.01	91.07	28.06	7.96	2.47	62.60	26.97
1961	7.39	2.21	58.20	90.47	32.27	8.23	2.43	57.43	31.92
1962	7.78	2.53	53.26	89.79	36.53	8.05	2.49	53.32	36.14
1963	8.18	2.89	48.33	89.03	40.71	7.96	2.36	50.36	39.32
1964	8.59	3.29	43.54	88.19	44.65	8.43	2.51	45.30	43.75
1965	9.02	3.75	39.01	87.25	48.24	8.81	2.60	40.44	48.14
1966	9.47	4.25	34.85	86.23	51.38	9.05	4.58	33.87	52.50
1967	9.92	4.81	31.11	85.11	54.00	9.34	5.08	31.94	53.64
1968	10.39	5.43	27.82	83.92	56.10	9.56	6.10	29.06	55.28
1969	10.88	6.11	24.98	82.64	57.66	9.64	6.63	27.02	56.71
1970	11.37	6.85	22.57	81.31	58.73	10.97	5.67	25.99	57.37
1971	11.87	7.65	20.56	79.91	59.36	11.74	7.48	20.43	60.35
1972	12.38	8.50	18.89	78.49	59.60	12.29	9.21	17.54	60.97
1973	12.90	9.39	17.52	77.04	59.52	12.41	10.25	16.43	60.91
1974	13.42	10.32	16.41	75.59	59.18	13.39	11.51	18.16	56.95
1975	13.95	11.27	15.51	74.16	58.65	14.81	11.88	14.73	58.59
1976	14.48	12.22	14.79	72.77	57.98	15.17	13.04	13.57	58.22
1977	15.01	13.15	14.21	71.43	57.22	15.50	14.39	12.49	57.62
1978	15.54	14.04	13.75	70.15	56.40	15.79	14.09	11.62	58.49
1979	16.07	14.87	13.39	68.95	55.56	15.79	14.62	12.38	57.21
1980	16.58	15.61	13.10	67.83	54.74	16.62	15.58	13.31	54.49
1981	17.09	16.25	12.86	66.80	53.94	17.55	16.56	13.88	52.02
1982	17.59	16.78	12.68	65.86	53.18	18.21	16.24	13.40	52.14
1983	18.07	17.20	12.54	65.01	52.47	18.46	16.76	12.99	51.80
1984	18.54	17.50	12.42	64.25	51.82	18.39	17.37	13.59	50.65
1985	18.99	17.72	12.33	63.57	51.23	18.30	17.64	13.60	50.46
1990	20.89	18.00	12.10	61.19	49.09				
1995	22.13	18.00	12.03	60.01	47.98				
2000	22.74	18.00	12.01	59.46	47.45				
2005	22.95	18.00	12.00	59.21	47.20				
2010	22.99	18.00	12.00	59.09	47.09				
1900	0.19	0.00	95.00	95.00	-0.00				

Electricity % = $A \cdot (1 - (B^C)^x) = [e \%$

$A = 23.0$; $B = 0.1743$; $C = 1.0648$; $x = (\text{Year} - 1985)$

Gas % = $A \cdot (1 - (B^C)^x) = [g \%$

$A = 18.0$; $B = 0.0158$; $C = 1.1547$; $x = (\text{Year} - 1985)$

Coal % = $Z + (95 - Z) / (1 + B^C)^x = [c \%$

$Z = 12.0$; $B = 247.15$; $C = 1.2701$; $x = (\text{Year} - 1985)$

(Coal + Oil) % = $Z + (95 - Z) / (1 + B^C)^x = [c + o \%$

$Z = 59.0$; $B = 6.8837$; $C = 1.1748$; $x = (\text{Year} - 1985)$

Oil % = $([c + o \%] - [c \%])$

TABLE 9

GERMANY

(File: GERDATA Page 4)

**% Market Shares of Total Final Energy Consumption in Germany
Differences between Calculated, and Actual % Market Shares**

Year	Sum of Calculated % Share	Calculated % - Actual %				Squares the Differences			
		Elec	Gas	Coal	Oil	Elec	Gas	Coal	Oil
1960	100.02	-0.95	-0.53	0.41	1.09	0.89	0.28	0.17	1.19
1961	100.07	-0.84	-0.21	0.77	0.35	0.70	0.04	0.59	0.12
1962	100.10	-0.27	0.05	-0.07	0.39	0.08	0.00	0.00	0.16
1963	100.10	0.22	0.53	-2.03	1.38	0.05	0.28	4.14	1.92
1964	100.08	0.16	0.78	-1.77	0.90	0.03	0.61	3.12	0.81
1965	100.02	0.21	1.15	-1.43	0.09	0.04	1.32	2.04	0.01
1966	99.95	0.42	-0.33	0.98	-1.12	0.17	0.11	0.96	1.26
1967	99.85	0.58	-0.26	-0.83	0.37	0.34	0.07	0.69	0.13
1968	99.75	0.83	-0.67	-1.24	0.82	0.69	0.44	1.53	0.67
1969	99.63	1.23	-0.51	-2.04	0.95	1.52	0.26	4.15	0.91
1970	99.53	0.40	1.19	-3.42	1.36	0.16	1.41	11.68	1.84
1971	99.44	0.13	0.17	0.13	-0.99	0.02	0.03	0.02	0.99
1972	99.37	0.09	-0.71	1.35	-1.37	0.01	0.50	1.83	1.87
1973	99.33	0.49	-0.85	1.09	-1.39	0.24	0.73	1.18	1.95
1974	99.34	0.04	-1.18	-1.75	2.23	0.00	1.40	3.05	4.97
1975	99.39	-0.86	-0.61	0.78	0.07	0.74	0.37	0.62	0.00
1976	99.47	-0.69	-0.82	1.22	-0.24	0.47	0.68	1.49	0.06
1977	99.59	-0.49	-1.24	1.73	-0.41	0.24	1.54	2.98	0.17
1978	99.74	-0.25	-0.05	2.13	-2.09	0.06	0.00	4.55	4.38
1979	99.89	0.28	0.25	1.00	-1.64	0.08	0.06	1.01	2.70
1980	100.03	-0.04	0.03	-0.22	0.25	0.00	0.00	0.05	0.06
1981	100.15	-0.45	-0.30	-1.01	1.92	0.21	0.09	1.02	3.68
1982	100.24	-0.62	0.54	-0.72	1.04	0.39	0.29	0.52	1.09
1983	100.28	-0.38	0.44	-0.45	0.68	0.15	0.19	0.20	0.46
1984	100.29	0.15	0.14	-1.17	1.17	0.02	0.02	1.37	1.38
1985	100.27	0.70	0.07	-1.26	0.77	0.48	0.01	1.59	0.59
1990	100.09								
1995	100.14	avg=	avg=	avg=	avg=	Sum =	Sum =	Sum =	Sum =
2000	100.20	0.003	-0.113	-0.300	0.253	7.77	10.74	50.55	33.36
2005	100.16	std =	std =	std =	std =				
2010	100.09	0.547	0.633	1.362	1.104				

Period 1960/85 :- avg = 99.84; std = 0.32

Note in the second column above, that the sum of the independently derived Shares of Electricity, Gas, Coal, and Oil remains close to 100 % not only in the region of interpolation, from 1960 to 1985, but also in the region of extrapolation from 1986 onwards. This justifies credence in the validity of the derived models.

TABLE 10

GERMANY

(File: GERDATA Page 5)

% Market Shares of Total Final Energy Consumption in Germany

% Market Shares of Total Final Energy Consumption										
Calculated Shares %										
Year	Ani- mal etc ={&}	Elec	Gas	Coal	Oil	{&}+ Coal	{&}+ Coal +Oil	{&}+ Coal +Oil+ Elec +Gas	{&}+ Coal +Oil	{&}+ Coal +Oil
1910	4.64	0.36	0.00	95.00	-0.00	99.64	99.64	100	100.00	100.00
1912	4.59	0.41	0.00	95.00	-0.00	99.59	99.59	100	100.00	100.00
1914	4.54	0.46	0.00	95.00	-0.00	99.54	99.53	100	100.00	100.00
1916	4.48	0.52	0.00	95.00	-0.00	99.48	99.47	100	100.00	100.00
1918	4.41	0.59	0.00	95.00	-0.00	99.41	99.40	100	100.00	100.00
1920	4.33	0.67	0.01	95.00	-0.00	99.33	99.32	100	100.00	100.00
1922	4.24	0.76	0.01	94.99	-0.00	99.24	99.23	100	100.00	100.00
1924	4.14	0.86	0.01	94.99	-0.00	99.13	99.13	100	100.00	100.00
1926	4.03	0.97	0.02	94.98	-0.00	99.02	99.01	100	100.00	100.00
1928	3.91	1.10	0.02	94.98	-0.00	98.88	98.88	100	100.00	100.00
1930	3.77	1.24	0.03	94.96	0.00	98.73	98.73	100	100.00	100.00
1932	3.61	1.40	0.04	94.94	0.02	98.55	98.56	100	100.00	100.00
1934	3.44	1.58	0.05	94.90	0.04	98.33	98.37	100	100.00	100.00
1936	3.24	1.78	0.06	94.83	0.08	98.08	98.15	99.9	100.00	100.00
1938	3.03	2.01	0.09	94.73	0.14	97.76	97.90	99.9	100.00	100.00
1940	2.79	2.27	0.11	94.57	0.26	97.36	97.62	99.9	100.00	100.00
1942	2.53	2.55	0.15	94.30	0.46	96.84	97.29	99.8	100.00	100.00
1944	2.26	2.87	0.20	93.88	0.79	96.14	96.92	99.8	100.00	100.00
1946	1.96	3.23	0.27	93.21	1.34	95.16	96.50	99.7	100.00	100.00
1948	1.64	3.62	0.36	92.15	2.23	93.79	96.02	99.6	100.00	100.00
1950	1.32	4.06	0.48	90.49	3.65	91.81	95.46	99.5	100.00	100.00
1952	0.99	4.55	0.64	87.96	5.86	88.95	94.82	99.4	100.00	100.00
1954	0.68	5.08	0.84	84.21	9.19	84.88	94.07	99.2	100.00	100.00
1956	0.39	5.67	1.12	78.88	13.95	79.27	93.21	98.9	100.00	100.00
1958	0.15	6.32	1.47	71.76	20.30	71.91	92.21	98.5	100.00	100.00
1960	0.00	7.02	1.93	63.01	28.06	63.01	91.07	98.1	100.02	100.02
1962	0.00	7.78	2.53	53.26	36.53	53.26	89.79	97.6	100.10	100.10
1964	0.00	8.59	3.29	43.54	44.65	43.54	88.19	96.8	100.08	100.08
1966	0.00	9.47	4.25	34.85	51.38	34.85	86.23	95.7	99.95	99.95
1968	0.00	10.39	5.43	27.82	56.10	27.82	83.92	94.3	99.75	99.75
1970	0.00	11.37	6.85	22.57	58.73	22.57	81.31	92.7	99.53	99.53
1972	0.00	12.38	8.50	18.89	59.60	18.89	78.49	90.9	99.37	99.37
1974	0.00	13.42	10.32	16.41	59.18	16.41	75.59	89.0	99.34	99.34
1976	0.00	14.48	12.22	14.79	57.98	14.79	72.77	87.3	99.47	99.47
1978	0.00	15.54	14.04	13.75	56.40	13.75	70.15	85.7	99.74	99.74
1980	0.00	16.58	15.61	13.10	54.74	13.10	67.83	84.4	100.03	100.03
1982	0.00	17.59	16.78	12.68	53.18	12.68	65.86	83.5	100.24	100.24
1984	0.00	18.54	17.50	12.42	51.82	12.42	64.25	82.8	100.29	100.29
1986	0.00	19.42	17.85	12.26	50.70	12.26	62.96	82.4	100.23	100.23
1988	0.00	20.21	17.97	12.16	49.80	12.16	61.96	82.2	100.14	100.14
1990	0.00	20.89	18.00	12.10	49.09	12.10	61.19	82.1	100.09	100.09
1992	0.00	21.47	18.00	12.06	48.55	12.06	60.62	82.1	100.09	100.09
1994	0.00	21.94	18.00	12.04	48.15	12.04	60.19	82.1	100.12	100.12
1996	0.00	22.29	18.00	12.02	47.84	12.02	59.87	82.2	100.16	100.16
1998	0.00	22.56	18.00	12.02	47.62	12.02	59.63	82.2	100.19	100.19
2000	0.00	22.74	18.00	12.01	47.45	12.01	59.46	82.2	100.20	100.20
2002	0.00	22.86	18.00	12.01	47.33	12.01	59.33	82.2	100.19	100.19
2004	0.00	22.93	18.00	12.00	47.24	12.00	59.24	82.2	100.17	100.17
2006	0.00	22.97	18.00	12.00	47.17	12.00	59.18	82.1	100.14	100.14
2008	0.00	22.99	18.00	12.00	47.13	12.00	59.13	82.1	100.11	100.11
2010	0.00	22.99	18.00	12.00	47.09	12.00	59.09	82.1	100.09	100.09

Electricity % = $A \cdot (1 - B \cdot (C^x))$ = [e %]
 A = 23.0 ; B = 0.1743 ; C = 1.0648 ; x = (Year - 1985)

Gas % = $A \cdot (1 - B \cdot (C^x))$ = [g %]
 A = 18.0 ; B = 0.0158 ; C = 1.1547 ; x = (Year - 1985)

Coal % = $Z + (95 - Z) / (1 + B \cdot (C^x))$ = [c %]
 Z = 12.0 ; B = 247.15 ; C = 1.2701 ; x = (Year - 1985)

(Coal + Oil) % = $Z + (95 - Z) / (1 + B \cdot (C^x))$ = [c+o %]
 Z = 59.0 ; B = 6.8837 ; C = 1.1748 ; x = (Year - 1985)

Oil % = ([c+o %] - [c %])

SOUTH AFRICA

TABLE 11

SOUTH AFRICA

(File: ZASUMARY Page 1)

South Africa : Final Energy Consumption. Unit ktoe

Year	Final Consumption in 000's toe					% Market Share		
	Coal	Gas	Oil	Elec	Total	Coal	Oil +Gas	Elec
1950	8634		1767	826	11227	76.90	15.74	7.35
1951	9234		2001	878	12113	76.23	16.52	7.25
1952	9794		2101	924	12818	76.41	16.39	7.21
1953	9650		2121	1014	12785	75.48	16.59	7.93
1954	9638		2250	1121	13009	74.09	17.30	8.61
1955	10584		2470	1267	14322	73.90	17.25	8.85
1956	10944		2699	1368	15011	72.91	17.98	9.11
1957	11201		2855	1481	15537	72.09	18.38	9.53
1958	11788		3050	1564	16402	71.87	18.60	9.53
1959	11357		3168	1665	16190	70.15	19.57	10.29
1960	11525		3286	1797	16608	69.39	19.78	10.82
1961	11920		3507	1880	17307	68.87	20.27	10.86
1962	12046		3782	2025	17853	67.47	21.18	11.34
1963	12573		3979	2162	18714	67.18	21.26	11.55
1964	13322		4948	2337	20607	64.65	24.01	11.34
1965	14508		5121	2527	22155	65.48	23.11	11.40
1966	14130		5819	2684	22634	62.43	25.71	11.86
1967	14005		6183	2919	23106	60.61	26.76	12.63
1968	14400		5977	3145	23522	61.22	25.41	13.37
1969	14017		6580	3389	23986	58.44	27.43	14.13
1970	14202		7230	3754	25186	56.39	28.71	14.91
1971	16490	139	9036	4008	29673	56.04	30.45	13.51
1972	15466	139	8951	4403	28959	53.89	30.91	15.21
1973	15603	150	9969	4742	30463	51.71	32.72	15.56
1974	15771	176	9680	5116	30743	51.87	31.49	16.64
1975	16396	231	10288	5488	32402	51.31	31.75	16.94
1976	16681	234	10480	5923	33317	50.77	31.45	17.78
1977	16189	224	10372	6253	33037	49.68	31.39	18.93
1978	15924	230	10568	6724	33446	48.30	31.60	20.10
1979	14746	284	10168	7371	32569	46.15	31.22	22.63
1980	15564	321	10345	7959	34189	46.46	30.26	23.28
1981	16959	312	11347	8439	37057	46.61	30.62	22.77
1982	16225	284	11615	8597	36721	44.96	31.63	23.41
1983	14818	322	11825	8830	35795	42.30	33.04	24.67
1984	16433	323	12729	9671	39157	42.79	32.51	24.70
1985	15506	305	12651	10116	38578	40.98	32.79	26.22
1986	15207	302	12814	10646	38970	39.80	32.88	27.32
1987	15349	296	13177	10955	39776	39.33	33.13	27.54
1988	16033	298	14100	11410	41841	39.03	33.70	27.27

TABLE 12

SOUTH AFRICA

(File ZASUMMARY Page 2)

% Market Shares of the carriers of Total Final Energy Consumption

Year	Calculated Shares %			Actual Shares %			(Calc-Actual) ^2		
	Coal +Gas	Oil	Elec	Coal +Gas	Oil	Elec	Coal +Gas	Oil	Elec
1950	78.01	13.44	8.56	76.90	15.74	7.35	1.2	5.3	1.4
1951	77.22	14.12	8.66	76.23	16.52	7.25	1.0	5.8	2.0
1952	76.41	14.82	8.77	76.41	16.39	7.21	0.0	2.5	2.4
1953	75.57	15.54	8.89	75.48	16.59	7.93	0.0	1.1	0.9
1954	74.71	16.27	9.02	74.09	17.30	8.61	0.4	1.0	0.2
1955	73.81	17.03	9.16	73.90	17.25	8.85	0.0	0.0	0.1
1956	72.89	17.79	9.32	72.91	17.98	9.11	0.0	0.0	0.0
1957	71.94	18.57	9.49	72.09	18.38	9.53	0.0	0.0	0.0
1958	70.96	19.36	9.69	71.87	18.60	9.53	0.8	0.6	0.0
1959	69.95	20.15	9.90	70.15	19.57	10.29	0.0	0.3	0.1
1960	68.92	20.94	10.13	69.39	19.78	10.82	0.2	1.3	0.5
1961	67.87	21.74	10.39	68.87	20.27	10.86	1.0	2.2	0.2
1962	66.79	22.53	10.68	67.47	21.18	11.34	0.5	1.8	0.4
1963	65.69	23.31	11.00	67.18	21.26	11.55	2.2	4.2	0.3
1964	64.57	24.08	11.35	64.65	24.01	11.34	0.0	0.0	0.0
1965	63.43	24.84	11.73	65.48	23.11	11.40	4.2	3.0	0.1
1966	62.27	25.58	12.15	62.43	25.71	11.86	0.0	0.0	0.1
1967	61.10	26.29	12.61	60.61	26.76	12.63	0.2	0.2	0.0
1968	59.92	26.98	13.11	61.22	25.41	13.37	1.7	2.5	0.1
1969	58.73	27.63	13.64	58.44	27.43	14.13	0.1	0.0	0.2
1970	57.53	28.25	14.22	56.39	28.71	14.91	1.3	0.2	0.5
1971	56.33	28.84	14.84	56.04	30.45	13.51	0.1	2.6	1.8
1972	55.13	29.38	15.49	53.89	30.91	15.21	1.5	2.3	0.1
1973	53.93	29.88	16.19	51.71	32.72	15.56	4.9	8.1	0.4
1974	52.74	30.34	16.91	51.87	31.49	16.64	0.8	1.3	0.1
1975	51.56	30.76	17.68	51.31	31.75	16.94	0.1	1.0	0.5
1976	50.40	31.13	18.47	50.77	31.45	17.78	0.1	0.1	0.5
1977	49.26	31.46	19.28	49.68	31.39	18.93	0.2	0.0	0.1
1978	48.14	31.75	20.11	48.30	31.60	20.10	0.0	0.0	0.0
1979	47.05	32.00	20.95	46.15	31.22	22.63	0.8	0.6	2.8
1980	45.98	32.21	21.80	46.46	30.26	23.28	0.2	3.8	2.2
1981	44.96	32.39	22.65	46.61	30.62	22.77	2.7	3.1	0.0
1982	43.97	32.53	23.50	44.96	31.63	23.41	1.0	0.8	0.0
1983	43.03	32.65	24.32	42.30	33.04	24.67	0.5	0.1	0.1
1984	42.13	32.74	25.13	42.79	32.51	24.70	0.4	0.1	0.2
1985	41.27	32.81	25.91	40.98	32.79	26.22	0.1	0.0	0.1
1986	40.47	32.87	26.66	39.80	32.88	27.32	0.5	0.0	0.4
1987	39.72	32.91	27.37	39.33	33.13	27.54	0.1	0.0	0.0
1988	39.02	32.94	28.04	39.03	33.70	27.27	0.0	0.6	0.6
1990	37.79	32.98	29.24						
1995	35.61	33.00	31.39				sum=	sum=	sum=
2000	34.53	33.00	32.47				29.1	56.8	19.6
2005	34.12	33.00	32.88						
2010	34.02	33.00	32.98						

Y[o] = Calculated Oil % = A*(1-B^(C^x)), where x = (Year- 1985),

A = 33.00 ; B = 0.00562 ; C = 1.06772 [File ZAOSIGMO]

Y[c] = Calculated (Coal + Gas) % = Z + (95-Z)*(B^(C^x)), where

Z = 34 ; B = 0.11924 ; C = 1.05499 [File ZACSIGM]

Y[e] = Calculated Electricity % = (100 - Y[o] - Y[c])

TABLE 13

SOUTH AFRICA

(File: ZASUMMARY Page 3)

Calculated values of the % Market Shares of the carriers of Total Final Energy Consumption in South Africa.

Year	Animal +Wind (etc)	Coal +Gas	Oil	Elec	Coal +Gas +Wind +(etc)	Oil+ Coal +Gas +(etc)	Oil+ Coal +Gas +(etc) +Elec
1900	4.53	93.65	0.65	1.18	98.17	98.82	100.0
1910	3.53	92.70	1.23	2.54	96.23	97.46	100.0
1912	3.23	92.45	1.40	2.92	95.68	97.08	100.0
1914	2.90	92.17	1.59	3.34	95.07	96.66	100.0
1916	2.56	91.86	1.81	3.78	94.42	96.22	100.0
1918	2.21	91.51	2.05	4.22	93.73	95.78	100.0
1920	1.88	91.13	2.33	4.66	93.01	95.34	100.0
1922	1.57	90.71	2.64	5.08	92.28	94.92	100.0
1924	1.29	90.24	3.00	5.47	91.53	94.53	100.0
1926	1.04	89.73	3.39	5.84	90.77	94.16	100.0
1928	0.83	89.16	3.84	6.16	90.00	93.84	100.0
1930	0.66	88.54	4.34	6.46	89.20	93.54	100.0
1932	0.51	87.86	4.90	6.73	88.37	93.27	100.0
1934	0.40	87.10	5.53	6.97	87.50	93.03	100.0
1936	0.31	86.28	6.22	7.19	86.59	92.81	100.0
1938	0.24	85.37	6.99	7.39	85.61	92.61	100.0
1940	0.18	84.39	7.85	7.58	84.57	92.42	100.0
1942	0.14	83.31	8.79	7.77	83.45	92.23	100.0
1944	0.11	82.14	9.81	7.94	82.24	92.06	100.0
1946	0.08	80.87	10.93	8.12	80.95	91.88	100.0
1948	0.06	79.49	12.14	8.31	79.55	91.69	100.0
1950	0.05	78.01	13.44	8.51	78.05	91.49	100.0
1952	0.00	76.41	14.82	8.77	76.41	91.23	100.0
1954	0.00	74.71	16.27	9.02	74.71	90.98	100.0
1956	0.00	72.89	17.79	9.32	72.89	90.68	100.0
1958	0.00	70.96	19.36	9.69	70.96	90.31	100.0
1960	0.00	68.92	20.94	10.13	68.92	89.87	100.0
1962	0.00	66.79	22.53	10.68	66.79	89.32	100.0
1964	0.00	64.57	24.08	11.35	64.57	88.65	100.0
1966	0.00	62.27	25.58	12.15	62.27	87.85	100.0
1968	0.00	59.92	26.98	13.11	59.92	86.89	100.0
1970	0.00	57.53	28.25	14.22	57.53	85.78	100.0
1972	0.00	55.13	29.38	15.49	55.13	84.51	100.0
1974	0.00	52.74	30.34	16.91	52.74	83.09	100.0
1976	0.00	50.40	31.13	18.47	50.40	81.53	100.0
1978	0.00	48.14	31.75	20.11	48.14	79.89	100.0
1980	0.00	45.98	32.21	21.80	45.98	78.20	100.0
1982	0.00	43.97	32.53	23.50	43.97	76.50	100.0
1984	0.00	42.13	32.74	25.13	42.13	74.87	100.0
1986	0.00	40.47	32.87	26.66	40.47	73.34	100.0
1988	0.00	39.02	32.94	28.04	39.02	71.96	100.0
1990	0.00	37.79	32.98	29.24	37.79	70.76	100.0
1992	0.00	36.77	32.99	30.24	36.77	69.76	100.0
1994	0.00	35.95	33.00	31.05	35.95	68.95	100.0
1996	0.00	35.32	33.00	31.68	35.32	68.32	100.0
1998	0.00	34.86	33.00	32.14	34.86	67.86	100.0
2000	0.00	34.53	33.00	32.47	34.53	67.53	100.0
2002	0.00	34.31	33.00	32.69	34.31	67.31	100.0
2004	0.00	34.17	33.00	32.83	34.17	67.17	100.0
2006	0.00	34.09	33.00	32.91	34.09	67.09	100.0
2008	0.00	34.04	33.00	32.96	34.04	67.04	100.0
2010	0.00	34.02	33.00	32.98	34.02	67.02	100.0

UNITED KINGDOM

TABLE 14 UNITED KINGDOM
 (File: UKDUTDAT Page 1)
 U.K. Energy data compiled from official sources, by R.K. Dutkiewicz
 United Kingdom : Final Energy Consumption

In million tce up to 1965, and in million Therm thereafter

Year	Elec.	Coal	Oil	Town gas	Nat. Gas	Other [solid]	Total
1923	0.0	133.9	4.7	10.5	0	23.5	172.6
1924	0.0	139.2	5.5	11.1	0	24.1	179.9
1925	0.0	132.4	5.4	11.0	0	22.1	170.9
1926	0.0	134.4	6.7	11.0	0	23.0	175.1
1927	0.0	136.4	7.4	11.4	0	23.9	179.1
1928	0.0	124.6	7.5	11.4	0	22.9	166.4
1929	0.0	130.9	7.5	11.7	0	25.4	175.5
1930	1.2	124.8	8.8	11.4	0	22.7	168.9
1931	1.3	117.7	8.6	11.2	0	17.0	155.8
1932	1.4	115.1	8.8	11.0	0	18.0	154.3
1933	1.5	114.2	9.4	10.8	0	18.3	154.2
1934	1.7	120.3	10.2	11.2	0	22.5	165.9
1935	2.0	123.8	10.5	11.3	0	22.7	170.3
1936	2.3	127.9	11.1	12.1	0	26.2	179.6
1937	2.6	131.4	11.7	12.3	0	27.9	185.9
1938	2.7	123.6	12.8	12.2	0	25.3	176.6
1939	3.0	122.4	12.9	12.5	0	25.8	176.6
1940	3.2	121.3	12.9	13.0	0	26.4	176.8
1941	3.6	120.1	13.0	13.2	0	26.9	176.8
1942	4.0	119.0	13.0	13.8	0	27.5	177.3
1943	4.2	117.9	13.1	14.2	0	28.0	177.4
1944	4.3	116.8	13.2	14.6	0	28.6	177.5
1945	4.2	115.7	13.2	15.0	0	29.2	177.3
1946	4.6	114.6	13.3	15.5	0	29.8	177.8
1947	4.8	112.3	17.3	16.2	0	30.1	180.7
1948	5.2	115.9	18.4	16.6	0	31.2	187.3
1949	5.5	115.4	19.6	16.9	0	31.4	188.8
1950	6.1	118.5	21.7	17.5	0	32.4	196.2
1951	6.7	118.7	24.0	17.9	0	34.4	201.7
1952	6.9	115.3	25.2	17.8	0	35.2	200.4
1953	7.4	115.4	27.4	17.3	0	36.3	203.8
1954	8.2	117.2	30.2	17.7	0	37.9	211.2
1955	9.0	114.5	33.7	17.7	0	38.3	213.2
1956	9.8	111.8	36.6	17.6	0	39.1	214.9
1957	10.3	106.1	35.4	16.7	0	38.5	207.0
1958	11.2	100.2	42.0	16.7	0	35.8	205.9
1959	12.1	92.6	47.5	16.0	0	33.1	201.3
1960	13.6	92.4	54.8	16.1	0	37.1	214.0
1961	14.7	84.4	59.6	16.1	0	35.2	210.0
1962	16.3	81.3	66.0	16.8	0	33.7	214.1
1963	17.8	77.6	73.0	17.6	0	34.3	220.3
1964	18.7	70.1	78.6	18.1	0	35.0	220.5
1965	5155	17409	19820	3338	0	8098	53820
1966	5354	16122	21034	3685	0	7502	53697
1967	5516	14402	22492	3983	1	7084	53478
1968	5934	13613	24063	4352	82	7239	55283
1969	6327	12883	25628	4536	426	7050	56850
1970	6616	11839	27198	4266	1454	6629	58002
1971	6805	9867	27617	3526	3744	5699	57258
1972	7041	8085	28634	3213	5980	5125	58078
1973	7527	8064	29623	2323	8172	5350	61059
1974	7298	7544	27024	1523	10217	4689	58295
1975	7285	6420	25715	713	11597	4169	55899
1976	7380	6019	26193	212	13182	4362	57348
1977	7537	6154	26741	69	14051	3996	58548
1978	7689	5738	26996	32	14993	3692	59140
1979	8040	6064	27323	36	16417	3827	61707
1980	7679	5103	24775	31	16562	2413	56563
1981	7562	4748	23192	0	16631	2829	54962
1982	7407	4831	22772	0	16691	2614	54315
1983	7518	4640	22412	0	16906	2709	54185
1984	7653	3840	22691	0	17208	2520	53912
1985	7987	4814	22397	0	18253	2862	56313
1986	8243	4902	23519	0	18517	2664	57845
1987	8520	4451	23440	0	19383	2883	58677
1988	8724	4284	24890	0	18665	2912	59475
1989	8909	3842	25209	0	18383	2733	59076

TABLE 15

UNITED KINGDOM

(File: UKDUTDAT Page 2)

[R.K.D.-data]

United Kingdom : Total Final Energy Consumption
 Percentage Market Shares of Different Energy Carriers

Year	Elec. %	Coal+ other [solid] %	Oil %	Gas %	Oil + Gas %
1923	0.000	91.194	2.723	6.083	8.806
1924	0.000	90.773	3.057	6.170	9.227
1925	0.000	90.404	3.160	6.437	9.596
1926	0.000	89.891	3.826	6.282	10.109
1927	0.000	89.503	4.132	6.365	10.497
1928	0.000	88.642	4.507	6.851	11.358
1929	0.000	89.060	4.274	6.667	10.940
1930	0.724	87.318	5.209	6.749	11.958
1931	0.813	86.475	5.521	7.190	12.711
1932	0.880	86.285	5.705	7.131	12.836
1933	0.975	85.926	6.096	7.004	13.100
1934	1.036	86.066	6.148	6.750	12.898
1935	1.147	86.049	6.167	6.637	12.805
1936	1.254	85.825	6.182	6.739	12.921
1937	1.375	85.712	6.295	6.618	12.913
1938	1.540	84.305	7.247	6.907	14.155
1939	1.679	83.935	7.306	7.080	14.386
1940	1.829	83.524	7.295	7.351	14.646
1941	2.059	83.125	7.351	7.464	14.816
1942	2.277	82.611	7.331	7.782	15.112
1943	2.364	82.247	7.385	8.005	15.390
1944	2.442	81.899	7.435	8.224	15.659
1945	2.359	81.734	7.446	8.461	15.907
1946	2.609	81.197	7.479	8.716	16.194
1947	2.646	78.813	9.575	8.966	18.541
1948	2.764	78.547	9.825	8.864	18.689
1949	2.890	77.772	10.384	8.953	19.337
1950	3.091	76.926	11.062	8.921	19.983
1951	3.339	75.892	11.897	8.873	20.770
1952	3.456	75.090	12.573	8.881	21.454
1953	3.635	74.432	13.444	8.488	21.932
1954	3.877	73.442	14.300	8.381	22.681
1955	4.217	71.673	15.808	8.302	24.110
1956	4.561	70.218	17.031	8.190	25.221
1957	4.974	69.857	17.102	8.068	25.170
1958	5.432	66.057	20.400	8.111	28.511
1959	5.996	62.454	23.600	7.950	31.550
1960	6.376	60.500	25.602	7.522	33.123
1961	6.999	56.953	28.381	7.667	36.048
1962	7.619	53.710	30.825	7.846	38.671
1963	8.099	50.784	33.130	7.987	41.117
1964	8.488	47.661	35.644	8.208	43.852
1965	9.577	47.394	36.827	6.202	43.029
1966	9.972	43.995	39.171	6.863	46.034
1967	10.314	40.177	42.058	7.450	49.508
1968	10.734	37.718	43.527	8.021	51.547
1969	11.129	35.063	45.080	8.728	53.809
1970	11.407	31.840	46.891	9.862	56.753
1971	11.885	27.186	48.233	12.697	60.930
1972	12.124	22.745	49.302	15.829	65.131
1973	12.327	21.969	48.516	17.188	65.704
1974	12.520	20.985	46.357	20.139	66.496
1975	13.032	18.943	46.003	22.022	68.025
1976	12.868	18.102	45.674	23.356	69.030
1977	12.874	17.336	45.673	24.117	69.790
1978	13.001	15.945	45.648	25.406	71.054
1979	13.030	16.029	44.278	26.663	70.942
1980	13.576	13.288	43.801	29.336	73.136
1981	13.758	13.786	42.197	30.259	72.456
1982	13.638	13.707	41.926	30.730	72.655
1983	13.875	13.563	41.362	31.200	72.562
1984	14.195	11.797	42.089	31.919	74.008
1985	14.183	13.631	39.772	32.413	72.186
1986	14.250	13.080	40.659	32.011	72.670
1987	14.520	12.499	39.948	33.033	72.981
1988	14.668	12.099	41.850	31.383	73.232
1989	15.081	11.130	42.672	31.118	73.790

TABLE 16

UNITED KINGDOM

(File: UKDUTDAT page 3) [R.K.D.-data]

Moving average Value, and Slope, of the curves of the % Market Shares of Total Final Energy Consumption

Year	Elec %	Coal+ Other %	Oil+ Gas %	Elec slope	Coal+ Other slope	Oil+ Gas slope
1923	The ten year averages are placed in the centres of the corresponding 11 year data - spans.					
1924	The values are calculated by fitting an linear equation (y=a+b*x) to each moving 11 year data-span. Note maximum slopes					
1925						
1926						
1927						
1928	0.31	88.68	11.01	0.112	-0.561	0.449
1929	0.40	88.21	11.38	0.128	-0.542	0.414
1930	0.51	87.78	11.71	0.140	-0.501	0.361
1931	0.62	87.37	12.01	0.146	-0.447	0.301
1932	0.75	86.99	12.27	0.147	-0.385	0.238
1933	0.89	86.51	12.60	0.142	-0.369	0.227
1934	1.04	86.09	12.87	0.130	-0.371	0.241
1935	1.20	85.58	13.21	0.109	-0.325	0.216
1936	1.33	85.20	13.47	0.122	-0.342	0.220
1937	1.46	84.85	13.69	0.137	-0.390	0.254
1938	1.59	84.48	13.92	0.146	-0.431	0.284
1939	1.73	84.12	14.15	0.151	-0.469	0.318
1940	1.85	83.72	14.43	0.142	-0.472	0.329
1941	1.98	83.28	14.74	0.138	-0.460	0.321
1942	2.11	82.65	15.25	0.129	-0.524	0.395
1943	2.23	81.99	15.77	0.119	-0.543	0.424
1944	2.36	81.40	16.24	0.111	-0.609	0.498
1945	2.48	80.76	16.75	0.108	-0.674	0.567
1946	2.62	80.07	17.31	0.111	-0.745	0.634
1947	2.75	79.34	17.91	0.118	-0.805	0.687
1948	2.87	78.60	18.53	0.132	-0.849	0.717
1949	3.01	77.79	19.20	0.150	-0.884	0.734
1950	3.17	76.87	19.96	0.174	-0.939	0.765
1951	3.37	75.82	20.81	0.193	-0.975	0.782
1952	3.59	74.79	21.63	0.224	-0.953	0.729
1953	3.84	73.63	22.53	0.257	-1.130	0.873
1954	4.13	72.16	23.70	0.296	-1.370	1.074
1955	4.45	70.59	24.96	0.330	-1.594	1.264
1956	4.81	68.78	26.42	0.372	-1.869	1.497
1957	5.19	66.76	28.04	0.420	-2.166	1.746
1958	5.62	64.55	29.83	0.457	-2.438	1.981
1959	6.06	62.12	31.82	0.480	-2.667	2.187
1960	6.58	59.75	33.67	0.521	-2.719	2.198
1961	7.10	57.23	35.67	0.546	-2.784	2.238
1962	7.62	54.50	37.87	0.554	-2.852	2.298
1963	8.15	51.58	40.27	0.551	-2.777	2.226
1964	8.66	48.76	42.57	0.538	-2.738	2.200
1965	9.16	45.98	44.86	0.518	-2.761	2.243
1966	9.66	42.95	47.39	0.490	-2.823	2.333
1967	10.12	39.84	50.03	0.457	-2.978	2.521
1968	10.55	36.96	52.49	0.421	-3.034	2.614
1969	10.95	34.25	54.80	0.377	-3.006	2.630
1970	11.37	31.64	57.00	0.337	-2.970	2.634
1971	11.66	28.97	59.36	0.307	-2.726	2.419
1972	11.93	26.55	61.52	0.270	-2.436	2.166
1973	12.17	24.35	63.48	0.231	-2.175	1.944
1974	12.38	22.38	65.24	0.191	-1.824	1.632
1975	12.60	20.40	67.00	0.177	-1.545	1.368
1976	12.82	18.76	68.43	0.164	-1.221	1.057
1977	12.98	17.53	69.49	0.151	-0.991	0.840
1978	13.14	16.70	70.17	0.145	-0.887	0.742
1979	13.31	15.77	70.92	0.149	-0.822	0.673
1980	13.46	15.10	71.44	0.146	-0.635	0.489
1981	13.57	14.57	71.86	0.159	-0.517	0.358
1982	13.72	14.06	72.22	0.164	-0.419	0.255
1983	13.88	13.58	72.53	0.161	-0.329	0.168
1984	14.07	13.15	72.78	0.168	-0.312	0.144

TABLE 17

UNITED KINGDOM

(File: UKDUTDAT Page 4) [R.K.D.-data]

Moving average Value, and Slope, of the curves of the % Market Shares of Total Final Energy Consumption

Year	Elec %	Coal+ Other %	Oil + Gas %	Elec slope	Coal+ Other slope	Oil+ Gas slope
1923	The averages are placed in the centres					
1924	of the corresponding 7 year data - spans.					
1925	The values are calculated by fitting a linear					
1926	equation ($y=a+b*x$) to each moving 7 year					
1927	data-span. Note maximum slopes					
1928	0.22	88.76	11.02	0.139	-0.621	0.482
1929	0.35	88.17	11.49	0.178	-0.650	0.472
1930	0.48	87.60	11.91	0.196	-0.644	0.448
1931	0.63	87.11	12.26	0.186	-0.537	0.351
1932	0.80	86.74	12.46	0.151	-0.432	0.281
1933	0.98	86.28	12.75	0.086	-0.198	0.112
1934	1.07	86.05	12.88	0.093	-0.110	0.017
1935	1.17	85.74	13.09	0.107	-0.236	0.129
1936	1.29	85.40	13.31	0.120	-0.351	0.231
1937	1.41	85.06	13.53	0.133	-0.478	0.344
1938	1.55	84.64	13.81	0.150	-0.541	0.391
1939	1.72	84.15	14.14	0.169	-0.557	0.388
1940	1.87	83.64	14.49	0.172	-0.521	0.349
1941	2.03	83.09	14.88	0.162	-0.411	0.250
1942	2.14	82.73	15.13	0.127	-0.383	0.256
1943	2.28	82.33	15.39	0.111	-0.374	0.263
1944	2.39	81.66	15.95	0.086	-0.581	0.495
1945	2.49	81.01	16.50	0.078	-0.706	0.627
1946	2.58	80.32	17.10	0.090	-0.823	0.733
1947	2.69	79.56	17.76	0.113	-0.910	0.797
1948	2.81	78.70	18.49	0.148	-0.968	0.820
1949	2.97	77.75	19.28	0.152	-0.921	0.769
1950	3.12	76.78	20.10	0.171	-0.783	0.612
1951	3.29	76.01	20.69	0.185	-0.851	0.666
1952	3.50	75.03	21.47	0.209	-0.954	0.746
1953	3.74	73.95	22.31	0.235	-1.079	0.844
1954	4.01	72.94	23.05	0.275	-1.093	0.818
1955	4.31	71.54	24.15	0.332	-1.410	1.078
1956	4.67	69.73	25.60	0.391	-1.876	1.485
1957	5.06	67.74	27.20	0.426	-2.194	1.768
1958	5.51	65.39	29.10	0.464	-2.536	2.071
1959	5.99	62.82	31.18	0.506	-2.889	2.383
1960	6.50	60.04	33.46	0.527	-3.122	2.595
1961	7.00	56.87	36.12	0.522	-3.047	2.525
1962	7.59	54.21	38.20	0.574	-2.751	2.177
1963	8.16	51.57	40.27	0.600	-2.667	2.067
1964	8.72	48.67	42.61	0.576	-2.612	2.036
1965	9.26	45.92	44.82	0.545	-2.602	2.057
1966	9.76	43.26	46.99	0.511	-2.652	2.141
1967	10.23	40.55	49.22	0.451	-2.800	2.349
1968	10.72	37.62	51.66	0.379	-3.216	2.837
1969	11.08	34.10	54.82	0.367	-3.415	3.048
1970	11.42	30.96	57.63	0.342	-3.302	2.960
1971	11.73	28.22	60.05	0.302	-3.053	2.751
1972	12.06	25.53	62.41	0.299	-2.689	2.390
1973	12.31	23.11	64.58	0.253	-2.124	1.871
1974	12.52	21.04	66.44	0.184	-1.495	1.311
1975	12.68	19.43	67.89	0.145	-1.162	1.017
1976	12.81	18.47	68.72	0.104	-1.054	0.950
1977	12.99	17.23	69.78	0.118	-1.110	0.992
1978	13.16	16.20	70.63	0.134	-0.943	0.809
1979	13.25	15.46	71.29	0.166	-0.819	0.653
1980	13.39	14.81	71.80	0.179	-0.644	0.465
1981	13.58	14.02	72.40	0.191	-0.606	0.415
1982	13.75	13.69	72.56	0.172	-0.371	0.199
1983	13.93	13.26	72.81	0.123	-0.102	-0.021
1984	14.06	13.15	72.79	0.136	-0.180	0.044
1985	14.19	12.91	72.90	0.158	-0.202	0.044
1986	14.40	12.54	73.06	0.175	-0.280	0.105

TABLE 18

UNITED KINGDOM

(File: UKDUTDAT Page 5) [R.K.D.-data]

Moving average Value, and Slope, of the curves of the % Market Shares of Total Final Energy Consumption

Year	Elec %	Coal+ Other %	Oil+ Gas %	Elec slope	Coal+ Other slope	Oil+ Gas slope
1923	The averages are placed in the centres of the corresponding 5 year data - spans.					
1924	The values are calculated by fitting a linear equation (y=a+b*x) to each moving 5 year data-span. Note dates of maximum slopes					
1925						
1926						
1927						
1928	0.14	88.88	10.97	0.145	-0.559	0.414
1929	0.31	88.20	11.49	0.235	-0.738	0.503
1930	0.48	87.56	11.96	0.257	-0.730	0.473
1931	0.68	87.01	12.31	0.211	-0.730	0.520
1932	0.89	86.41	12.70	0.079	-0.305	0.227
1933	0.97	86.16	12.87	0.082	-0.107	0.025
1934	1.06	86.03	12.91	0.092	-0.080	-0.012
1935	1.16	85.92	12.93	0.102	-0.067	-0.035
1936	1.27	85.59	13.14	0.124	-0.386	0.262
1937	1.40	85.17	13.44	0.135	-0.575	0.440
1938	1.54	84.66	13.80	0.145	-0.638	0.492
1939	1.70	84.12	14.18	0.166	-0.595	0.430
1940	1.88	83.50	14.62	0.185	-0.420	0.235
1941	2.04	83.09	14.87	0.182	-0.429	0.247
1942	2.19	82.68	15.12	0.153	-0.413	0.260
1943	2.30	82.32	15.38	0.076	-0.349	0.273
1944	2.41	81.94	15.65	0.066	-0.334	0.268
1945	2.48	81.18	16.34	0.073	-0.757	0.684
1946	2.56	80.44	17.00	0.093	-0.963	0.869
1947	2.65	79.61	17.73	0.122	-1.057	0.936
1948	2.80	78.65	18.55	0.121	-0.958	0.837
1949	2.95	77.59	19.46	0.171	-0.746	0.575
1950	3.11	76.85	20.05	0.183	-0.880	0.696
1951	3.28	76.02	20.70	0.185	-0.852	0.666
1952	3.48	75.16	21.36	0.187	-0.843	0.656
1953	3.70	74.11	22.19	0.218	-1.008	0.791
1954	3.95	72.97	23.08	0.279	-1.250	0.971
1955	4.25	71.92	23.82	0.336	-1.238	0.901
1956	4.61	70.25	25.14	0.387	-1.659	1.272
1957	5.04	68.05	26.91	0.443	-2.260	1.817
1958	5.47	65.82	28.72	0.465	-2.684	2.219
1959	5.96	63.16	30.88	0.499	-3.136	2.637
1960	6.48	59.93	33.58	0.538	-3.020	2.482
1961	7.02	56.88	36.10	0.545	-3.013	2.468
1962	7.52	53.92	38.56	0.532	-3.185	2.653
1963	8.16	51.30	40.54	0.603	-2.517	1.914
1964	8.75	48.71	42.54	0.618	-2.282	1.664
1965	9.29	46.00	44.71	0.591	-2.488	1.896
1966	9.82	43.39	46.79	0.523	-2.710	2.187
1967	10.35	40.87	48.79	0.387	-3.094	2.707
1968	10.71	37.76	51.53	0.368	-2.942	2.574
1969	11.09	34.40	54.51	0.381	-3.186	2.805
1970	11.46	30.91	57.63	0.354	-3.782	3.429
1971	11.77	27.76	60.47	0.311	-3.528	3.217
1972	12.05	24.94	63.00	0.267	-2.693	2.426
1973	12.38	22.37	65.26	0.269	-1.825	1.556
1974	12.57	20.55	66.88	0.219	-1.231	1.012
1975	12.72	19.47	67.81	0.144	-1.215	1.071
1976	12.86	18.26	68.88	0.080	-1.169	1.088
1977	12.96	17.27	69.77	0.013	-0.799	0.786
1978	13.07	16.14	70.79	0.157	-1.094	0.936
1979	13.25	15.28	71.48	0.234	-0.976	0.741
1980	13.40	14.55	72.05	0.200	-0.672	0.472
1981	13.58	14.07	72.35	0.175	-0.451	0.276
1982	13.81	13.23	72.96	0.136	-0.321	0.185
1983	13.93	13.30	72.77	0.141	-0.222	0.081
1984	14.03	13.16	72.82	0.153	-0.119	-0.035
1985	14.20	12.91	72.88	0.134	-0.084	-0.050
1986	14.36	12.62	73.02	0.128	-0.053	-0.076
1987	14.54	12.49	72.97	0.221	-0.598	0.377

TABLE 19

UNITED KINGDOM

(File: UKDUTDAT Page 6 [see also page 10])

% Market Shares of Total Final Energy Consumption

Year	Calculated Shares %			Actual Shares %		
	Coal	Elec	Gas+ Oil	Coal	Elec	Gas+ Oil
1923	91.40	0.35	8.26	91.194	0.000	8.806
1924	91.13	0.38	8.48	90.773	0.000	9.227
1925	90.85	0.42	8.73	90.404	0.000	9.596
1926	90.55	0.46	8.99	89.891	0.000	10.109
1927	90.23	0.51	9.26	89.503	0.000	10.497
1928	89.89	0.55	9.56	88.642	0.000	11.358
1929	89.52	0.61	9.87	89.060	0.000	10.940
1930	89.13	0.67	10.20	87.318	0.724	11.958
1931	88.71	0.73	10.56	86.475	0.813	12.711
1932	88.26	0.80	10.94	86.285	0.880	12.836
1933	87.78	0.88	11.34	85.926	0.975	13.100
1934	87.27	0.96	11.77	86.066	1.036	12.898
1935	86.73	1.05	12.22	86.049	1.147	12.805
1936	86.14	1.15	12.70	85.825	1.254	12.921
1937	85.52	1.26	13.22	85.712	1.375	12.913
1938	84.86	1.38	13.76	84.305	1.540	14.155
1939	84.16	1.50	14.34	83.935	1.679	14.386
1940	83.41	1.64	14.95	83.524	1.829	14.646
1941	82.62	1.79	15.60	83.125	2.059	14.816
1942	81.77	1.95	16.28	82.611	2.277	15.112
1943	80.88	2.12	17.01	82.247	2.364	15.390
1944	79.93	2.30	17.77	81.899	2.442	15.659
1945	78.92	2.50	18.59	81.734	2.359	15.907
1946	77.85	2.71	19.44	81.197	2.609	16.194
1947	76.73	2.93	20.34	78.813	2.646	18.541
1948	75.54	3.17	21.29	78.547	2.764	18.689
1949	74.29	3.42	22.30	77.772	2.890	19.337
1950	72.97	3.68	23.35	76.926	3.091	19.983
1951	71.58	3.96	24.46	75.892	3.339	20.770
1952	70.12	4.26	25.62	75.090	3.456	21.454
1953	68.60	4.57	26.84	74.432	3.635	21.932
1954	67.00	4.89	28.11	73.442	3.877	22.681
1955	65.34	5.22	29.44	71.673	4.217	24.110
1956	63.60	5.56	30.83	70.218	4.561	25.221
1957	61.80	5.92	32.28	69.857	4.974	25.170
1958	59.93	6.28	33.79	66.057	5.432	28.511
1959	58.00	6.65	35.35	62.454	5.996	31.550
1960	56.01	7.03	36.96	60.500	6.376	33.123
1961	53.96	7.41	38.63	56.953	6.999	36.048
1962	51.87	7.80	40.34	53.710	7.619	38.671
1963	49.73	8.18	42.09	50.784	8.099	41.117
1964	47.55	8.57	43.88	47.661	8.488	43.852
1965	45.35	8.95	45.70	47.394	9.577	43.029
1966	43.13	9.33	47.55	43.995	9.972	46.034
1967	40.90	9.70	49.40	40.177	10.314	49.508
1968	38.68	10.06	51.26	37.718	10.734	51.547
1969	36.47	10.42	53.12	35.063	11.129	53.809
1970	34.29	10.76	54.95	31.840	11.407	56.753
1971	32.15	11.09	56.76	27.186	11.885	60.930
1972	30.06	11.42	58.52	22.745	12.124	65.131
1973	28.05	11.72	60.23	21.969	12.327	65.704
1974	26.11	12.02	61.87	20.985	12.520	66.496
1975	24.27	12.30	63.43	18.943	13.032	68.025
1976	22.53	12.57	64.90	18.102	12.868	69.030
1977	20.91	12.82	66.27	17.336	12.874	69.790
1978	19.41	13.06	67.53	15.945	13.001	71.054
1979	18.04	13.28	68.68	16.029	13.030	70.942
1980	16.80	13.49	69.71	13.288	13.576	73.136
1981	15.69	13.69	70.62	13.786	13.758	72.456
1982	14.72	13.87	71.41	13.707	13.638	72.655
1983	13.88	14.05	72.08	13.563	13.875	72.562
1984	13.16	14.20	72.64	11.797	14.195	74.008
1985	12.56	14.35	73.09	13.631	14.183	72.186
1986	12.06	14.49	73.45	13.080	14.250	72.670
1987	11.66	14.62	73.72	12.499	14.520	72.981
1988	11.34	14.73	73.92	12.099	14.668	73.232
1989	11.10	14.84	74.06	11.130	15.081	73.790
1995	10.54	15.33	74.13			
2000	10.50	15.58	73.92			
2005	10.50	15.74	73.76			
2010	10.50	15.84	73.66			
2015	10.50	15.90	73.60			
2020	10.50	15.94	73.56			

Electricity % = $A/(1+B*(C^x)) = [e\%]$, where :-
 A = 16.00 ; B = 0.1148 ; C = 0.9082
 Coal % [including other solid fuels] = $[c\%] = Z+(95-Z)^*(B*(C^x))$, where :-
 Z = 10.50 ; B = 0.02432 ; C = 1.07434
 (Gas + Oil) % = $100 - ([e\%] + [c\%]) = [(g+o)\%]$
 $x = (\text{Year} - 1985)$

TABLE 20

UNITED KINGDOM

(File: UKDUTDAT Page 7 [see also page 11])
 % Market Shares of Total Final Energy Consumption
 Differences between Calculated, and Actual Market Shares.

Year	(Calculated %-Actual %)			Squares of the Diffs.		
	Coal	Elec	Gas + Oil	Coal	Elec	Gas + Oil
	avg = -0.34 std = 3.22	avg = 0.08 std = 0.48	avg = 0.26 std = 2.88	sum = 701.83	*sum = 14.21	sum = 559.67
1923	0.20	0.35	-0.55	0.04	0.12	0.30
1924	0.36	0.38	-0.74	0.13	0.15	0.55
1925	0.45	0.42	-0.87	0.20	0.18	0.76
1926	0.66	0.46	-1.12	0.44	0.21	1.26
1927	0.73	0.51	-1.24	0.53	0.26	1.53
1928	1.25	0.55	-1.80	1.56	0.31	3.25
1929	0.46	0.61	-1.07	0.21	0.37	1.15
1930	1.81	-0.06	-1.76	3.28	0.00	3.08
1931	2.23	-0.08	-2.15	4.99	0.01	4.64
1932	1.98	-0.08	-1.90	3.91	0.01	3.61
1933	1.86	-0.10	-1.76	3.45	0.01	3.10
1934	1.20	-0.07	-1.13	1.45	0.01	1.28
1935	0.68	-0.09	-0.58	0.46	0.01	0.34
1936	0.32	-0.10	-0.22	0.10	0.01	0.05
1937	-0.19	-0.11	0.30	0.04	0.01	0.09
1938	0.56	-0.16	-0.39	0.31	0.03	0.16
1939	0.22	-0.18	-0.05	0.05	0.03	0.00
1940	-0.11	-0.19	0.30	0.01	0.04	0.09
1941	-0.51	-0.27	0.78	0.26	0.07	0.61
1942	-0.84	-0.33	1.17	0.70	0.11	1.37
1943	-1.37	-0.25	1.62	1.88	0.06	2.62
1944	-1.97	-0.14	2.12	3.89	0.02	4.48
1945	-2.82	0.14	2.68	7.92	0.02	7.17
1946	-3.34	0.10	3.25	11.17	0.01	10.54
1947	-2.09	0.28	1.80	4.35	0.08	3.25
1948	-3.01	0.40	2.61	9.05	0.16	6.79
1949	-3.49	0.53	2.96	12.16	0.28	8.76
1950	-3.96	0.59	3.37	15.68	0.35	11.33
1951	-4.31	0.63	3.69	18.60	0.39	13.59
1952	-4.97	0.80	4.16	24.67	0.64	17.34
1953	-5.84	0.93	4.90	34.05	0.87	24.05
1954	-6.44	1.01	5.43	41.48	1.02	29.49
1955	-6.34	1.00	5.33	40.16	1.01	28.45
1956	-6.62	1.00	5.61	43.78	1.01	31.51
1957	-8.06	0.94	7.11	64.93	0.89	50.59
1958	-6.13	0.85	5.28	37.53	0.72	27.83
1959	-4.46	0.66	3.80	19.85	0.43	14.42
1960	-4.49	0.65	3.84	20.18	0.43	14.73
1961	-2.99	0.41	2.58	8.95	0.17	6.65
1962	-1.84	0.18	1.67	3.40	0.03	2.78
1963	-1.06	0.08	0.97	1.12	0.01	0.95
1964	-0.11	0.08	0.03	0.01	0.01	0.00
1965	-2.04	-0.63	2.67	4.18	0.40	7.15
1966	-0.87	-0.65	1.51	0.75	0.42	2.29
1967	0.72	-0.62	-0.11	0.52	0.38	0.01
1968	0.96	-0.67	-0.28	0.92	0.45	0.08
1969	1.40	-0.71	-0.69	1.97	0.51	0.48
1970	2.45	-0.65	-1.80	5.98	0.42	3.24
1971	4.96	-0.79	-4.17	24.61	0.62	17.40
1972	7.32	-0.71	-6.61	53.55	0.50	43.69
1973	6.08	-0.60	-5.48	36.94	0.36	29.98
1974	5.13	-0.50	-4.63	26.29	0.25	21.41
1975	5.33	-0.73	-4.60	28.37	0.53	21.12
1976	4.43	-0.30	-4.13	19.63	0.09	17.05
1977	3.57	-0.05	-3.52	12.77	0.00	12.39
1978	3.46	0.06	-3.52	12.00	0.00	12.40
1979	2.01	0.25	-2.26	4.03	0.06	5.11
1980	3.51	-0.08	-3.43	12.32	0.01	11.74
1981	1.91	-0.07	-1.84	3.63	0.00	3.38
1982	1.01	0.24	-1.25	1.03	0.06	1.56
1983	0.31	0.17	-0.48	0.10	0.03	0.23
1984	1.36	0.01	-1.37	1.85	0.00	1.88
1985	-1.08	0.17	0.91	1.16	0.03	0.82
1986	-1.02	0.24	0.78	1.04	0.06	0.61
1987	-0.84	0.10	0.74	0.71	0.01	0.55
1988	-0.76	0.07	0.69	0.57	0.00	0.48
1989	-0.03	-0.24	0.27	0.00	0.06	0.07

TABLE 21

UNITED KINGDOM

(File: UKDUTDAT Page 8 [see also page 9])

% Market Shares of Total Final Energy Consumption

Year	Oil +Gas	Elec	Coal	Oil +Gas +Coal	Oil +Gas +Coal +Elec
1910	6.337	0.10	93.56	99.90	100
1912	6.535	0.12	93.34	99.88	100
1914	6.762	0.15	93.09	99.85	100
1916	7.022	0.18	92.80	99.82	100
1918	7.318	0.22	92.47	99.78	100
1920	7.657	0.26	92.08	99.74	100
1922	8.044	0.32	91.64	99.68	100
1924	8.484	0.38	91.13	99.62	100
1926	8.986	0.46	90.55	99.54	100
1928	9.556	0.55	89.89	99.45	100
1930	10.203	0.67	89.13	99.33	100
1932	10.936	0.80	88.26	99.20	100
1934	11.766	0.96	87.27	99.04	100
1936	12.704	1.15	86.14	98.85	100
1938	13.760	1.38	84.86	98.62	100
1940	14.949	1.64	83.41	98.36	100
1942	16.282	1.95	81.77	98.05	100
1944	17.775	2.30	79.93	97.70	100
1946	19.441	2.71	77.85	97.29	100
1948	21.295	3.17	75.54	96.83	100
1950	23.350	3.68	72.97	96.32	100
1952	25.619	4.26	70.12	95.74	100
1954	28.112	4.89	67.00	95.11	100
1956	30.835	5.56	63.60	94.44	100
1958	33.787	6.28	59.93	93.72	100
1960	36.961	7.03	56.01	92.97	100
1962	40.338	7.80	51.87	92.20	100
1964	43.882	8.57	47.55	91.43	100
1966	47.546	9.33	43.13	90.67	100
1968	51.264	10.06	38.68	89.94	100
1970	54.953	10.76	34.29	89.24	100
1972	58.521	11.42	30.06	88.58	100
1974	61.869	12.02	26.11	87.98	100
1976	64.900	12.57	22.53	87.43	100
1978	67.533	13.06	19.41	86.94	100
1980	69.710	13.49	16.80	86.51	100
1982	71.406	13.87	14.72	86.13	100
1984	72.637	14.20	13.16	85.80	100
1986	73.451	14.49	12.06	85.51	100
1988	73.924	14.73	11.34	85.27	100
1990	74.145	14.94	10.91	85.06	100
1992	74.202	15.12	10.68	84.88	100
1994	74.165	15.26	10.57	84.74	100
1996	74.088	15.39	10.52	84.61	100
1998	74.002	15.49	10.51	84.51	100
2000	73.920	15.58	10.50	84.42	100
2002	73.849	15.65	10.50	84.35	100
2004	73.789	15.71	10.50	84.29	100
2006	73.739	15.76	10.50	84.24	100
2008	73.698	15.80	10.50	84.20	100
2010	73.664	15.84	10.50	84.16	100
2012	73.635	15.86	10.50	84.14	100
2014	73.612	15.89	10.50	84.11	100
2016	73.592	15.91	10.50	84.09	100
2018	73.576	15.92	10.50	84.08	100
2020	73.563	15.94	10.50	84.06	100
2050	73.504	16.00	10.50	73.504	

TABLE 22

UNITED KINGDOM

(File: UKDUTDAT Page 9)

% Market Shares of Total Final Energy Consumption
[Alternative model for (Oil + Gas)]

Year	Animal +Wind &Water etc	Oil +Gas	Elec	Coal	Wind etc + Coal	Wind et + Coal + Oil + Gas	Wind etc + Coal + Oil + Gas Elec
1910	4.35	1.98	0.10	93.56	97.91	99.90	100.00
1912	4.27	2.27	0.12	93.34	97.61	99.88	100.00
1914	4.17	2.59	0.15	93.09	97.26	99.85	100.00
1916	4.07	2.96	0.18	92.80	96.87	99.82	100.00
1918	3.94	3.37	0.22	92.47	96.41	99.78	100.00
1920	3.81	3.85	0.26	92.08	95.89	99.74	100.00
1922	3.66	4.39	0.32	91.64	95.30	99.68	100.00
1924	3.48	5.00	0.38	91.13	94.62	99.62	100.00
1926	3.29	5.69	0.46	90.55	93.84	99.54	100.00
1928	3.07	6.48	0.55	89.89	92.96	99.45	100.00
1930	2.83	7.37	0.67	89.13	91.96	99.33	100.00
1932	2.56	8.37	0.80	88.26	90.82	99.20	100.00
1934	2.26	9.50	0.96	87.27	89.53	99.04	100.00
1936	1.93	10.77	1.15	86.14	88.08	98.85	100.00
1938	1.57	12.19	1.38	84.86	86.43	98.62	100.00
1940	1.17	13.78	1.64	83.41	84.58	98.36	100.00
1942	0.74	15.55	1.95	81.77	82.51	98.05	100.00
1944	0.27	17.51	2.30	79.93	80.20	97.70	100.00
1946	0.00	19.67	2.71	77.85	77.85	97.52	100.22
1948	0.00	22.04	3.17	75.54	75.54	97.58	100.74
1950	0.00	24.62	3.68	72.97	72.97	97.59	101.27
1952	0.00	27.42	4.26	70.12	70.12	97.55	101.81
1954	0.00	30.44	4.89	67.00	67.00	97.44	102.32
1956	0.00	33.64	5.56	63.60	63.60	97.24	102.81
1958	0.00	37.02	6.28	59.93	59.93	96.95	103.23
1960	0.00	40.54	7.03	56.01	56.01	96.55	103.58
1962	0.00	44.15	7.80	51.87	51.87	96.02	103.81
1964	0.00	47.80	8.57	47.55	47.55	95.36	103.92
1966	0.00	51.43	9.33	43.13	43.13	94.56	103.89
1968	0.00	54.97	10.06	38.68	38.68	93.64	103.70
1970	0.00	58.32	10.76	34.29	34.29	92.61	103.37
1972	0.00	61.43	11.42	30.06	30.06	91.49	102.91
1974	0.00	64.22	12.02	26.11	26.11	90.33	102.35
1976	0.00	66.64	12.57	22.53	22.53	89.17	101.74
1978	0.00	68.65	13.06	19.41	19.41	88.06	101.11
1980	0.00	70.25	13.49	16.80	16.80	87.05	100.54
1982	0.00	71.46	13.87	14.72	14.72	86.18	100.05
1984	0.00	72.31	14.20	13.16	13.16	85.47	99.68
1986	0.00	72.88	14.49	12.06	12.06	84.94	99.43
1988	0.00	73.23	14.73	11.34	11.34	84.58	99.31
1990	0.00	73.43	14.94	10.91	10.91	84.34	99.28
1992	0.00	73.53	15.12	10.68	10.68	84.21	99.33
1994	0.00	73.57	15.26	10.57	10.57	84.14	99.41
1996	0.00	73.59	15.39	10.52	10.52	84.12	99.50
1998	0.00	73.60	15.49	10.51	10.51	84.10	99.60
2000	0.00	73.60	15.58	10.50	10.50	84.10	99.68
2002	0.00	73.60	15.65	10.50	10.50	84.10	99.75
2004	0.00	73.60	15.71	10.50	10.50	84.10	99.81
2006	0.00	73.60	15.76	10.50	10.50	84.10	99.86
2008	0.00	73.60	15.80	10.50	10.50	84.10	99.90
2010	0.00	73.60	15.84	10.50	10.50	84.10	99.94
2012	0.00	73.60	15.86	10.50	10.50	84.10	99.96
2014	0.00	73.60	15.89	10.50	10.50	84.10	99.99
2016	0.00	73.60	15.91	10.50	10.50	84.10	100.01
2018	0.00	73.60	15.92	10.50	10.50	84.10	100.02
2020	0.00	73.60	15.94	10.50	10.50	84.10	100.04

(Oil+Gas) % = $A \cdot (1 - B \cdot (C^x))$, where :-
 A = 73.6 ; B = 0.0132 ; C = 1.0699

Electricity % = $A / (1 + B \cdot (C^x)) = [e\%]$, where :-
 A = 16.00 ; B = 0.1148 ; C = 0.9082

Coal % [including other solid fuels] = [c%] =
 $Z + (95 - Z) \cdot (B \cdot (C^x))$, where :-
 Z = 10.50 ; B = 0.02432 ; C = .07434
 x = (Year - 1985)

TABLE 23

UNITED KINGDOM

(File: UKDUTDAT Page 10)

% Market Shares of Total Final Energy Consumption

Year	Calculated Shares %					Actual Shares %		
	Coal	Elec	Gas + Oil	Animal + Water etc.	Gas + Oil + Water etc.	Coal	Elec	Gas + Oil + Water etc.
1923	91.40	0.35	4.68	3.57	8.26	91.194	0.000	8.806
1924	91.13	0.38	5.00	3.48	8.48	90.773	0.000	9.227
1925	90.85	0.42	5.34	3.39	8.73	90.404	0.000	9.596
1926	90.55	0.46	5.69	3.29	8.99	89.891	0.000	10.109
1927	90.23	0.51	6.08	3.19	9.26	89.503	0.000	10.497
1928	89.89	0.55	6.48	3.07	9.56	88.642	0.000	11.358
1929	89.52	0.61	6.91	2.96	9.87	89.060	0.000	10.940
1930	89.13	0.67	7.37	2.83	10.20	87.318	0.724	11.958
1931	88.71	0.73	7.86	2.70	10.56	86.475	0.813	12.711
1932	88.26	0.80	8.37	2.56	10.94	86.285	0.880	12.836
1933	87.78	0.88	8.92	2.42	11.34	85.926	0.975	13.100
1934	87.27	0.96	9.50	2.26	11.77	86.066	1.036	12.898
1935	86.73	1.05	10.12	2.10	12.22	86.049	1.147	12.805
1936	86.14	1.15	10.77	1.93	12.70	85.825	1.254	12.921
1937	85.52	1.26	11.46	1.75	13.22	85.712	1.375	12.913
1938	84.86	1.38	12.19	1.57	13.76	84.305	1.540	14.155
1939	84.16	1.50	12.96	1.37	14.34	83.935	1.679	14.386
1940	83.41	1.64	13.78	1.17	14.95	83.524	1.829	14.646
1941	82.62	1.79	14.64	0.96	15.60	83.125	2.059	14.816
1942	81.77	1.95	15.55	0.74	16.28	82.611	2.277	15.112
1943	80.88	2.12	16.50	0.51	17.01	82.247	2.364	15.390
1944	79.93	2.30	17.51	0.27	17.77	81.899	2.442	15.659
1945	78.92	2.50	18.56	0.03	18.59	81.734	2.359	15.907
1946	77.85	2.71	19.67	0.00	19.67	81.197	2.609	16.194
1947	76.73	2.93	20.82	0.00	20.82	78.813	2.646	18.541
1948	75.54	3.17	22.04	0.00	22.04	78.547	2.764	18.689
1949	74.29	3.42	23.30	0.00	23.30	77.772	2.890	19.337
1950	72.97	3.68	24.62	0.00	24.62	76.926	3.091	19.983
1951	71.58	3.96	26.00	0.00	26.00	75.892	3.339	20.770
1952	70.12	4.26	27.42	0.00	27.42	75.090	3.456	21.454
1953	68.60	4.57	28.90	0.00	28.90	74.432	3.635	21.932
1954	67.00	4.89	30.44	0.00	30.44	73.442	3.877	22.681
1955	65.34	5.22	32.02	0.00	32.02	71.673	4.217	24.110
1956	63.60	5.56	33.64	0.00	33.64	70.218	4.561	25.221
1957	61.80	5.92	35.31	0.00	35.31	69.857	4.974	25.170
1958	59.93	6.28	37.02	0.00	37.02	66.057	5.432	28.511
1959	58.00	6.65	38.76	0.00	38.76	62.454	5.996	31.550
1960	56.01	7.03	40.54	0.00	40.54	60.500	6.376	33.123
1961	53.96	7.41	42.34	0.00	42.34	56.953	6.999	36.048
1962	51.87	7.80	44.15	0.00	44.15	53.710	7.619	38.671
1963	49.73	8.18	45.98	0.00	45.98	50.784	8.099	41.117
1964	47.55	8.57	47.80	0.00	47.80	47.661	8.488	43.852
1965	45.35	8.95	49.63	0.00	49.63	47.394	9.577	43.029
1966	43.13	9.33	51.43	0.00	51.43	43.995	9.972	46.034
1967	40.90	9.70	53.22	0.00	53.22	40.177	10.314	49.508
1968	38.68	10.06	54.97	0.00	54.97	37.718	10.734	51.547
1969	36.47	10.42	56.67	0.00	56.67	35.063	11.129	53.809
1970	34.29	10.76	58.32	0.00	58.32	31.840	11.407	56.753
1971	32.15	11.09	59.91	0.00	59.91	27.186	11.885	60.930
1972	30.06	11.42	61.43	0.00	61.43	22.745	12.124	65.131
1973	28.05	11.72	62.87	0.00	62.87	21.369	12.327	65.704
1974	26.11	12.02	64.22	0.00	64.22	20.985	12.520	66.496
1975	24.27	12.30	65.48	0.00	65.48	18.943	13.032	68.025
1976	22.53	12.57	66.64	0.00	66.64	18.102	12.868	69.030
1977	20.91	12.82	67.69	0.00	67.69	17.336	12.874	69.790
1978	19.41	13.06	68.65	0.00	68.65	15.945	13.001	71.054
1979	18.04	13.28	69.50	0.00	69.50	16.029	13.030	70.942

1980	16.80	13.49	70.25	0.00	70.25	13.288	13.576	73.136
1981	15.69	13.69	70.90	0.00	70.90	13.786	13.758	72.456
1982	14.72	13.87	71.46	0.00	71.46	13.707	13.638	72.655
1983	13.88	14.05	71.93	0.00	71.93	13.563	13.875	72.562
1984	13.16	14.20	72.31	0.00	72.31	11.797	14.195	74.008
1985	12.56	14.35	72.63	0.00	72.63	13.631	14.183	72.186
1986	12.06	14.49	72.88	0.00	72.88	13.080	14.250	72.670
1987	11.66	14.62	73.08	0.00	73.08	12.499	14.520	72.981
1988	11.34	14.73	73.23	0.00	73.23	12.099	14.668	73.232
1989	11.10	14.84	73.35	0.00	73.35	11.130	15.081	73.790
1995	10.54	15.33	73.59	0.00	73.59			
2000	10.50	15.58	73.60	0.00	73.60			
2005	10.50	15.74	73.60	0.00	73.60			
2010	10.50	15.84	73.60	0.00	73.60			
2015	10.50	15.90	73.60	0.00	73.60			
2020	10.50	15.94	73.60	0.00	73.60			

Electricity % = $A/(1+B*(C^x)) = [e\%]$, where :-
 A = 16.00 ; B = 0.1148 ; C = 0.9082

Coal % [including other solid fuels] = [c%] =
 $Z+(95-Z)*(B^x(C^x))$, where :-
 Z = 10.50 ; B = 0.02432 ; C = 1.07434

(Oil+GAS) % = $A*(1-B*(C^x))$, where :-
 A = 73.6 ; B = 0.0132 ; C = 1.0699
 x = (Year - 1985)

TABLE 24

UNITED KINGDOM

(File: UKDUTDAT Page 11 [see also page 7])

% Market Shares of Total Final Energy Consumption
Differences between Calculated, and Actual Market Shares.

Year	(Calculated %-Actual %)			Squares of the Diffis.		
	Coal	Elec	Gas + Oil + etc	Coal	Elec	Gas + Oil + etc
	avg = -0.34	avg = 0.08	avg = 1.50	*sum =		
	std = 3.22	std = 0.48	std = 3.52	sum = 701.83	sum = 15.80	sum = 980.51
1923	0.20	0.35	-0.55	0.04	0.12	0.30
1924	0.36	0.38	-0.74	0.13	0.15	0.55
1925	0.45	0.42	-0.87	0.20	0.18	0.76
1926	0.66	0.46	-1.12	0.44	0.21	1.26
1927	0.73	0.51	-1.24	0.53	0.26	1.53
1928	1.25	0.55	-1.80	1.56	0.31	3.25
1929	0.46	0.61	-1.07	0.21	0.37	1.15
1930	1.81	-0.06	-1.76	3.28	0.00	3.08
1931	2.23	-0.08	-2.15	4.99	0.01	4.64
1932	1.98	-0.08	-1.90	3.91	0.01	3.61
1933	1.86	-0.10	-1.76	3.45	0.01	3.10
1934	1.20	-0.07	-1.13	1.45	0.01	1.28
1935	0.68	-0.09	-0.58	0.46	0.01	0.34
1936	0.32	-0.10	-0.22	0.10	0.01	0.05
1937	-0.19	-0.11	0.30	0.04	0.01	0.09
1938	0.56	-0.16	-0.39	0.31	0.03	0.16
1939	0.22	-0.18	-0.05	0.05	0.03	0.00
1940	-0.11	-0.19	0.30	0.01	0.04	0.09
1941	-0.51	-0.27	0.78	0.26	0.07	0.61
1942	-0.84	-0.33	1.17	0.70	0.11	1.37
1943	-1.37	-0.25	1.62	1.88	0.06	2.62
1944	-1.97	-0.14	2.12	3.89	0.02	4.48
1945	-2.82	0.14	2.68	7.92	0.02	7.17
1946	-3.34	0.10	3.47	11.17	0.01	12.05
1947	-2.09	0.28	2.28	4.35	0.08	5.22
1948	-3.01	0.40	3.35	9.05	0.16	11.21
1949	-3.49	0.53	3.97	12.16	0.20	15.73
1950	-3.96	0.59	4.64	15.68	0.35	21.53
1951	-4.31	0.63	5.23	18.60	0.39	27.33
1952	-4.97	0.80	5.97	24.67	0.64	35.65
1953	-5.84	0.93	6.97	34.05	0.87	48.62
1954	-6.44	1.01	7.75	41.48	1.02	60.13
1955	-6.34	1.00	7.91	40.16	1.01	62.49
1956	-6.62	1.00	8.42	43.78	1.01	70.91
1957	-8.06	0.94	10.14	64.93	0.89	102.84
1958	-6.13	0.85	8.51	37.53	0.72	72.39
1959	-4.46	0.66	7.21	19.85	0.43	52.03
1960	-4.49	0.65	7.41	20.18	0.43	54.97
1961	-2.99	0.41	6.29	8.95	0.17	39.53
1962	-1.84	0.18	5.48	3.40	0.03	30.03
1963	-1.06	0.08	4.86	1.12	0.01	23.61
1964	-0.11	0.08	3.95	0.01	0.01	15.62
1965	-2.04	-0.63	6.60	4.18	0.40	43.52
1966	-0.87	-0.65	5.40	0.75	0.42	29.16
1967	0.72	-0.62	3.71	0.52	0.38	13.75
1968	0.96	-0.67	3.42	0.92	0.45	11.68
1969	1.40	-0.71	2.86	1.97	0.51	8.19
1970	2.45	-0.65	1.57	5.98	0.42	2.46
1971	4.96	-0.79	-1.02	24.61	0.62	1.04
1972	7.32	-0.71	-3.70	53.55	0.50	13.70
1973	6.08	-0.60	-2.84	36.94	0.36	8.05
1974	5.13	-0.50	-2.28	26.29	0.25	5.19
1975	5.33	-0.73	-2.55	28.37	0.53	6.50
1976	4.43	-0.30	-2.39	19.63	0.09	5.73
1977	3.57	-0.05	-2.10	12.77	0.00	4.40
1978	3.46	0.06	-2.41	12.00	0.00	5.79
1979	2.01	0.25	-1.44	4.03	0.06	2.08
1980	3.51	-0.08	-2.89	12.32	0.01	8.34
1981	1.91	-0.07	-1.56	3.63	0.00	2.42
1982	1.01	0.24	-1.20	1.03	0.06	1.44
1983	0.31	0.17	-0.64	0.10	0.03	0.41
1984	1.36	0.01	-1.69	1.85	0.00	2.87
1985	-1.08	0.17	0.44	1.16	0.03	0.20
1986	-1.02	0.24	0.21	1.04	0.06	0.05
1987	-0.84	0.10	0.10	0.71	0.01	0.01
1988	-0.76	0.07	0.00	0.57	0.00	0.00
1989	-0.03	-0.24	-0.44	0.00	0.06	0.20

TABLE 25

UNITED KINGDOM

(File: UKDUTDAT Page 12)

Slopes of the Market- Share Curves

Year	11-year span			7-year span			5-year span		
	Elec	Coal	Oil+ Gas	Elec	Coal	Oil+ Gas	Elec	Coal	Oil+ Gas
1928	0.11	-0.56	0.45	0.14	-0.62	0.48	0.14	-0.56	0.41
1929	0.13	-0.54	0.41	0.18	-0.65	0.47	0.24	-0.74	0.50
1930	0.14	-0.50	0.36	0.20	-0.64	0.45	0.26	-0.73	0.47
1931	0.15	-0.45	0.30	0.19	-0.54	0.35	0.21	-0.73	0.52
1932	0.15	-0.38	0.24	0.15	-0.43	0.28	0.08	-0.31	0.23
1933	0.14	-0.37	0.23	0.09	-0.20	0.11	0.08	-0.11	0.02
1934	0.13	-0.37	0.24	0.09	-0.11	0.02	0.09	-0.08	-0.01
1935	0.11	-0.32	0.22	0.11	-0.24	0.13	0.10	-0.07	-0.03
1936	0.12	-0.34	0.22	0.12	-0.35	0.23	0.12	-0.39	0.26
1937	0.14	-0.39	0.25	0.13	-0.48	0.34	0.14	-0.57	0.44
1938	0.15	-0.43	0.28	0.15	-0.54	0.39	0.15	-0.64	0.49
1939	0.15	-0.47	0.32	0.17	-0.56	0.39	0.17	-0.60	0.43
1940	0.14	-0.47	0.33	0.17	-0.52	0.35	0.19	-0.42	0.23
1941	0.14	-0.46	0.32	0.16	-0.41	0.25	0.18	-0.43	0.25
1942	0.13	-0.52	0.40	0.13	-0.38	0.26	0.15	-0.41	0.26
1943	0.12	-0.54	0.42	0.11	-0.37	0.26	0.08	-0.35	0.27
1944	0.11	-0.61	0.50	0.09	-0.58	0.49	0.07	-0.33	0.27
1945	0.11	-0.67	0.57	0.08	-0.71	0.63	0.07	-0.76	0.68
1946	0.11	-0.75	0.63	0.09	-0.82	0.73	0.09	-0.96	0.87
1947	0.12	-0.80	0.69	0.11	-0.91	0.80	0.12	-1.06	0.94
1948	0.13	-0.85	0.72	0.15	-0.97	0.82	0.12	-0.96	0.84
1949	0.15	-0.88	0.73	0.15	-0.92	0.77	0.17	-0.75	0.58
1950	0.17	-0.94	0.76	0.17	-0.78	0.61	0.18	-0.88	0.70
1951	0.19	-0.98	0.78	0.19	-0.85	0.67	0.19	-0.85	0.67
1952	0.22	-0.95	0.73	0.21	-0.95	0.75	0.19	-0.84	0.66
1953	0.26	-1.13	0.87	0.24	-1.08	0.84	0.22	-1.01	0.79
1954	0.30	-1.37	1.07	0.27	-1.09	0.82	0.28	-1.25	0.97
1955	0.33	-1.59	1.26	0.33	-1.41	1.08	0.34	-1.24	0.90
1956	0.37	-1.87	1.50	0.39	-1.88	1.48	0.39	-1.66	1.27
1957	0.42	-2.17	1.75	0.43	-2.19	1.77	0.44	-2.26	1.82
1958	0.46	-2.44	1.98	0.46	-2.54	2.07	0.47	-2.68	2.22
1959	0.48	-2.67	2.19	0.51	-2.89	2.38	0.50	-3.14	2.64
1960	0.52	-2.72	2.20	0.53	-3.12	2.59	0.54	-3.02	2.48
1961	0.55	-2.78	2.24	0.52	-3.05	2.53	0.55	-3.01	2.47
1962	0.55	-2.85	2.30	0.57	-2.75	2.18	0.53	-3.18	2.65
1963	0.55	-2.78	2.23	0.60	-2.67	2.07	0.60	-2.52	1.91
1964	0.54	-2.74	2.20	0.58	-2.61	2.04	0.62	-2.28	1.66
1965	0.52	-2.76	2.24	0.54	-2.60	2.06	0.59	-2.49	1.90
1966	0.49	-2.82	2.33	0.51	-2.65	2.14	0.52	-2.71	2.19
1967	0.46	-2.98	2.52	0.45	-2.80	2.35	0.39	-3.09	2.71
1968	0.42	-3.03	2.61	0.38	-3.22	2.84	0.37	-2.94	2.57
1969	0.38	-3.01	2.63	0.37	-3.41	3.05	0.38	-3.19	2.80
1970	0.34	-2.97	2.63	0.34	-3.30	2.96	0.35	-3.78	3.43
1971	0.31	-2.73	2.42	0.30	-3.05	2.75	0.31	-3.53	3.22
1972	0.27	-2.44	2.17	0.30	-2.69	2.39	0.27	-2.69	2.43
1973	0.23	-2.17	1.94	0.25	-2.12	1.87	0.27	-1.82	1.56
1974	0.19	-1.82	1.63	0.18	-1.50	1.31	0.22	-1.23	1.01
1975	0.18	-1.54	1.37	0.15	-1.16	1.02	0.14	-1.21	1.07
1976	0.16	-1.22	1.06	0.10	-1.05	0.95	0.08	-1.17	1.09
1977	0.15	-0.99	0.84	0.12	-1.11	0.99	0.01	-0.80	0.79
1978	0.15	-0.89	0.74	0.13	-0.94	0.81	0.16	-1.09	0.94
1979	0.15	-0.82	0.67	0.17	-0.82	0.65	0.23	-0.98	0.74
1980	0.15	-0.63	0.49	0.18	-0.64	0.47	0.20	-0.67	0.47
1981	0.16	-0.52	0.36	0.19	-0.61	0.42	0.18	-0.45	0.28
1982	0.16	-0.42	0.25	0.17	-0.37	0.20	0.14	-0.32	0.18
1983	0.16	-0.33	0.17	0.12	-0.10	-0.02	0.14	-0.22	0.08
1984	0.17	-0.31	0.14	0.14	-0.18	0.04	0.15	-0.12	-0.03

UNITED STATES

TABLE 26

UNITED STATES

(File: USDATA47 Page 1)

U.S. energy data --[US Dept of Interior 1972] [All figures in Trillions of Btu's, and exclude non-fuel use]						
Year	Oil Total Requi- rement	Oil used for elec	Oil Final Consum- ption	Gas Total Requi- rement	Gas used for elec	Gas Final Consum- ption
1947	10610	468	10142	4016	386	3630
1948	11746	444	11302	4535	495	4040
1949	11339	577	10762	4846	569	4277
1950	12600	662	11938	5725	651	5074
1951	13833	499	13334	6807	791	6016
1952	14297	492	13805	7379	942	6437
1953	15017	577	14440	7845	1070	6775
1954	15005	480	14525	8198	1206	6992
1955	16257	512	15745	8870	1194	7676
1956	17252	497	16755	9449	1283	8166
1957	17170	512	16658	10019	1385	8634
1958	17762	515	17247	10618	1421	9197
1959	18111	546	17565	11603	1684	9919
1960	18325	564	17761	12327	1785	10542
1961	18686	577	18109	12890	1889	11001
1962	19333	579	18754	13810	2034	11776
1963	19871	600	19271	14545	2218	12327
1964	20284	636	19648	15351	2403	12948
1965	21038	744	20294	15805	2392	13413
1966	21989	905	21084	17097	2692	14405
1967	22806	1013	21793	17789	2834	14955
1968	24289	1180	23109	19125	3245	15880
1969	25462	1628	23834	20306	3594	16712
1970	26517	2087	24430	21342	4015	17327
1971	27354	2417	24937	22048	4124	17924

TABLE 27

UNITED STATES

(File: USDATA47 Page 2)

U.S. Energy data -[US Dept of Interior 1972]						
[All figures in Trillions Btu's, & exclude non-fuel use]						
Year	Coal Total Requi- rement	Coal used for elec	Coal Final Consum- tion	[Oil + Gas + Coal] Total Requi- rement	used for elec	Final Consum- tion
1947	15701	2084	13617	30327	2938	27389
1948	14776	2392	12384	31057	3331	27726
1949	15522	2021	13501	31707	3167	28540
1950	12785	2228	10557	31110	3541	27569
1951	13082	2537	10545	33722	3827	29895
1952	11745	2588	9157	33421	4022	29399
1953	11746	2805	8941	34608	4452	30156
1954	10072	2866	7206	33275	4552	28723
1955	11391	3482	7909	36518	5188	31330
1956	11605	3815	7790	38306	5595	32711
1957	11019	3881	7138	38208	5778	32430
1958	9733	3743	5990	38113	5679	32434
1959	9696	4050	5646	39410	6280	33130
1960	10015	4252	5763	40667	6601	34066
1961	9785	4374	5411	41361	6840	34521
1962	10084	4636	5448	43227	7249	35978
1963	10595	5065	5530	45011	7883	37128
1964	11134	5395	5739	46769	8434	38335
1965	11770	5843	5927	48613	8979	39634
1966	12360	6327	6033	51446	9924	41522
1967	11121	6457	4664	51716	10304	41412
1968	12508	6994	5514	55922	11419	44503
1969	12574	7227	5347	58342	12449	45893
1970	12771	7483	5288	60630	13585	47045
1971	12427	7698	4729	61829	14239	47590

TABLE 28

UNITED STATES

(File: USDATA47 Page 3)

U.S. energy data --[US Dept of Interior 1972]

Year	**A** Electr Utilities Final Consumption		**B** Electricity - Billion kWh Purchased				Ratio *B/*A
	Billion KWH	Btu / 10 ⁹	Indus-Trans- try port	House &Comm.	Total		
1947	255.7	872.7	135	8	115	258	1.009
1948	282.7	964.9	147	8	130	285	1.008
1949	291.1	993.5	142	7	143	292	1.003
1950	329.1	1123.2	164	7	160	331	1.006
1951	370.7	1265.2	192	7	180	379	1.022
1952	399.2	1362.5	200	6	195	401	1.005
1953	442.7	1510.9	224	6	215	445	1.005
1954	471.7	1609.9	235	6	234	475	1.007
1955	547.0	1866.9	295	6	250	551	1.007
1956	600.7	2050.2	326	5	274	605	1.007
1957	631.5	2155.3	332	4	299	635	1.006
1958	645.1	2201.7	323	5	321	649	1.006
1959	710.0	2423.2	356	5	353	714	1.006
1960	753.4	2571.4	383	5	370	758	1.006
1961	792.0	2703.1	383	6	406	795	1.004
1962	852.3	2908.9	411	5	437	853	1.001
1963	916.8	3129.0	429	6	482	917	1.000
1964	984.0	3358.4	453	6	525	984	1.000
1965	1055.0	3600.7	479	5	571	1055	1.000
1966	1144.4	3905.8	524	5	616	1145	1.001
1967	1214.4	4144.7	547	5	661	1213	0.999
1968	1329.4	4537.2	599	5	723	1327	0.998
1969	1442.2	4922.2	632	5	807	1444	1.001
1970	1529.8	5221.2	648	5	879	1532	1.001
1971	1614.0	5508.6	681	5	925	1611	0.998

TABLE 29

UNITED STATES

(File: USDATA47 Page 4)

U.S. energy data --[US Dept of Interior 1972]

Year	Electricity Purchased in Trillions of Btu			
	Indus- try	Trans- port	House & Commerce	Total
1947	459	29	391	879
1948	500	27	442	969
1949	485	25	488	998
1950	559	24	546	1129
1951	656	23	615	1294
1952	682	22	666	1370
1953	765	20	733	1518
1954	802	18	797	1617
1955	1008	19	854	1881
1956	1113	17	935	2065
1957	1133	15	1019	2167
1958	1102	16	1095	2213
1959	1215	17	1203	2435
1960	1306	18	1262	2586
1961	1306	19	1385	2710
1962	1402	18	1490	2910
1963	1464	19	1645	3128
1964	1544	20	1792	3356
1965	1634	18	1948	3600
1966	1788	16	2101	3905
1967	1868	17	2257	4142
1968	2044	18	2467	4529
1969	2155	17	2752	4924
1970	2210	16	3000	5226
1971	2325	17	3155	5497

TABLE 30

UNITED STATES

(File: USDATA47 Page 5)

U.S. energy data --[US Dept of Interior 1972]

Total Final Energy Consumption in Trillions of Btu

Year	Oil	Gas	Coal	Elec- tricity	Total
1947	10142	3630	13617	879	28268
1948	11302	4040	12384	969	28695
1949	10762	4277	13501	998	29538
1950	11938	5074	10557	1129	28698
1951	13334	6016	10545	1294	31189
1952	13805	6437	9157	1370	30769
1953	14440	6775	8941	1518	31674
1954	14525	6992	7206	1617	30340
1955	15745	7676	7909	1881	33211
1956	16755	8166	7790	2065	34776
1957	16658	8634	7138	2167	34597
1958	17247	9197	5990	2213	34647
1959	17565	9919	5646	2435	35565
1960	17761	10542	5763	2586	36652
1961	18109	11001	5411	2710	37231
1962	18754	11776	5448	2910	38888
1963	19271	12327	5530	3128	40256
1964	19648	12948	5739	3356	41691
1965	20294	13413	5927	3600	43234
1966	21084	14405	6033	3905	45427
1967	21793	14955	4664	4142	45554
1968	23109	15880	5514	4529	49032
1969	23834	16712	5347	4924	50817
1970	24430	17327	5288	5226	52271
1971	24937	17924	4729	5497	53087

TABLE 31

UNITED STATES

(File: USDATA47 Page 6)

U.S. energy data --[US Dept of Interior 1972]
 Total Final Energy Consumption in Mtoe

[1 kWh = 3.412 Btu ; 1 toe = 11.630*10³ kWh
 1/(3.412*11.630) = 0.0252

Year	Oil	Gas	Coal	Elec- tricity	Total
1947	255.58	91.48	343.16	22.15	712.37
1948	284.82	101.81	312.08	24.42	723.13
1949	271.21	107.78	340.23	25.15	744.38
1950	300.85	127.87	266.04	28.45	723.21
1951	336.03	151.61	265.74	32.61	785.98
1952	347.89	162.22	230.76	34.52	775.40
1953	363.90	170.73	225.32	38.25	798.20
1954	366.04	176.20	181.60	40.75	764.59
1955	396.78	193.44	199.31	47.40	836.94
1956	422.24	205.79	196.31	52.04	876.38
1957	419.79	217.58	179.88	54.61	871.87
1958	434.64	231.77	150.95	55.77	873.13
1959	442.65	249.96	142.28	61.36	896.26
1960	447.59	265.66	145.23	65.17	923.65
1961	456.36	277.23	136.36	68.29	938.24
1962	472.61	296.76	137.29	73.33	980.00
1963	485.64	310.65	139.36	78.83	1014.48
1964	495.14	326.30	144.63	84.57	1050.64
1965	511.42	338.02	149.36	90.72	1089.52
1966	531.33	363.01	152.04	98.41	1144.79
1967	549.20	376.88	117.54	104.38	1147.99
1968	582.36	400.19	138.96	114.13	1235.64
1969	600.63	421.15	134.75	124.09	1280.62
1970	615.65	436.65	133.26	131.70	1317.26
1971	628.43	451.70	119.17	138.53	1337.83

TABLE 32

UNITED STATES

(File: USDATA47 Page 7) IEA Statistics - USA

Final Energy Consumption in Mtoe.

Year	Coal+ Other Solids	Oil	Gas	Elec- tricity	Total
1947					
1948					
1949					
1950					
1951					
1952					
1953					
1954					
1955					
1956					
1957					
1958					
1959					
1960	137.65	436.66	199.01	59.17	832.49
1961	131.12	445.01	203.68	62.09	841.90
1962	130.49	465.61	215.54	66.91	878.55
1963	132.88	492.76	224.78	71.64	922.06
1964	135.88	507.92	241.14	77.06	962.00
1965	138.04	521.87	249.55	82.04	991.50
1966	140.71	546.26	269.35	89.01	1045.33
1967	148.37	558.43	308.68	94.51	1109.99
1968	148.47	594.10	325.96	103.46	1171.99
1969	146.81	618.45	324.26	113.00	1202.52
1970	142.28	586.86	336.15	115.88	1181.17
1971	129.22	603.59	348.41	123.83	1205.05

TABLE 33

UNITED STATES

(File: USDATA47 Page 8)

Final Energy Consumption

Ratio (I.E.A. Statistics) / (Dept. of Interior data)					
Year	Coal+ Other Solids	Oil	Gas	Elec- tricity	Total
1947					
1948	Conclusion :-				
1949	[i] In respect of "Coal + Other Solids",				
1950	and in respect of "Oil", there is				
1951	satisfactory agreement between the "I.E.A.				
1952	Statistics" on page 7, and the "Dept				
1953	Interior - data" on page 6.				
1954	[ii] The "Gas" figures of the Dept of the				
1955	Interior, on page 6 are overstated, as				
1956	the "use in Petroleum Refineries" and				
1957	"Own Use in Transf. Industry" must be				
1958	subtracted to give FINAL Consumption.				
1959					
1960	0.95	0.98	0.75	0.91	0.90
1961	0.96	0.98	0.73	0.91	0.90
1962	0.95	0.99	0.73	0.91	0.90
1963	0.95	1.01	0.72	0.91	0.91
1964	0.94	1.03	0.74	0.91	0.92
1965	0.92	1.02	0.74	0.90	0.91
1966	0.93	1.03	0.74	0.90	0.91
1967	1.26	1.02	0.82	0.91	0.97
1968	1.07	1.02	0.81	0.91	0.95
1969	1.09	1.03	0.77	0.91	0.94
1970	1.07	0.95	0.77	0.88	0.90
1971	1.08	0.96	0.77	0.89	0.90
Average	1.015	1.000	0.7581	0.9046	0.916
	[iii] The "Dept of Interior - data " indicates				
	Electricity Generated without reduction				
	i.r.o."own use", and distribution losses.				
	[vi] The "Gas" figures of the Dept of the				
	Interior, on page 6, should be reduced by				
	the factor 0.758, and the "Electricity"				
	figures must similarly be reduced by the				
	factor 0.9046.				

TABLE 34

UNITED STATES

(File: USDATA47 Page 9)

U.S. energy data --[US Dept of Interior 1972]
Total Final Energy Consumption in M toe

Oil and Electricity data adjusted for losses and "own use".

Year	Oil	Gas	Coal	Electricity	Total	Ratio of totals
1947	255.58	69.34	343.16	20.04	688.12	
1948	284.82	77.17	312.08	22.09	696.16	(I.E.A.)/
1949	271.21	81.70	340.23	22.75	715.89	(Dept of
1950	300.85	96.92	266.04	25.74	689.55	Inter.)
1951	336.03	114.92	265.74	29.50	746.18	
1952	347.89	122.96	230.76	31.23	732.85	
1953	363.90	129.42	225.32	34.61	753.24	
1954	366.04	133.56	181.60	36.86	718.06	
1955	396.78	146.63	199.31	42.88	785.60	
1956	422.24	155.99	196.31	47.07	821.61	
1957	419.79	164.93	179.88	49.40	814.00	
1958	434.64	175.68	150.95	50.45	811.72	
1959	442.65	189.47	142.28	55.51	829.91	
1960	447.59	201.37	145.23	58.95	853.15	0.976
1961	456.36	210.14	136.36	61.78	864.64	0.974
1962	472.61	224.95	137.29	66.34	901.19	0.975
1963	485.64	235.47	139.36	71.31	931.78	0.990
1964	495.14	247.33	144.63	76.50	963.61	0.998
1965	511.42	256.22	149.36	82.07	999.07	0.992
1966	531.33	275.17	152.04	89.02	1047.55	0.998
1967	549.20	285.67	117.54	94.42	1046.83	1.060
1968	582.36	303.34	138.96	103.25	1127.90	1.039
1969	600.63	319.23	134.75	112.25	1166.86	1.031
1970	615.65	330.98	133.26	119.13	1199.03	0.985
1971	628.43	342.39	119.17	125.31	1215.30	0.992
					Average =	1.001

TABLE 35

UNITED STATES

(File: USDATA47 Page 10)

Market Shares of carriers of Total Final Energy Consumption

Year	Oil %	Gas %	Coal %	Elec- tricity %	Oil+ Gas %	Electr+ Gas %	Coal+ Gas %
1947	37.14	10.08	49.87	2.91	47.22	12.99	59.95
1948	40.91	11.09	44.83	3.17	52.00	14.26	55.91
1949	37.88	11.41	47.53	3.18	49.30	14.59	58.94
1950	43.63	14.06	38.58	3.73	57.69	17.79	52.64
1951	45.03	15.40	35.61	3.95	60.43	19.35	51.01
1952	47.47	16.78	31.49	4.26	64.25	21.04	48.27
1953	48.31	17.18	29.91	4.59	65.49	21.78	47.09
1954	50.98	18.60	25.29	5.13	69.58	23.73	43.89
1955	50.51	18.66	25.37	5.46	69.17	24.12	44.03
1956	51.39	18.99	23.89	5.73	70.38	24.72	42.88
1957	51.57	20.26	22.10	6.07	71.83	26.33	42.36
1958	53.55	21.64	18.60	6.22	75.19	27.86	40.24
1959	53.34	22.83	17.14	6.69	76.17	29.52	39.97
1960	52.45	23.91	16.53	7.11	76.36	31.01	40.44
1961	52.86	24.19	15.57	7.37	77.05	31.57	39.77
1962	53.00	24.53	14.85	7.62	77.53	32.15	39.39
1963	53.44	24.38	14.41	7.77	77.82	32.15	38.79
1964	52.80	25.07	14.12	8.01	77.86	33.08	39.19
1965	52.63	25.17	13.92	8.27	77.80	33.44	39.09
1966	52.26	25.77	13.46	8.52	78.02	34.28	39.23
1967	50.31	27.81	13.37	8.51	78.12	36.32	41.18
1968	50.69	27.81	12.67	8.83	78.50	36.64	40.48
1969	51.43	26.97	12.21	9.40	78.39	36.36	39.17
1970	49.68	28.46	12.05	9.81	78.14	38.27	40.50
1971	50.09	28.91	10.72	10.28	79.00	39.19	39.64
1972	50.27	29.11	10.13	10.49	79.38	39.60	39.24
1973	51.11	27.64	10.13	11.12	78.74	38.76	37.77
1974	50.56	27.62	10.33	11.49	78.18	39.11	37.95
1975	51.84	26.23	9.87	12.05	78.07	38.29	36.10
1976	52.81	25.30	9.81	12.08	78.11	37.38	35.11
1977	54.83	23.52	9.42	12.23	78.35	35.75	32.94
1978	53.67	23.78	9.94	12.61	77.46	36.39	33.72
1979	52.58	24.33	10.25	12.83	76.91	37.16	34.58
1980	51.23	25.45	9.68	13.64	76.67	39.09	35.13
1981	49.92	25.52	10.38	14.17	75.44	39.69	35.90
1982	51.16	24.77	9.63	14.44	75.93	39.21	34.39
1983	50.61	23.91	10.29	15.19	74.52	39.10	34.20
1984	49.79	24.15	10.73	15.33	73.95	39.48	34.88
1985	50.08	23.61	10.62	15.68	73.69	39.30	34.23

The figures from 1947 to 1959 are derived from the "Dept of Interior - data", and those from 1960 to 1988 are from the "I.E.A. Statistics".

TABLE 36

UNITED STATES

(File: USDATA47 Page 11)

Market Shares of carriers of Total Final Energy Consumption

Year	Electricity %		Coal %		(Oil +Gas) %	
	Actual	Calcd	Actual	Calcd	Actual	Calcd
1947	2.91	3.29	49.87	50.16	47.22	46.55
1948	3.17	3.48	44.83	45.92	52.00	50.60
1949	3.18	3.68	47.53	41.97	49.30	54.35
1950	3.73	3.89	38.58	38.34	57.69	57.78
1951	3.95	4.11	35.61	35.01	60.43	60.88
1952	4.26	4.34	31.49	32.00	64.25	63.67
1953	4.59	4.57	29.91	29.28	65.49	66.14
1954	5.13	4.82	25.29	26.86	69.58	68.32
1955	5.46	5.08	25.37	24.69	69.17	70.23
1956	5.73	5.35	23.89	22.77	70.38	71.88
1957	6.07	5.63	22.10	21.08	71.83	73.29
1958	6.22	5.91	18.60	19.59	75.19	74.50
1959	6.69	6.21	17.14	18.28	76.17	75.51
1960	7.11	6.52	16.53	17.13	76.36	76.36
1961	7.37	6.83	15.57	16.12	77.05	77.05
1962	7.62	7.15	14.85	15.24	77.53	77.60
1963	7.77	7.49	14.41	14.48	77.82	78.03
1964	8.01	7.82	14.12	13.82	77.86	78.36
1965	8.27	8.17	13.92	13.24	77.80	78.59
1966	8.52	8.52	13.46	12.73	78.02	78.74
1967	8.51	8.88	13.37	12.30	78.12	78.82
1968	8.83	9.25	12.67	11.92	78.50	78.83
1969	9.40	9.62	12.21	11.59	78.39	78.79
1970	9.81	9.99	12.05	11.31	78.14	78.70
1971	10.28	10.37	10.72	11.06	79.00	78.57
1972	10.49	10.75	10.13	10.85	79.38	78.40
1973	11.12	11.13	10.13	10.67	78.74	78.20
1974	11.49	11.51	10.33	10.51	78.18	77.98
1975	12.05	11.89	9.87	10.37	78.07	77.74
1976	12.08	12.27	9.81	10.25	78.11	77.47
1977	12.23	12.65	9.42	10.15	78.35	77.20
1978	12.61	13.03	9.94	10.06	77.46	76.91
1979	12.83	13.40	10.25	9.98	76.91	76.61
1980	13.64	13.77	9.68	9.92	76.67	76.31
1981	14.17	14.14	10.38	9.86	75.44	76.00
1982	14.44	14.50	9.63	9.81	75.93	75.69
1983	15.19	14.85	10.29	9.77	74.52	75.38
1984	15.33	15.20	10.73	9.73	73.95	75.07
1985	15.68	15.53	10.62	9.70	73.69	74.77
1986		15.87		9.67		74.46
1990		17.10		9.60		73.30
1995		18.44		9.55		72.01
2000		19.53		9.52		70.94
2005		20.40		9.51		70.09
2010		21.08		9.51		69.42
2015		21.59		9.50		68.91
2020		21.97		9.50		68.53
2030		22.46		9.50		68.04
2040		22.72		9.50		67.78
2050		22.85		9.50		67.65
1880		0.00		100.00		0.00
1890		0.00		100.00		-0.00
1900		0.00		100.00		-0.00
1910		0.00		100.00		-0.00
1920		0.00		100.00		0.00
1930		0.00		99.94		0.06
1935		0.00		97.24		2.76
1940		0.00		82.99		17.01
1947		0.00		50.16		49.83

Coal Share % = $Z + ((100-Z)*(1 - B^{(C^x)}))$
 $Z = 9.5$; $B = 0.99778$; $C = 0.86312$
 Electricity Share % = $A/(1+B^{(C^x)})$
 $A = 23.0$; $B = 0.480612$; $C = 0.935723$
 $x = (\text{Year} - 1985)$
 (Oil + Gas) % = $100 - (\text{Coal share} + \text{Gas Share}) \%$

TABLE 37
(File: USDATA47 Page 12)

UNITED STATES

Consider 3 alternative Sigmoidal Models for the Electricity Market Share of the USA Total Final Energy Consumption.

[i] Gompertz: $Y \% = A \cdot (B^{(C^x)})$; Point of Inflectn at $Y=13.979$
 $A = 38.0$; $B = 0.4099$; $C = 0.9734$

[ii] Middelhoek: $Y \% = A \cdot (1 - B^{(C^x)})$; Point of Inflectn $Y=11.694$
 $A = 18.5$; $B = 0.1570$; $C = 1.0603$

[iii] Logistic: $Y \% = A / (1 + B^{(C^x)})$; Point of inflectn at 11.50
 $A = 23.0$; $B = 0.4806$; $C = 0.9357$
 and $x = (\text{Year} - 1985)$

Year	Calculated Values		
	Gom- pertz	Middel- hoek	Logis- tic
1900	0.006	0.235	0.168
1910	0.046	0.420	0.323
1912	0.065	0.472	0.369
1914	0.091	0.530	0.420
1916	0.125	0.594	0.479
1918	0.169	0.667	0.545
1920	0.224	0.748	0.620
1922	0.294	0.839	0.706
1924	0.379	0.940	0.803
1926	0.482	1.053	0.912
1928	0.607	1.180	1.036
1930	0.753	1.321	1.176
1932	0.925	1.478	1.333
1934	1.124	1.653	1.510
1936	1.352	1.848	1.709
1938	1.610	2.064	1.931
1940	1.901	2.304	2.179
1942	2.224	2.569	2.456
1944	2.581	2.862	2.763
1946	2.971	3.185	3.103
1948	3.396	3.540	3.477
1950	3.854	3.930	3.888
1952	4.345	4.356	4.336
1954	4.868	4.819	4.823
1956	5.422	5.322	5.349
1958	6.005	5.866	5.913
1960	6.614	6.450	6.516
1962	7.249	7.075	7.154
1964	7.907	7.738	7.824
1966	8.585	8.438	8.524
1968	9.281	9.171	9.248
1970	9.993	9.932	9.992
1972	10.718	10.712	10.748
1974	11.453	11.506	11.511
1976	12.196	12.301	12.274
1978	12.944	13.088	13.030
1980	13.696	13.854	13.773
1982	14.449	14.587	14.496
1984	15.200	15.273	15.195
1986	15.948	15.902	15.865
1988	16.690	16.464	16.502
1990	17.426	16.952	17.103
1992	18.153	17.362	17.667
1994	18.869	17.695	18.192
1996	19.575	17.955	18.678
1998	20.267	18.148	19.125
2000	20.946	18.285	19.534
2002	21.610	18.376	19.907
2004	22.259	18.434	20.246
2006	22.892	18.467	20.552
2008	23.508	18.485	20.828
2010	24.108	18.494	21.076
2012	24.690	18.498	21.297
2014	25.254	18.499	21.495
2016	25.801	18.500	21.672
2018	26.330	18.500	21.829
2020	26.841	18.500	21.968
2025	28.042	18.500	22.250
2030	29.136	18.500	22.457
2035	30.127	18.500	22.608
2040	31.021	18.500	22.717
2045	31.824	18.500	22.797
2050	32.543	18.500	22.854

TABLE 38

UNITED STATES

(File: USDATA47 Page 13)

Market Shares of carriers of Total Final Energy Consumption

Year	Electr	Coal	Oil+ Gas	Oil+ Gas+ Coal
1910	0.32	100.00	-0.32	99.68
1912	0.37	100.00	-0.37	99.63
1914	0.42	100.00	-0.42	99.58
1916	0.48	100.00	-0.48	99.52
1918	0.54	100.00	-0.54	99.46
1920	0.62	100.00	-0.62	99.38
1922	0.71	100.00	-0.71	99.29
1924	0.80	100.00	-0.80	99.20
1926	0.91	100.00	-0.91	99.09
1928	1.04	99.99	-1.03	98.96
1930	1.18	99.94	-1.11	98.82
1932	1.33	99.60	-0.94	98.67
1934	1.51	98.41	0.08	98.49
1936	1.71	95.55	2.74	98.29
1938	1.93	90.40	7.66	98.07
1940	2.18	82.99	14.83	97.82
1942	2.46	73.95	23.59	97.54
1944	2.76	64.22	33.02	97.24
1946	3.10	54.66	42.23	96.90
1948	3.48	45.92	50.60	96.52
1950	3.89	38.34	57.78	96.11
1952	4.34	32.00	63.67	95.66
1954	4.82	26.86	68.32	95.18
1956	5.35	22.77	71.88	94.65
1958	5.91	19.59	74.50	94.09
1960	6.52	17.13	76.36	93.48
1962	7.15	15.24	77.60	92.85
1964	7.82	13.82	78.36	92.18
1966	8.52	12.73	78.74	91.48
1968	9.25	11.92	78.83	90.75
1970	9.99	11.31	78.70	90.01
1972	10.75	10.85	78.40	89.25
1974	11.51	10.51	77.98	88.49
1976	12.27	10.25	77.47	87.73
1978	13.03	10.06	76.91	86.97
1980	13.77	9.92	76.31	86.23
1982	14.50	9.81	75.69	85.50
1984	15.20	9.73	75.07	84.80
1986	15.87	9.67	74.46	84.13
1988	16.50	9.63	73.87	83.50
1990	17.10	9.60	73.30	82.90
1992	17.67	9.57	72.76	82.33
1994	18.19	9.55	72.25	81.81
1996	18.68	9.54	71.78	81.32
1998	19.12	9.53	71.35	80.88
2000	19.53	9.52	70.94	80.47
2002	19.91	9.52	70.58	80.09
2004	20.25	9.51	70.24	79.75
2006	20.55	9.51	69.94	79.45
2008	20.83	9.51	69.67	79.17
2010	21.08	9.51	69.42	78.92
2012	21.30	9.50	69.20	78.70
2014	21.50	9.50	69.00	78.50
2016	21.67	9.50	66.83	78.33
2018	21.83	9.50	68.67	78.17
2020	21.97	9.50	68.53	78.03

$$\begin{aligned} \text{Coal Share \%} &= Z + ((100-Z)*(1 - B^{(C^x)}) \\ Z &= 9.5 ; B = 0.99778 ; C = *0.86312 \\ \text{Electricity Share \%} &= A/(1+B^{(C^x)}) \\ A &= 23.0 ; B = 0.480612 ; C = *0.93572 \\ x &= (\text{Year}-1985) (\text{Oil} + \text{Gas})\% \\ &= 100 - (\text{Coal share} + \text{Gas Share}) \% \end{aligned}$$

FIGURES

FIGURE 1. SOUTH AFRICA FINAL ENERGY DEMAND

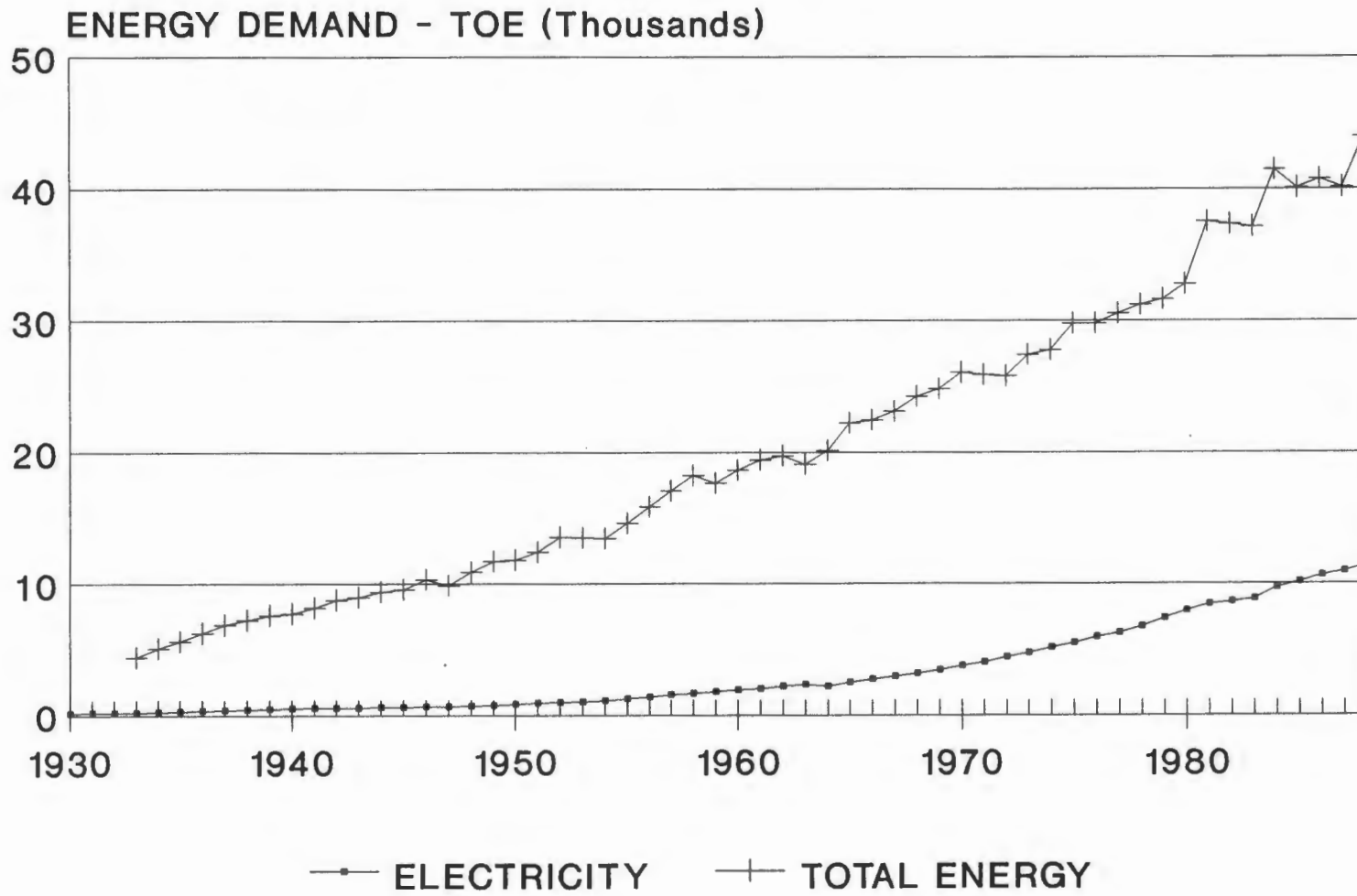


Figure 1 South Africa - Final energy demand

FIGURE 2. CONTRIBUTION OF ENERGY SOURCES TO FINAL ENERGY DEMAND IN SOUTH AFRICA

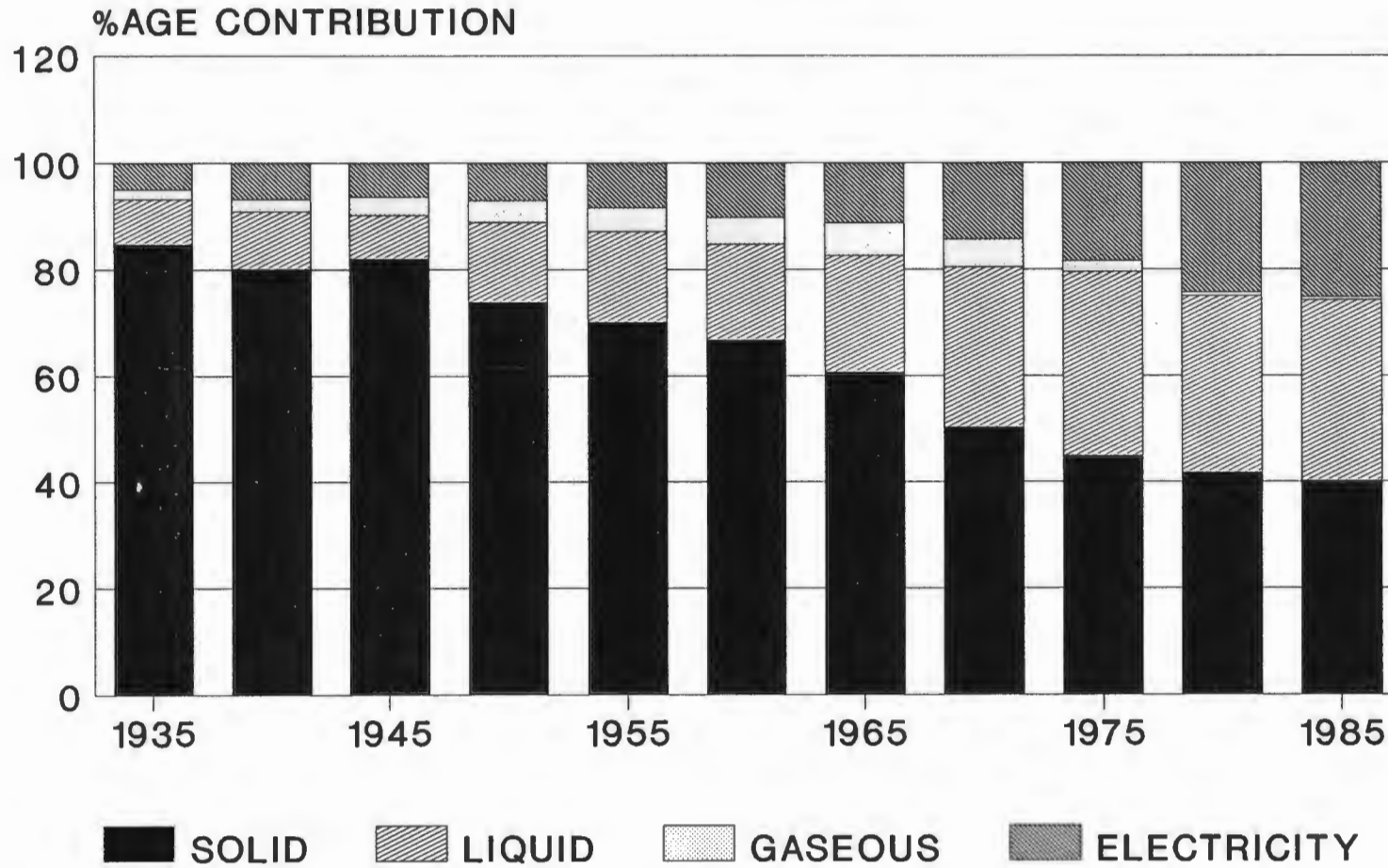
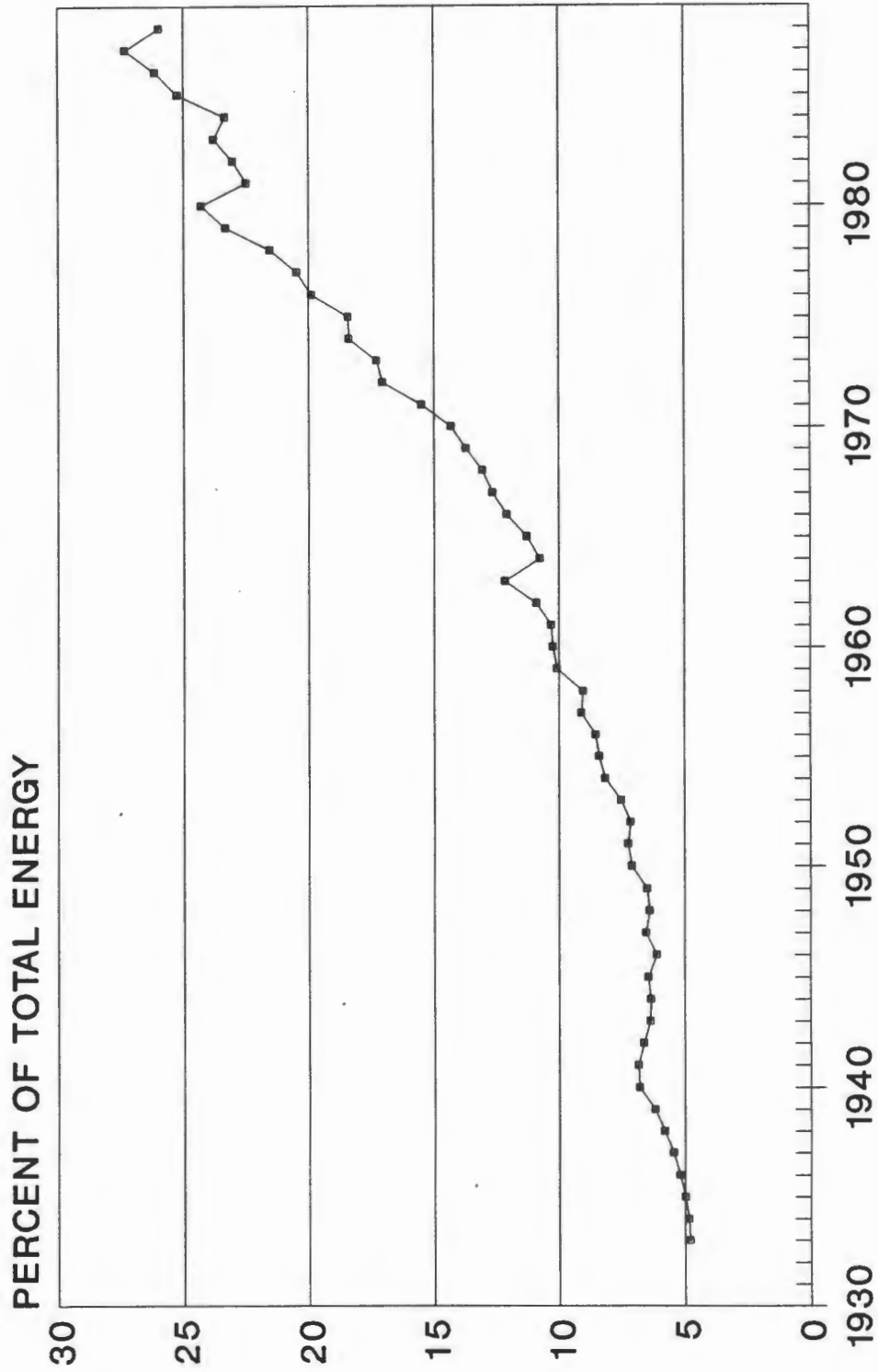


Figure 2 Contribution of energy sources to final energy demand in South Africa

129/SA_EN_EC_04

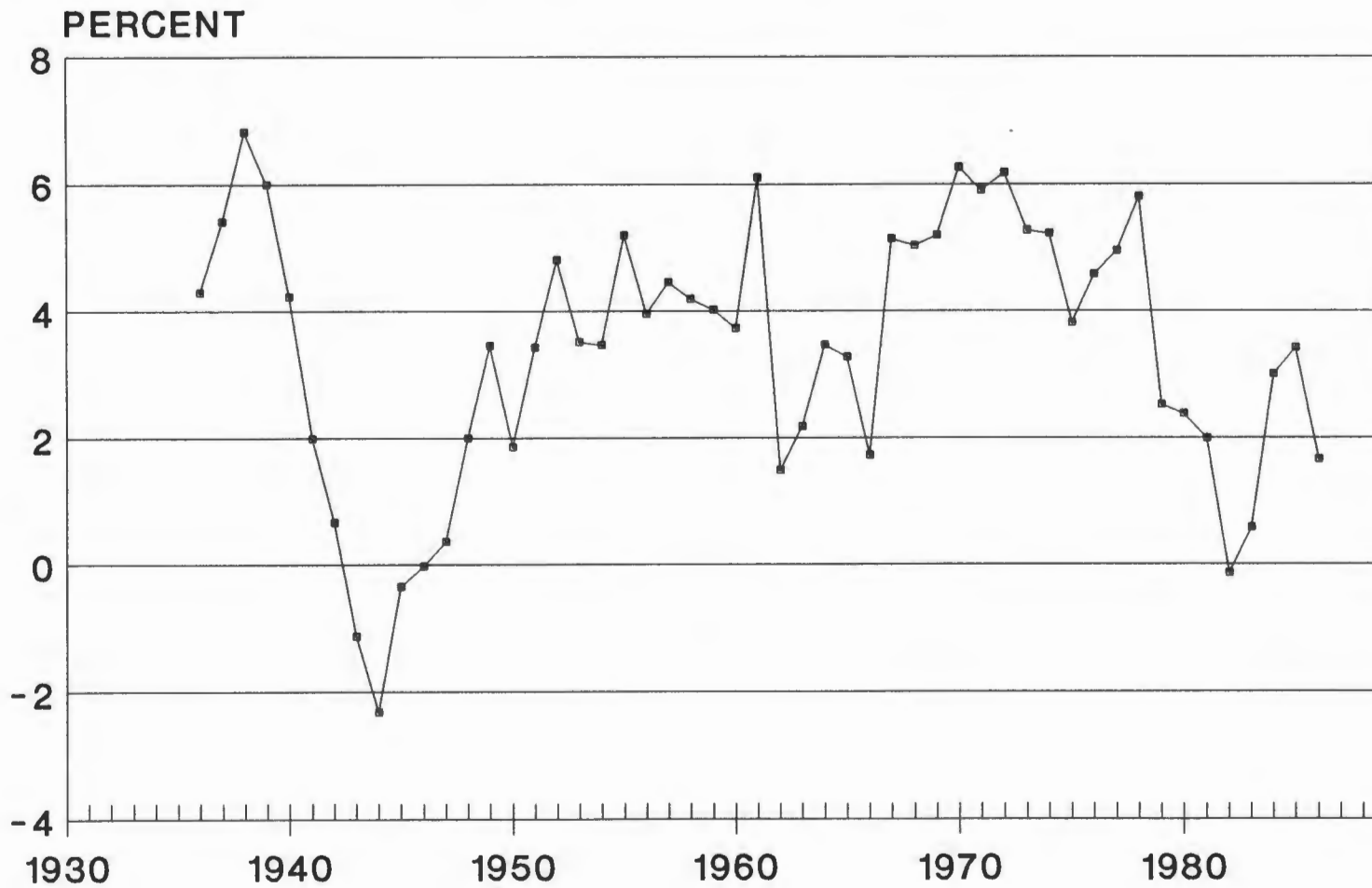
Figure 3 South Africa - Role of electricity in final energy demand

FIGURE 3. SOUTH AFRICA -
ROLE OF ELECTRICITY IN
FINAL ENERGY DEMAND



129/SA_EN_EC_11

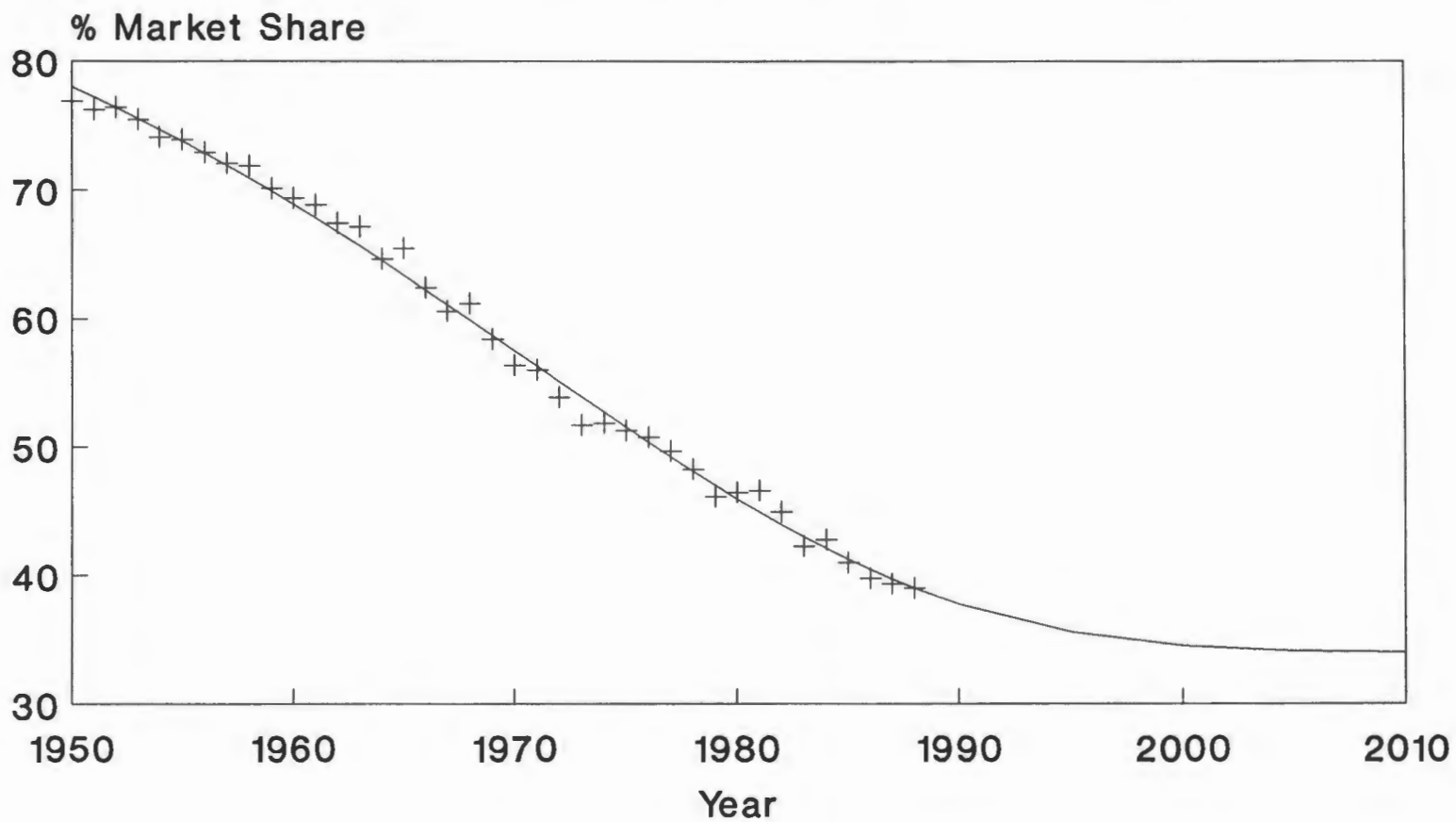
FIGURE 4. DIFFERENCE BETWEEN ANNUAL GROWTH RATE (ELECTRICITY - ENERGY) 5 POINT MOVING AVERAGE



129/SA_EN_EC_13

Figure 4 Difference between annual growth rate (Electricity - Energy)

FIGURE 5 SOUTH AFRICA - COAL
Coal Share of Final Energy Consumption

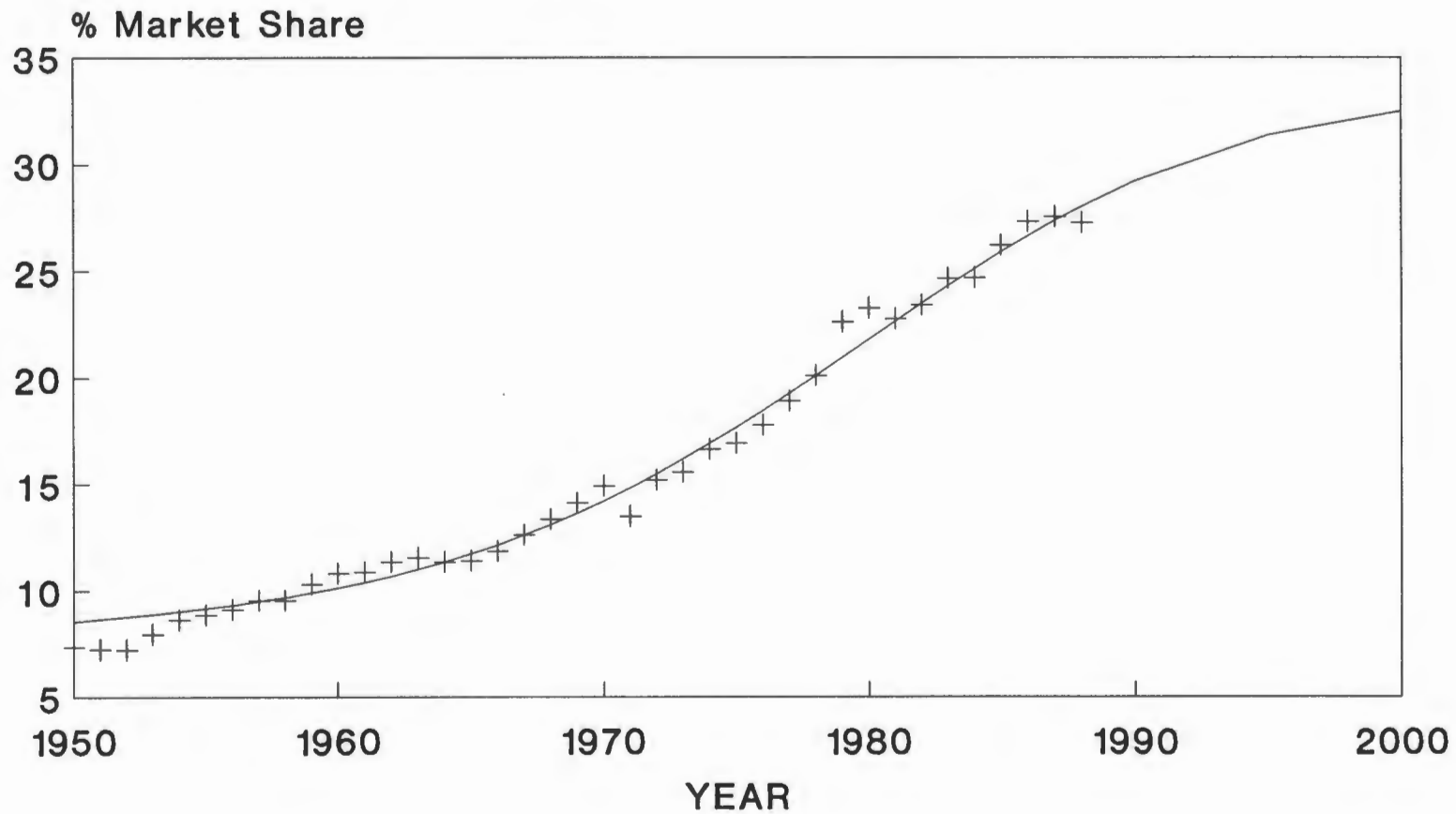


— Calculated Values + Actual Values

SACOAL

Figure 5 South Africa - Coal

FIGURE 6 SOUTH AFRICA - ELECTRICITY
Component of Final Energy Consumption

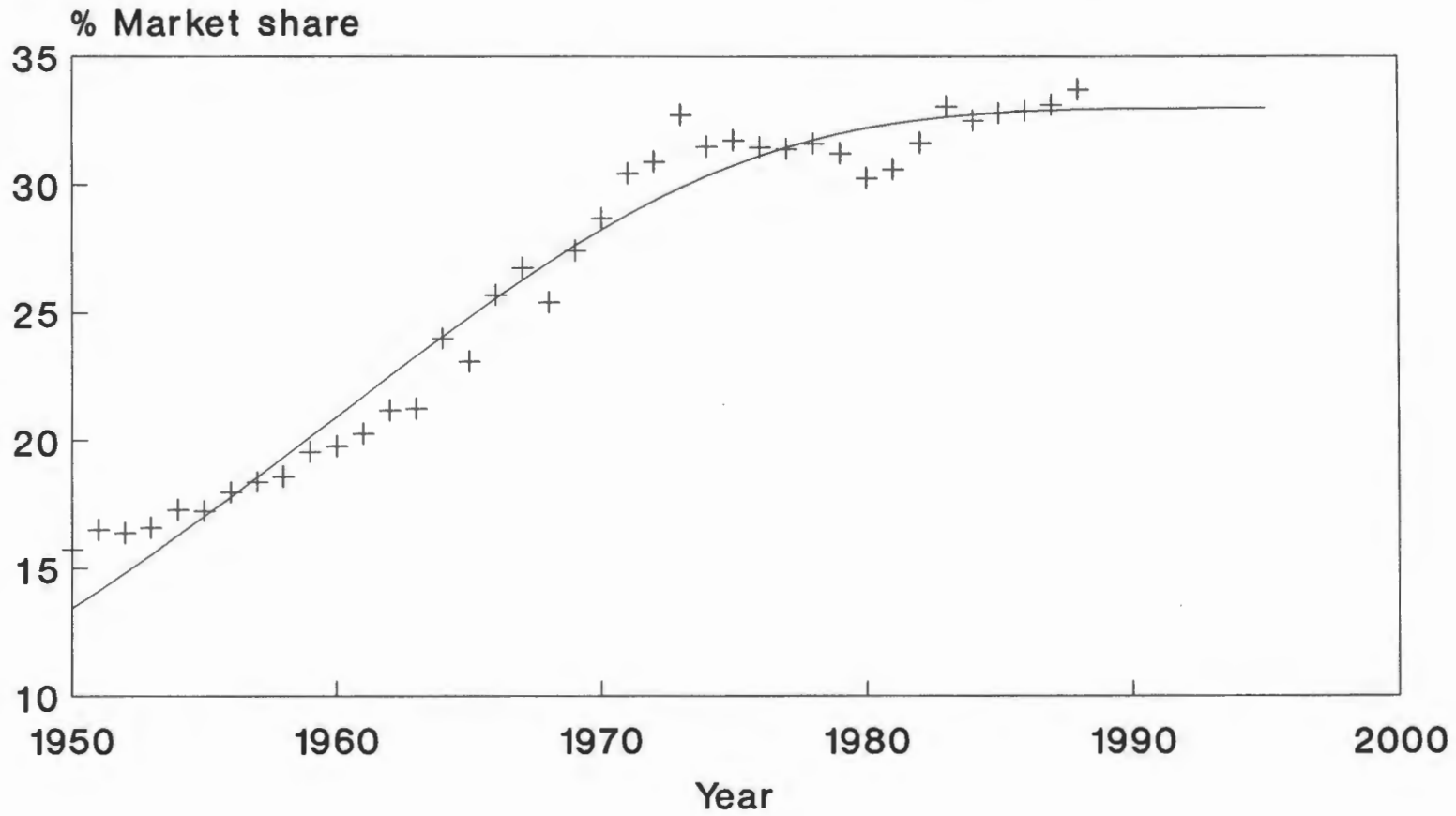


— Calculated Curve + Actual Values

SAELECTR

Figure 6 South Africa - Electricity

FIGURE 7 SOUTH AFRICA - OIL
Oil as % of Total Final Consumption



— Calculated Curve + Actual Values

SAOIL

Figure 7 South Africa - Oil

**FIGURE 8 SOUTH AFRICA - TOTAL
Total Final Energy Consumption**

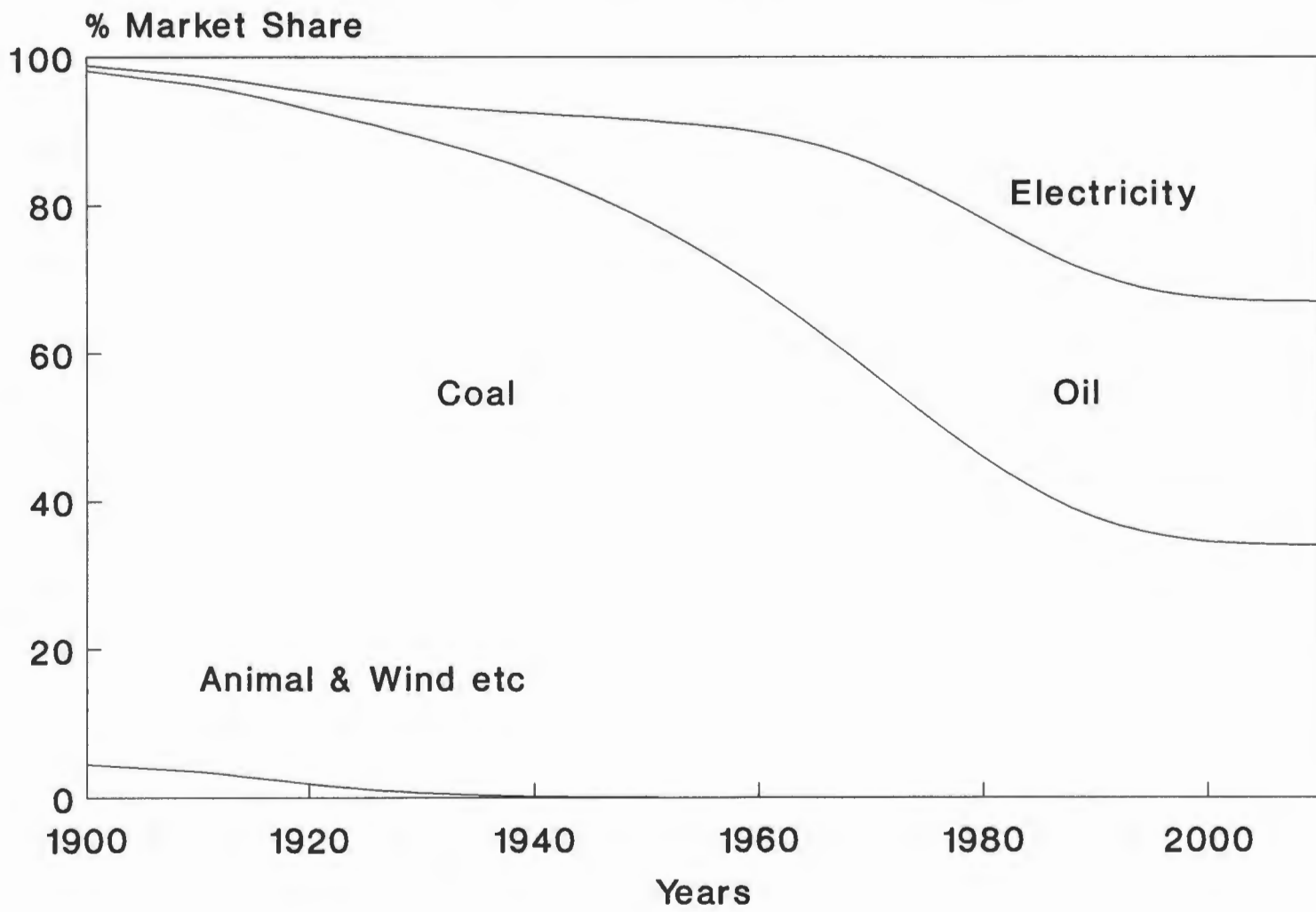
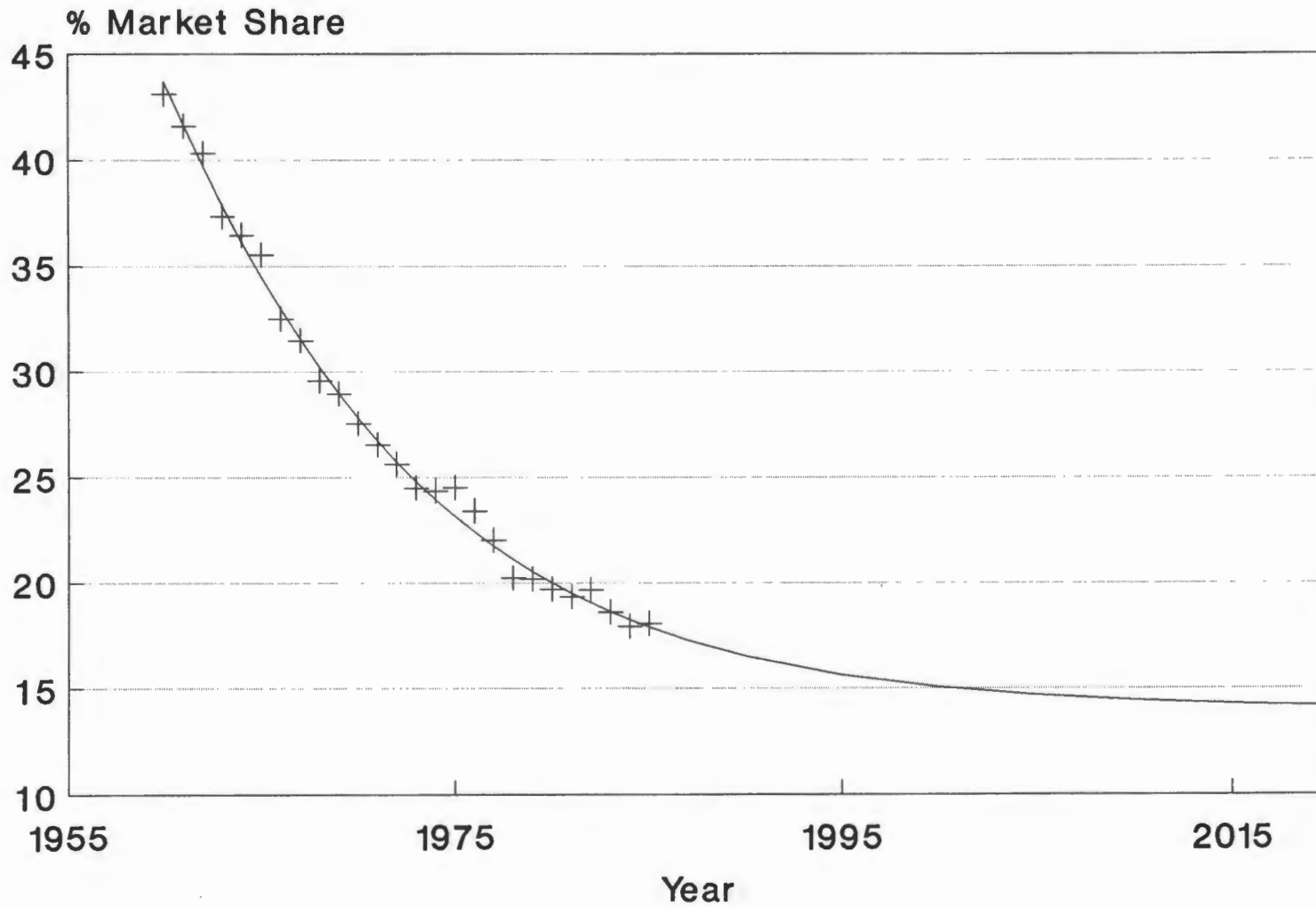


Figure 8 South Africa - Total

ZATOTAL

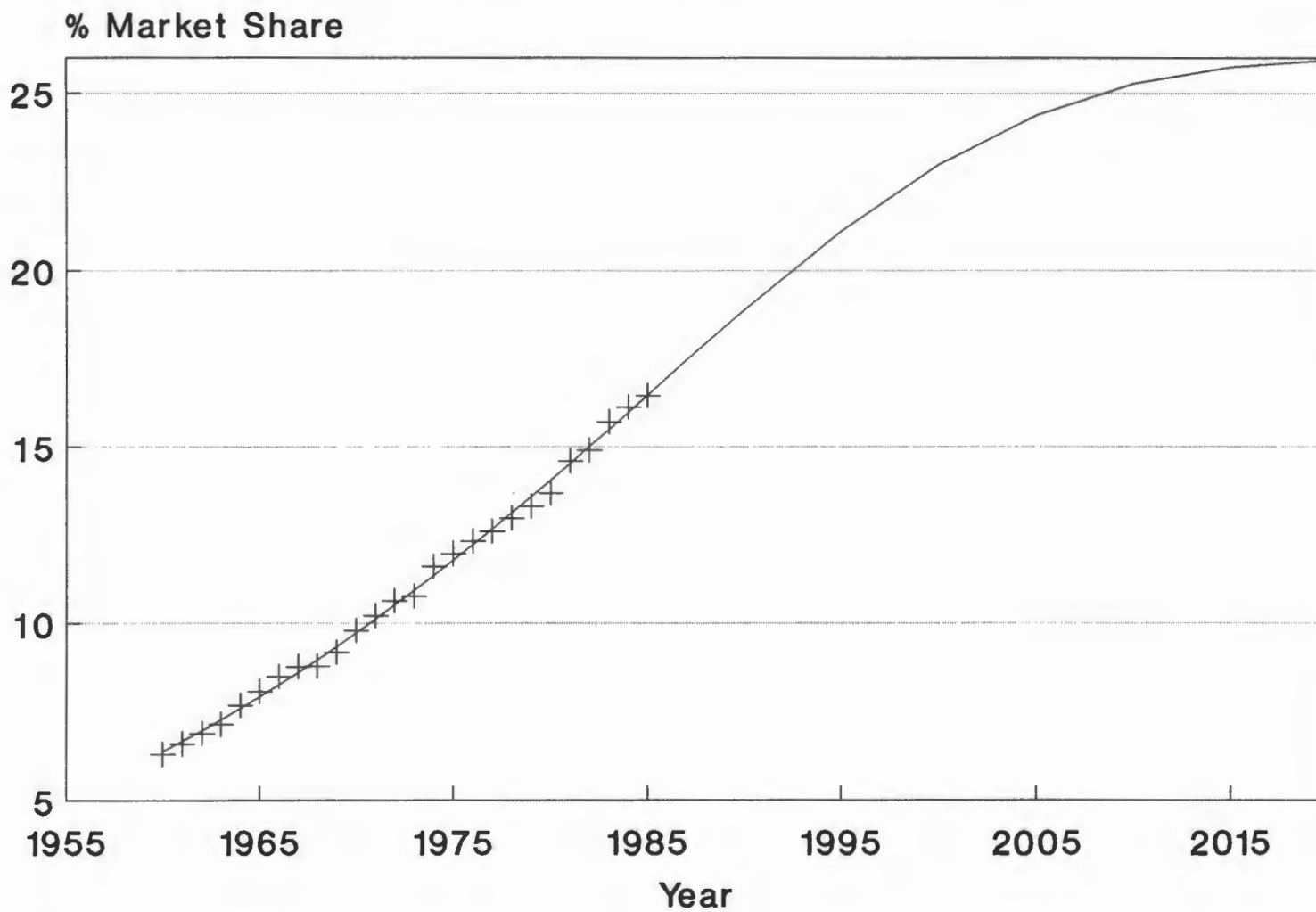
FIGURE 9 AUSTRALIA - COAL
Coal share of final Energy Consumption



AUSCOAL

Figure 9 Australia - Coal

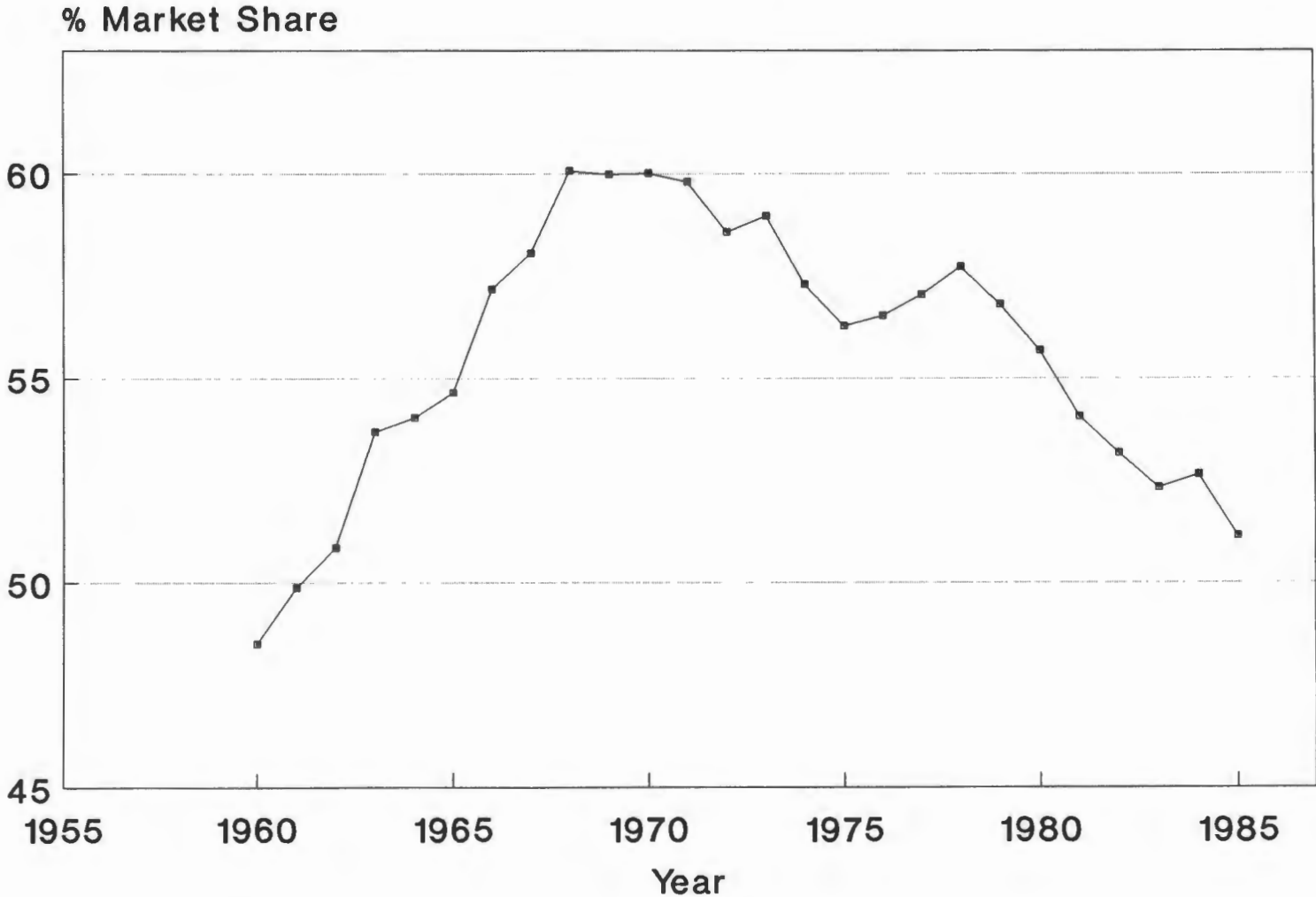
FIGURE 10 AUSTRALIA - ELECTRICITY
Electricity share of final demand



AUSELECT

Figure 10 Australia electricity

FIGURE 11 AUSTRALIA - OIL
Oil share of final demand



AUSOIL

Figure 11 Australia - Oil

FIGURE 12 AUSTRALIA - GAS
Gas share of final demand

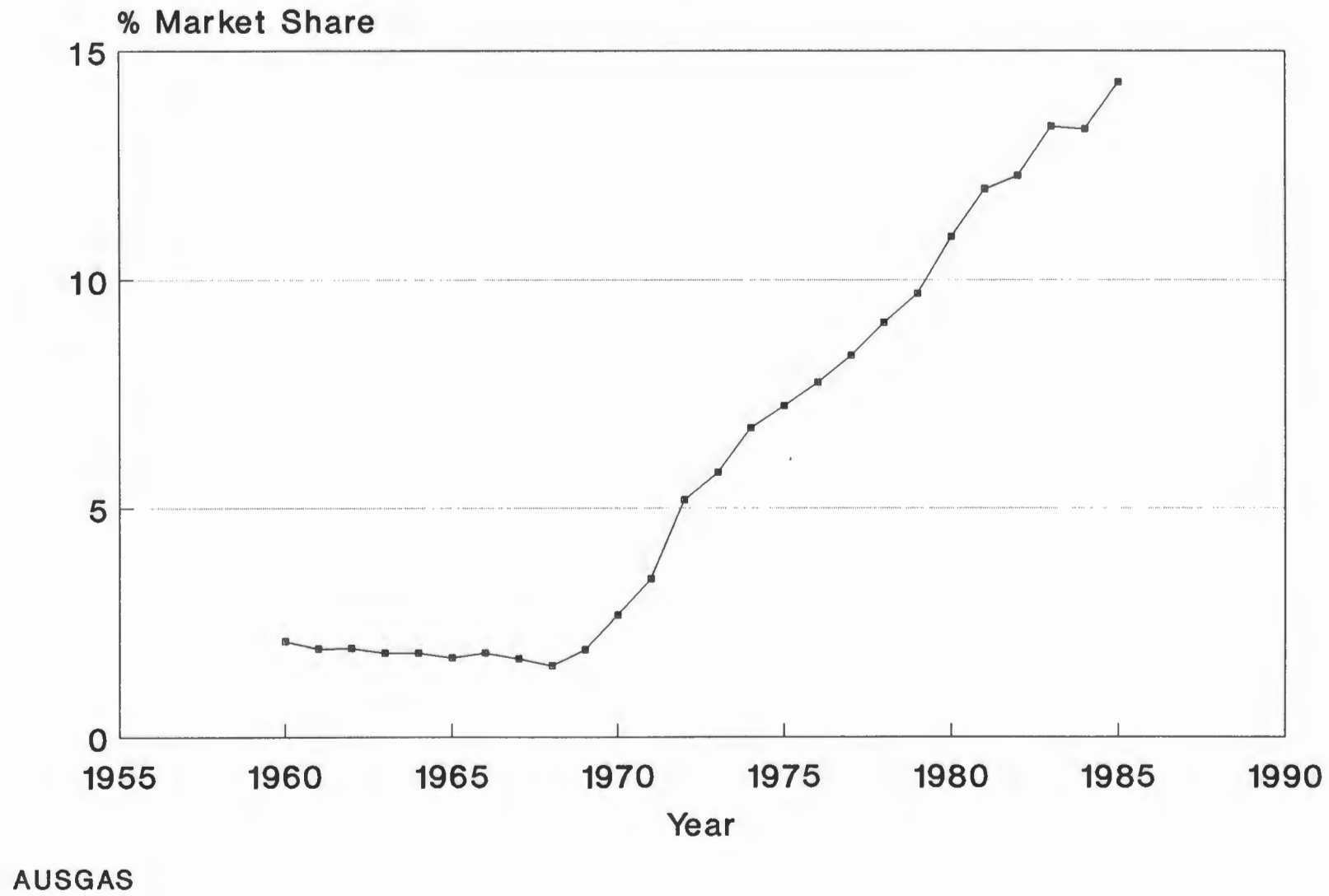
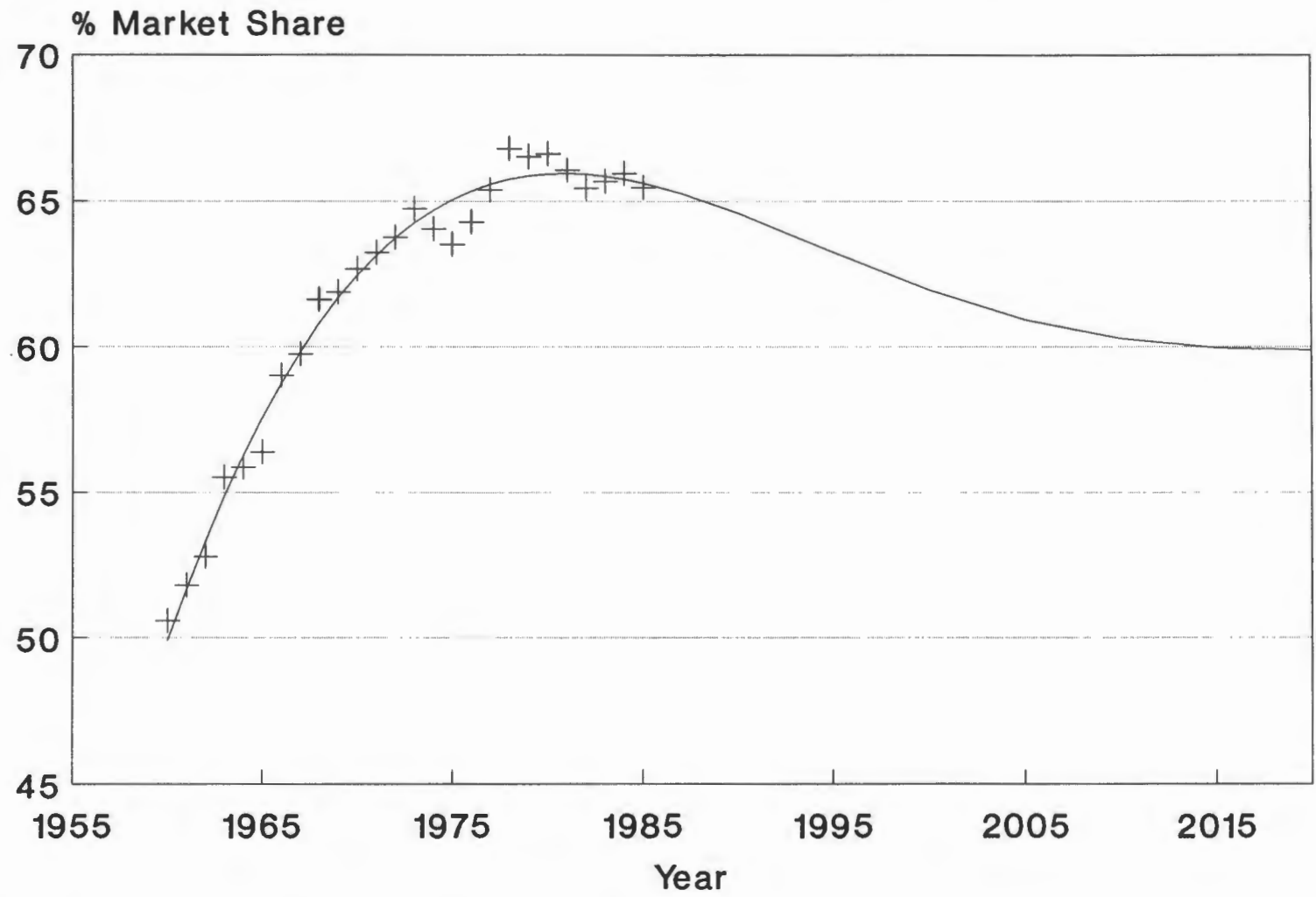


Figure 12 Australia - Gas

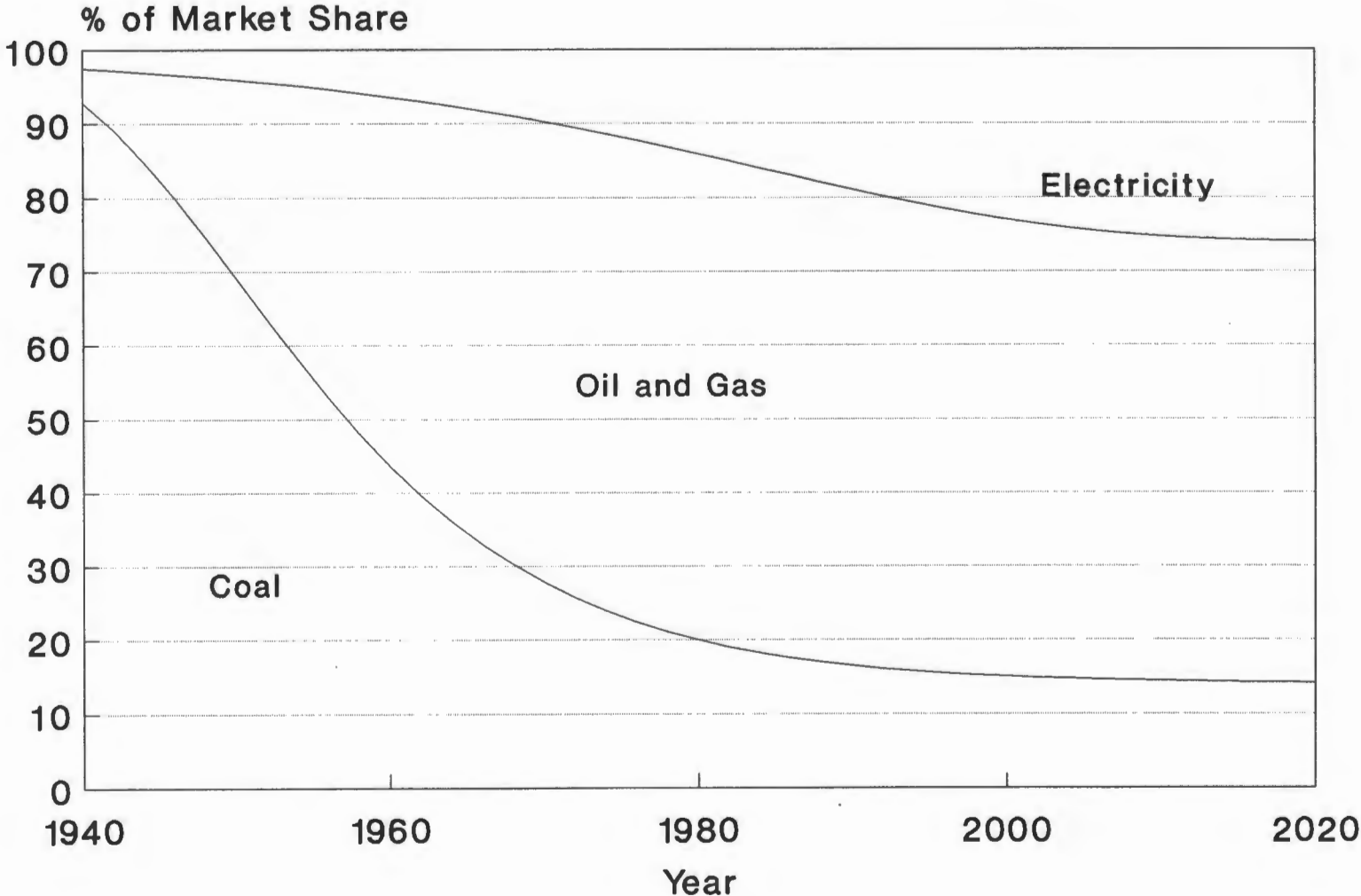
FIGURE 13 AUSTRALIA - OIL & GAS
(Oil & Gas) share of final demand



AUSOILGA

Figure 13 Australia - Oil & gas

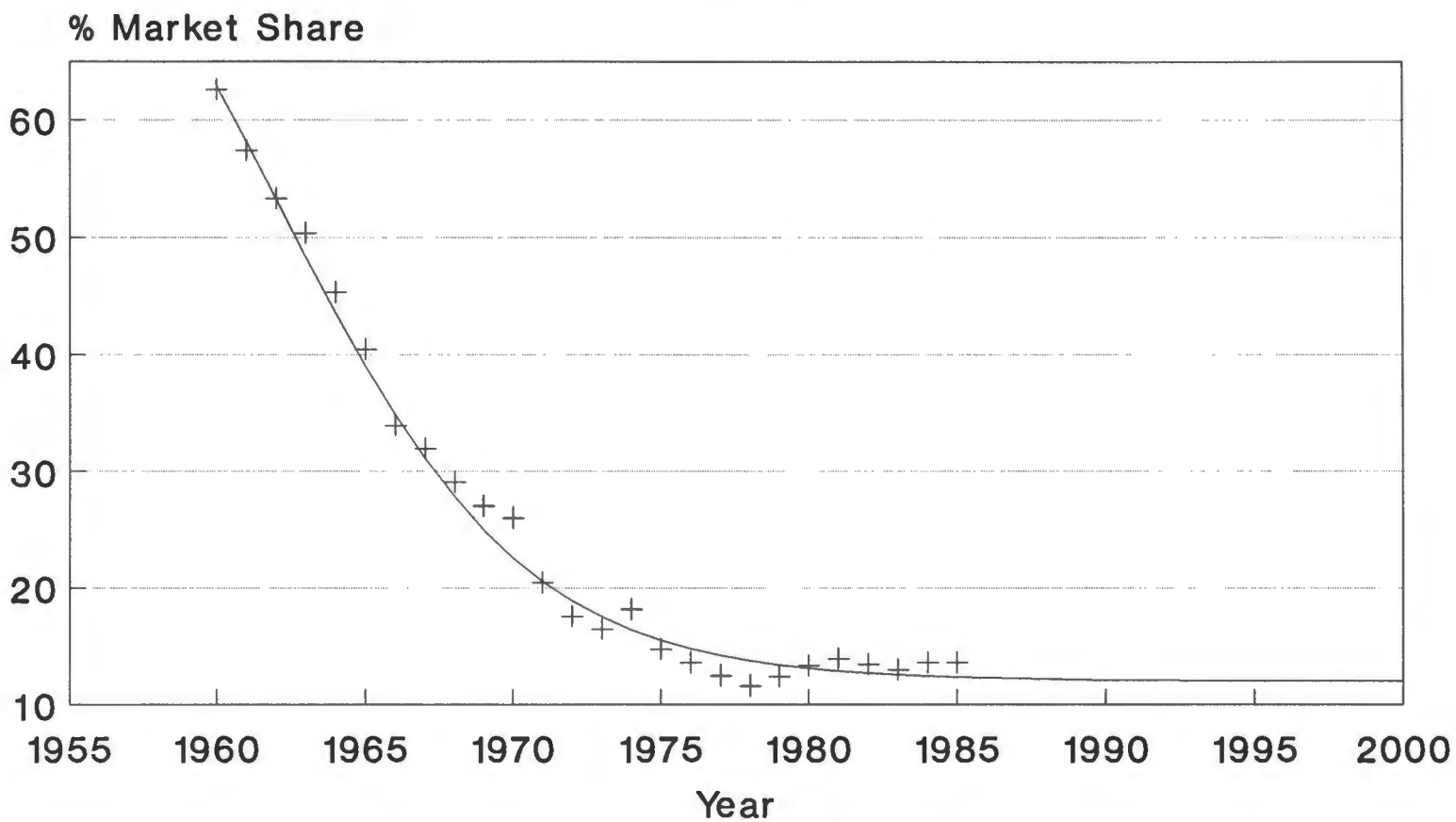
FIGURE 14 AUSTRALIA - TOTAL ENERGY
Total Final Energy Consumption



AUSTOTAL

Figure 14 Australia - Total energy

FIGURE 15 GERMANY - COAL
Coal share of final demand

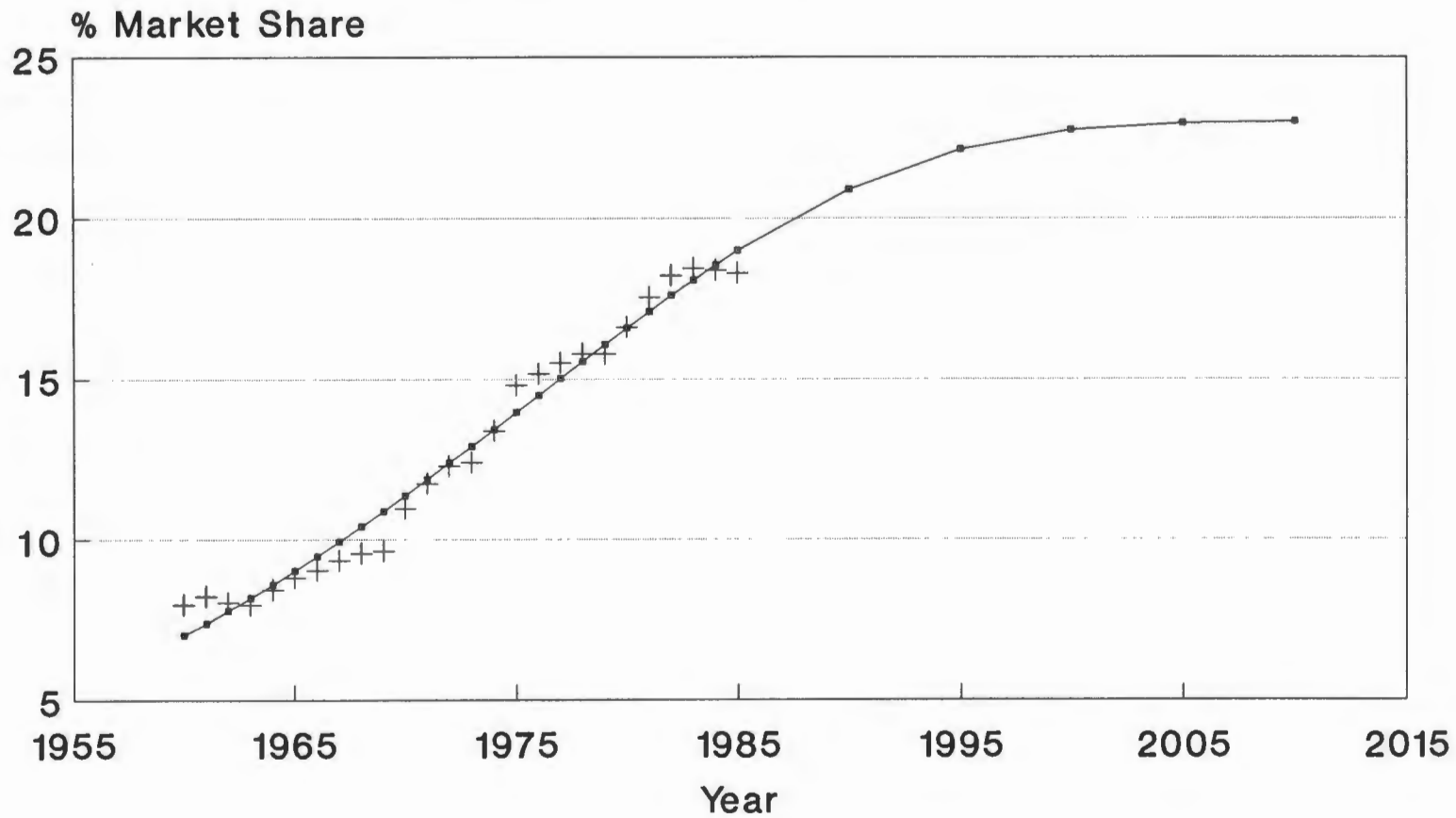


— Calculated Curve + Actual Values

GERCOAL

Figure 15 Germany - Coal

FIGURE 16 GERMANY - ELECTRICITY
Electricity share of final demand

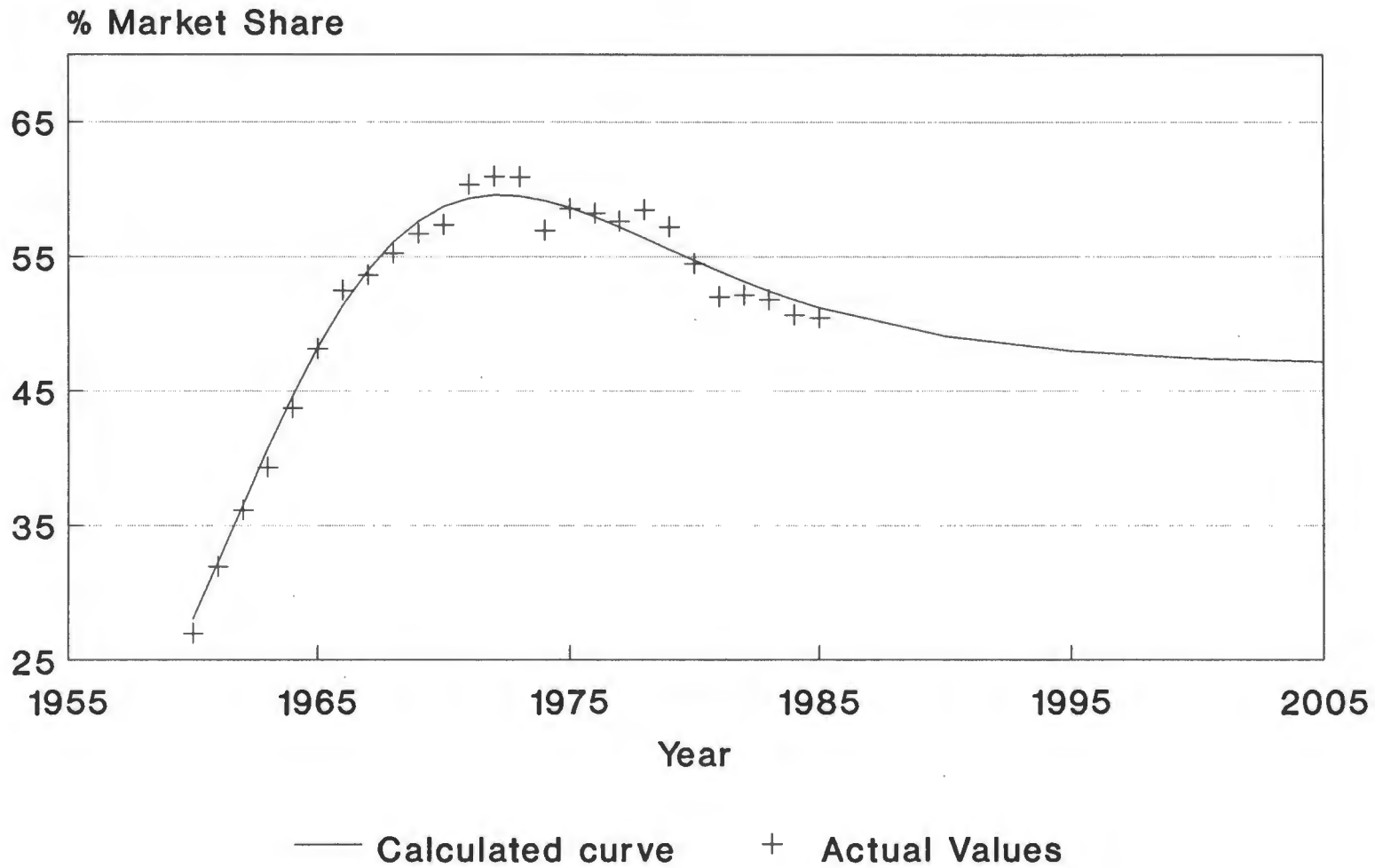


—●— Calculated Curve + Actual Values

GERELECT

Figure 16 Germany - Electricity

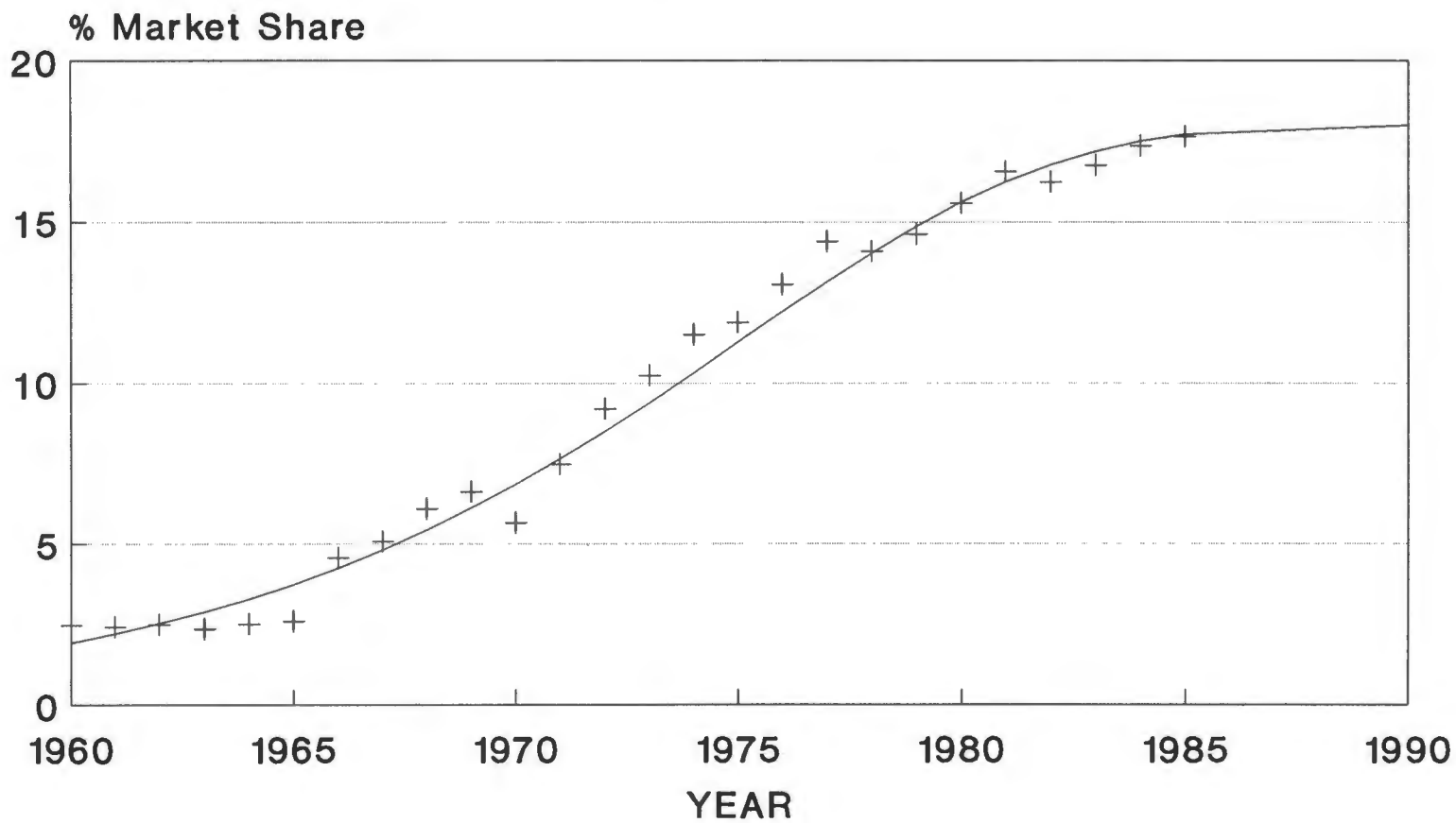
FIGURE 17 GERMANY - OIL
Oil share of final demand



GEROIL

Figure 17 Germany - Oil

FIGURE 18 GERMANY - GAS
Gas share of final demand



— Calculated Curve + Actual Values

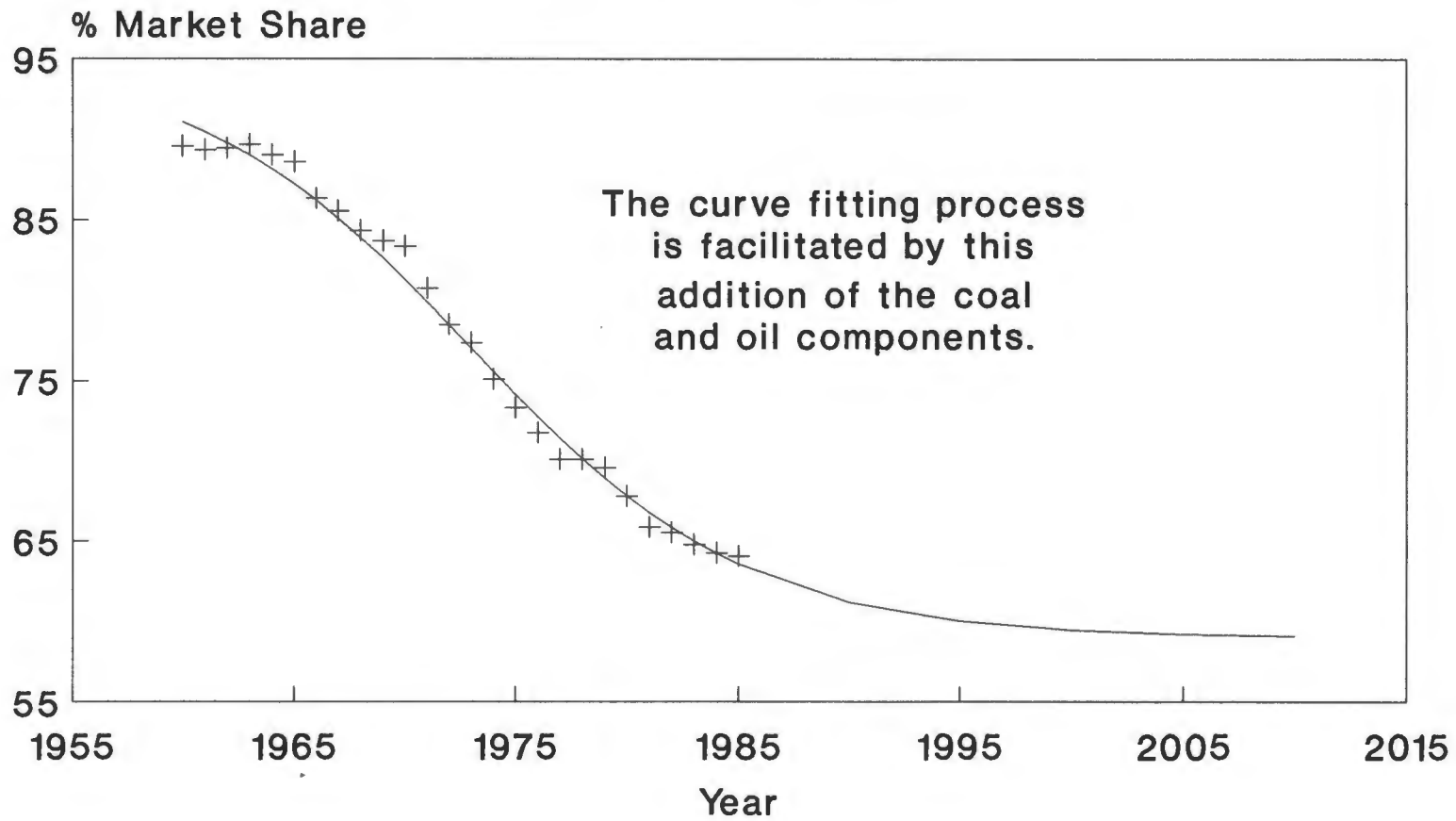
GERGAS

Figure 18 Germany - Gas

- 90 -

Electricity Saturation

FIGURE 19 GERMANY - (COAL & OIL)
(Coal & Oil) share of final demand

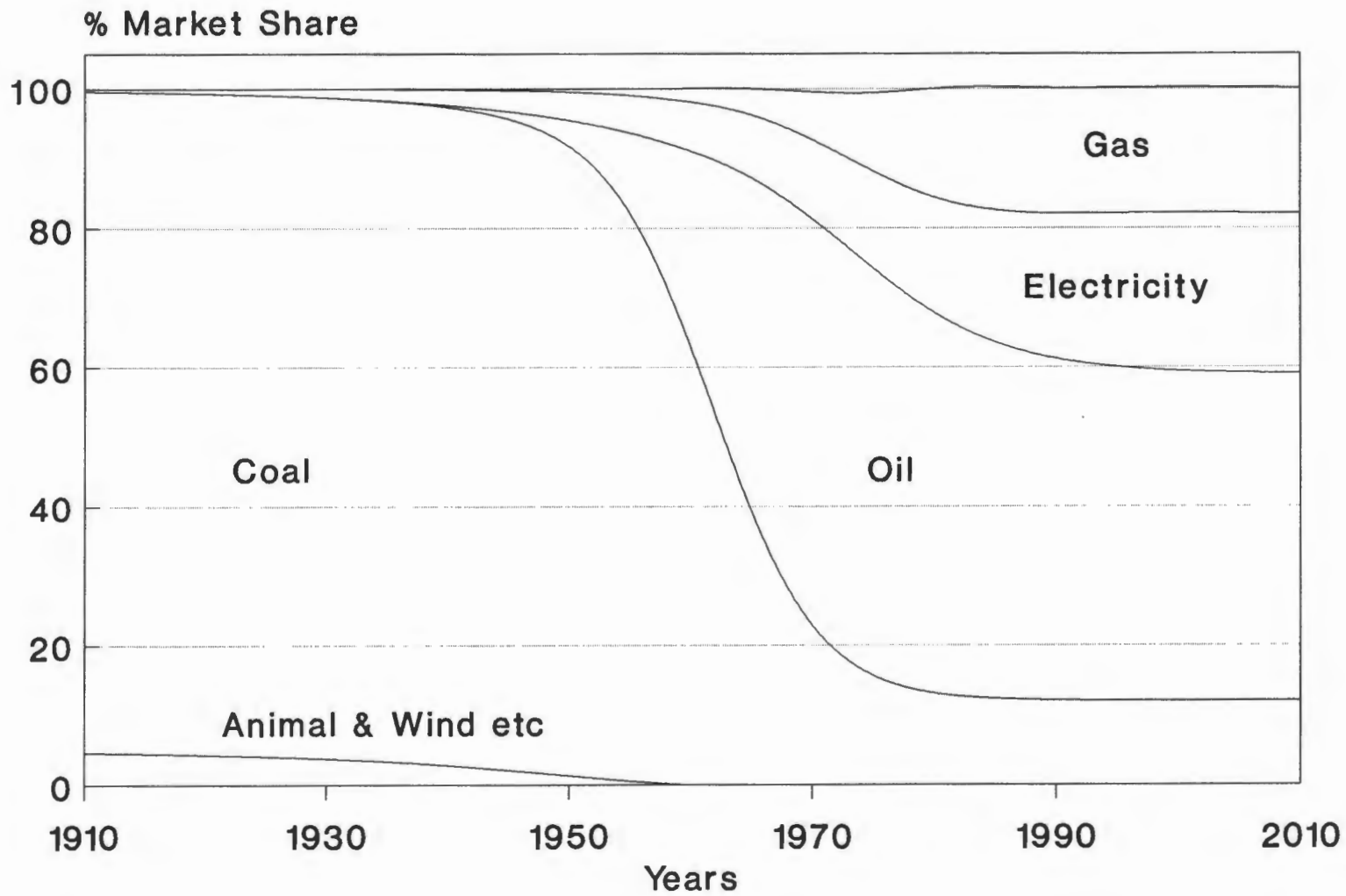


— Calculated Curve + Actual Values

GEROCL

Figure 19 Germany - (Coal & oil)

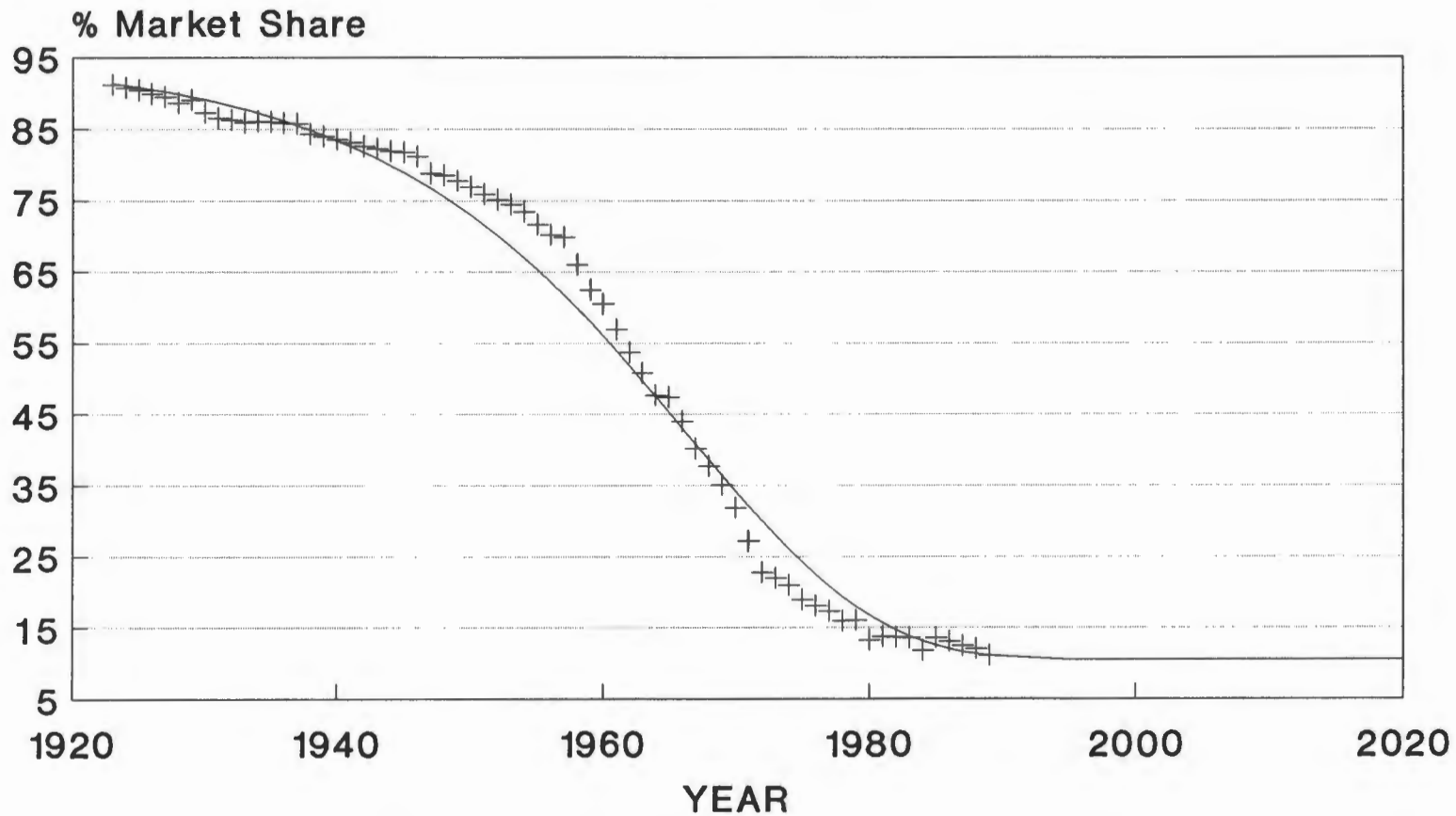
FIGURE 20 GERMANY - FINAL ENERGY
Total Final Energy Consumption



GERCALCD

Figure 20 Germany - Final energy

FIGURE 21 UNITED KINGDOM - COAL
Coal share of final energy demand

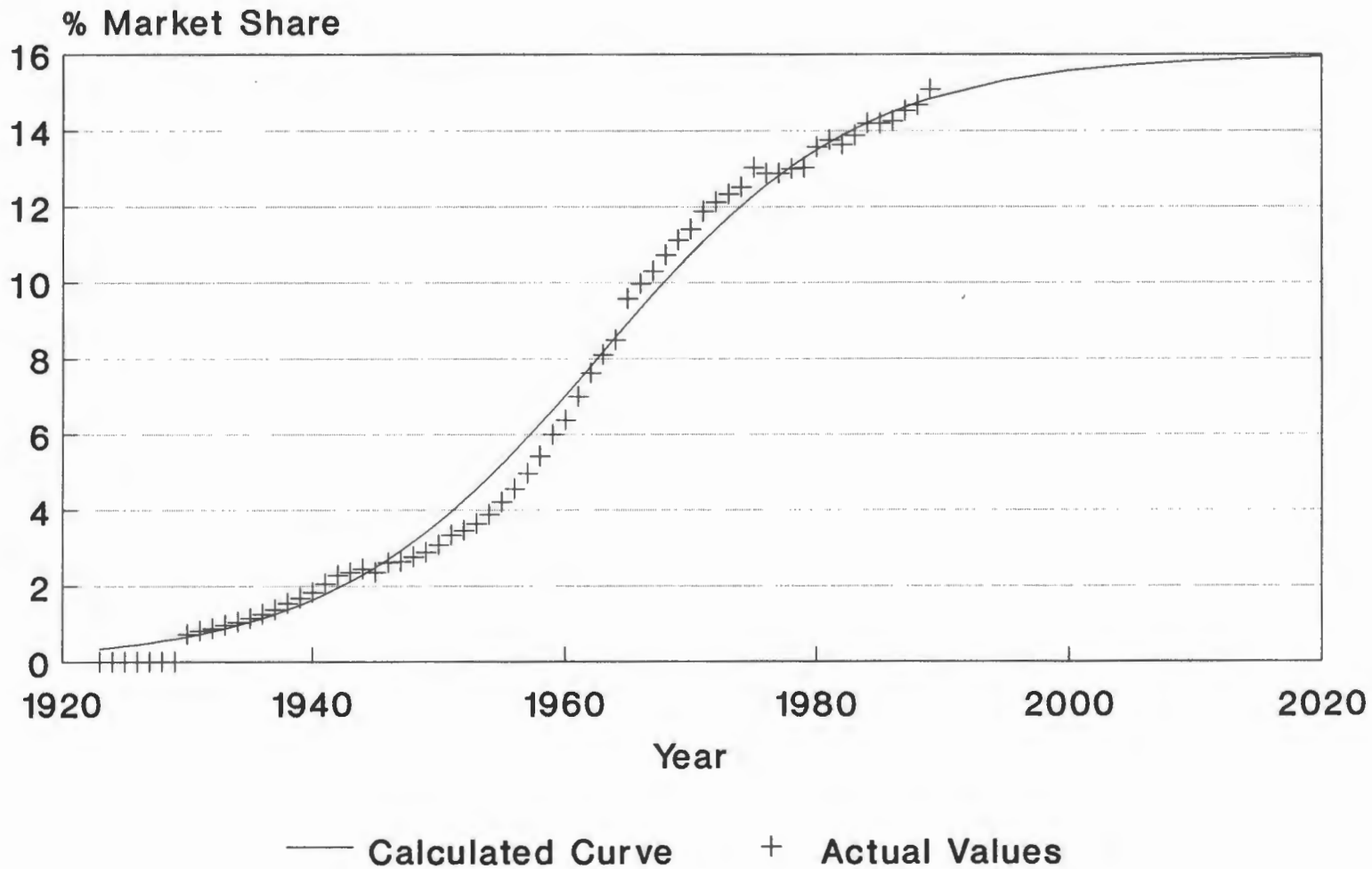


— Calculated Curve + Actual Values

UKCOAL

Figure 21 United Kingdom - Coal

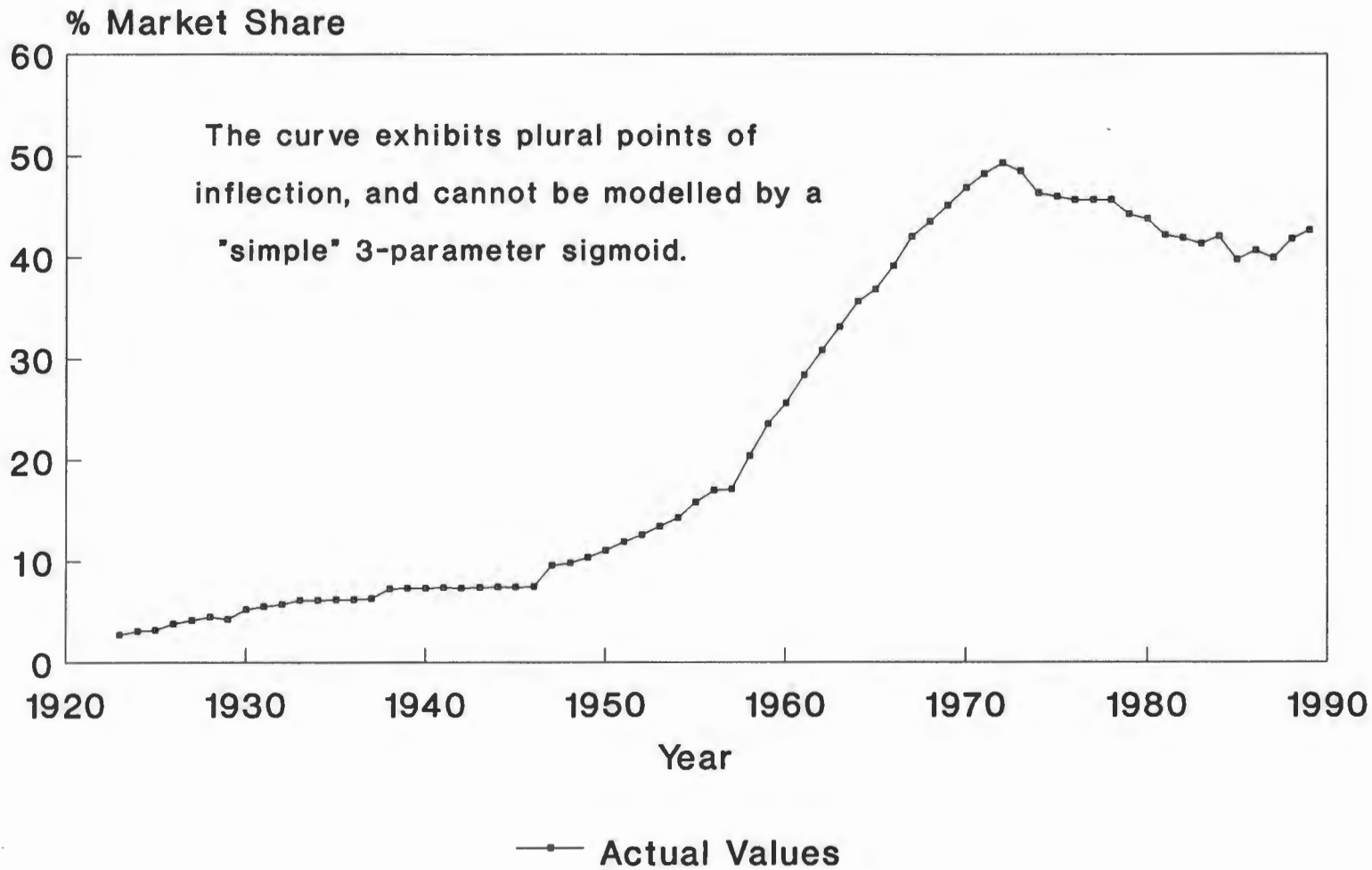
FIGURE 22 UNITED KINGDOM - ELECTRICITY
Electricity share of final demand



UKELECTR

Figure 22 United Kingdom - Electricity

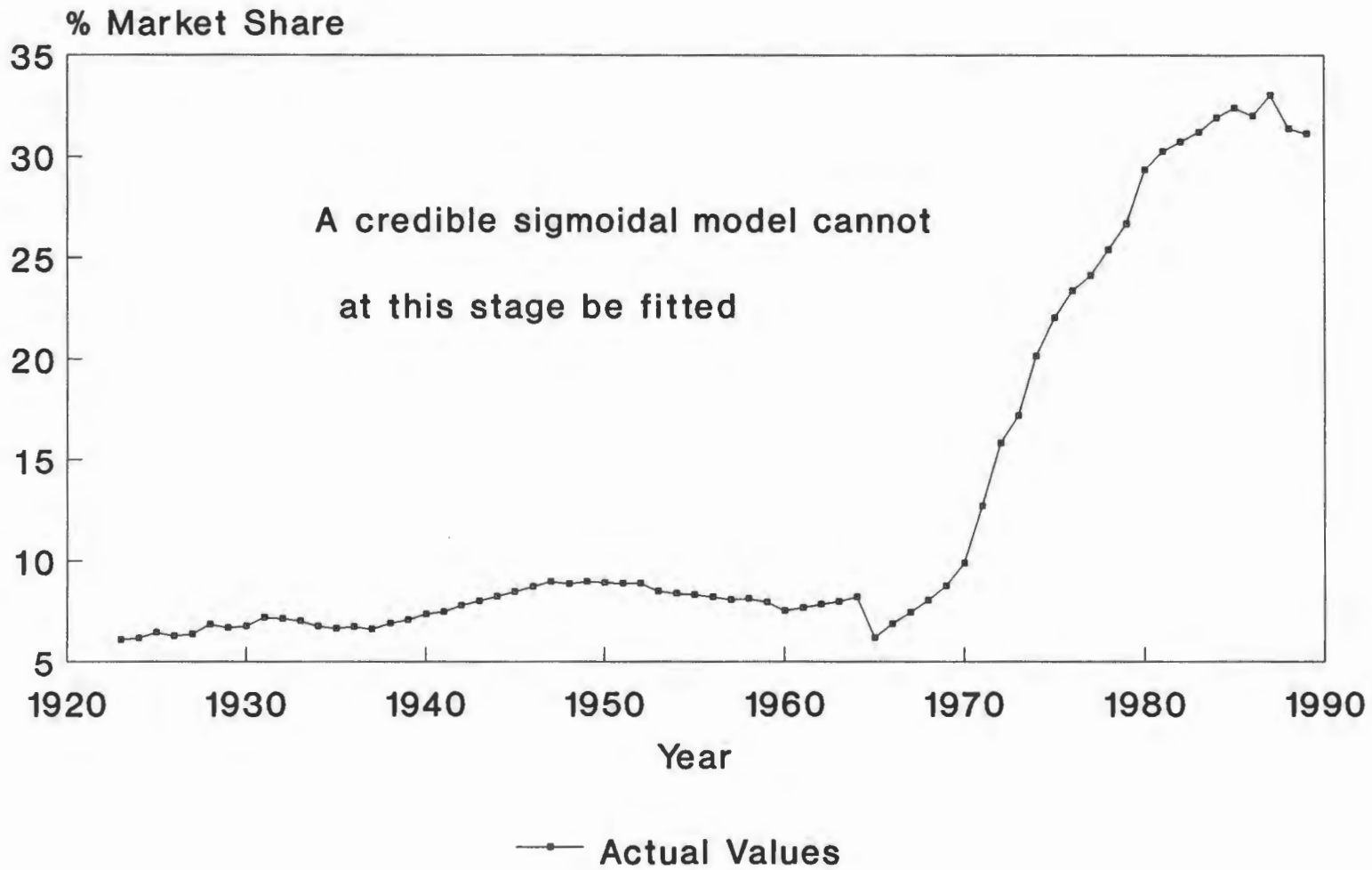
FIGURE 23 UNITED KINGDOM - OIL
Oil share of final demand



UKOIL

Figure 23 United Kingdom - Oil

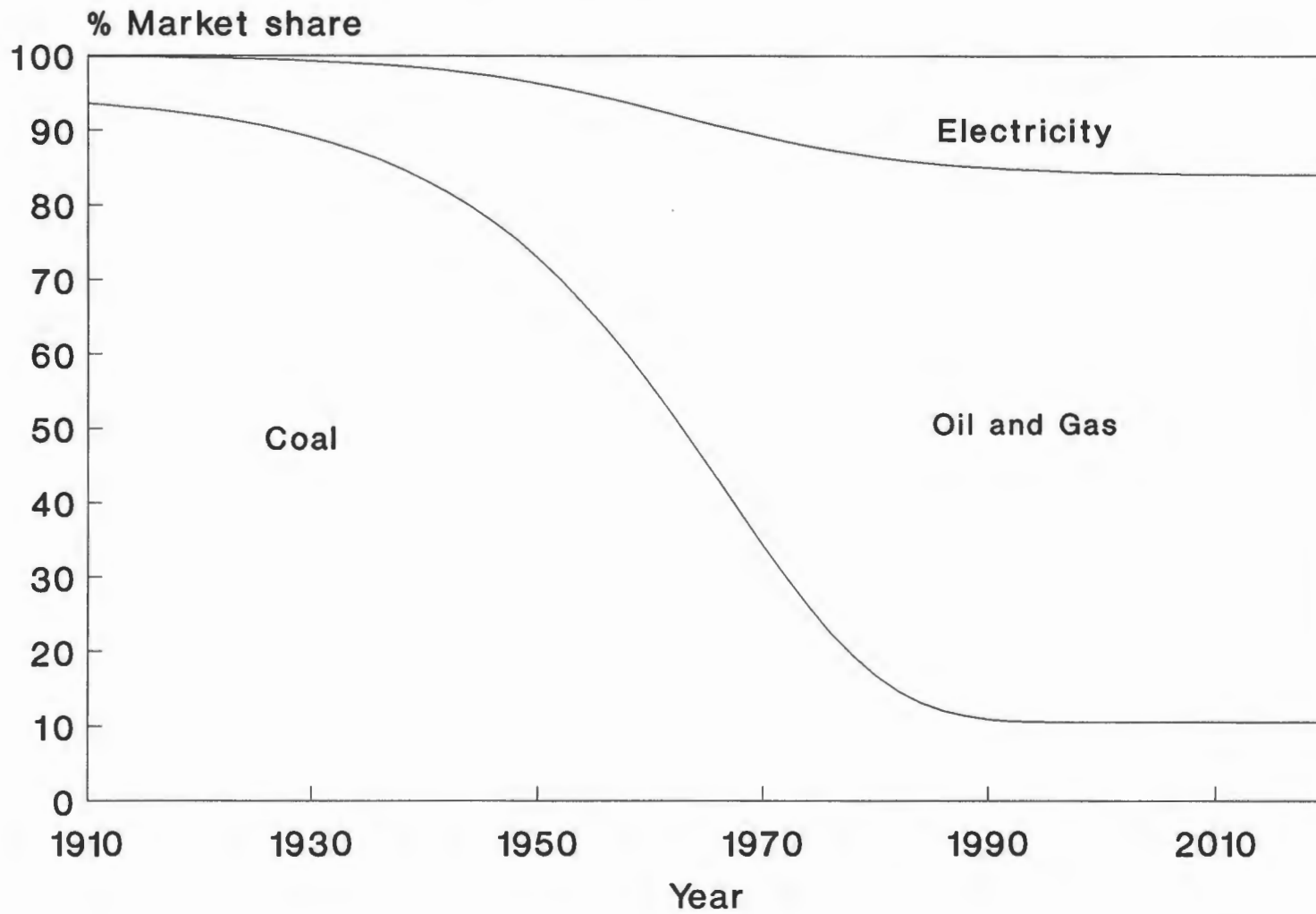
FIGURE 24 UNITED KINGDOM - GAS
Gas share of final demand



UKGAS

Figure 24 United Kingdom - Gas

FIGURE 25 UNITED KINGDOM - TOTAL
Total Final Energy Consumption



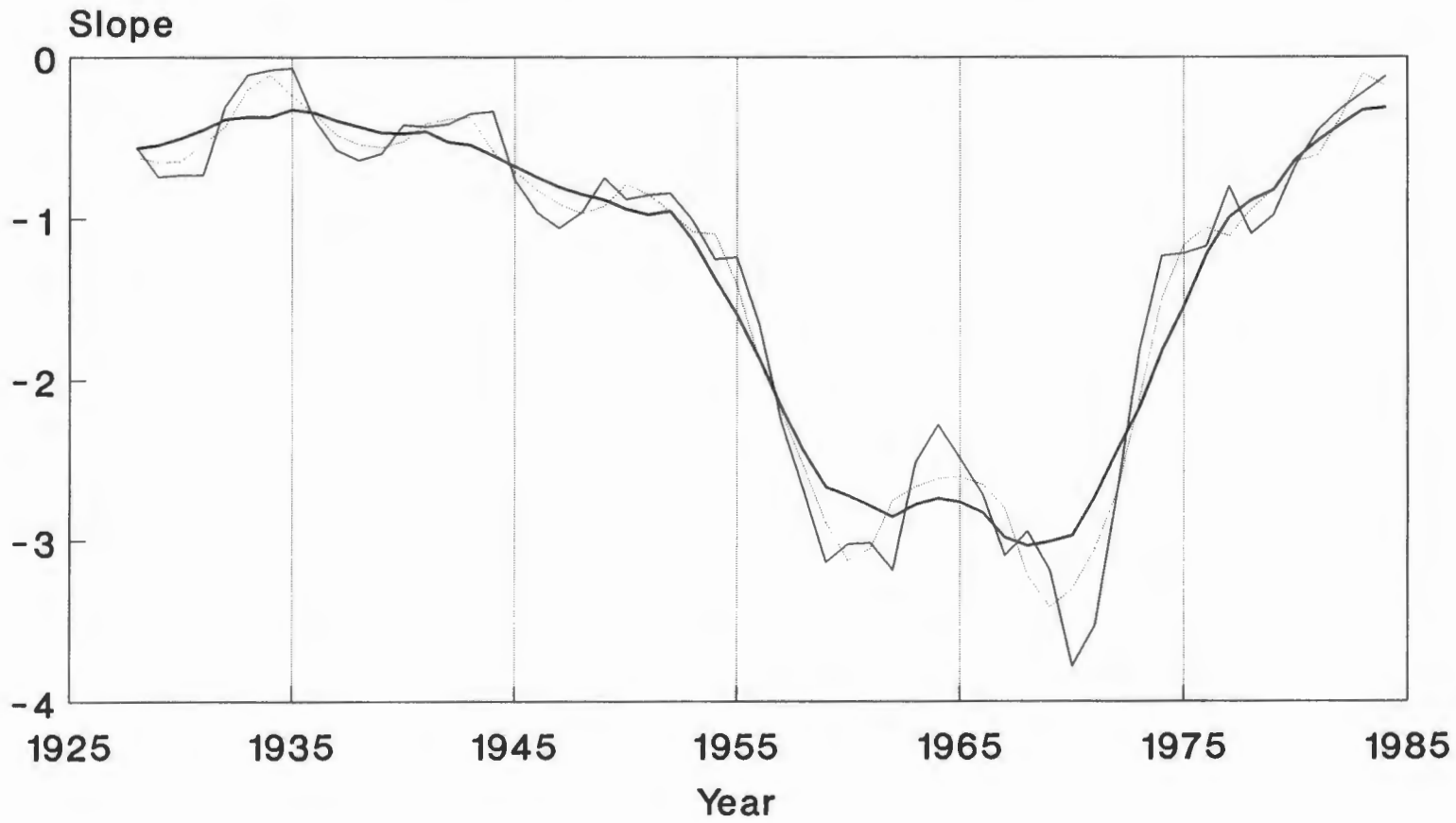
UKTOTAL

Figure 25 United Kingdom - Total

- 97 -

Electricity Saturation

FIGURE 26 UNITED KINGDOM - COAL
Slope of the % Market Share - curve



— 11-Yr Moving Ave. - - - 9-Yr Moving Ave . . . 7-Yr Moving Ave.

UKSLPC

Figure 26 United Kingdom - Coal

- 98 -

Electricity Saturation

FIGURE 27 UNITED KINGDOM - ELECTRICITY
Slope of the Market Share- curve

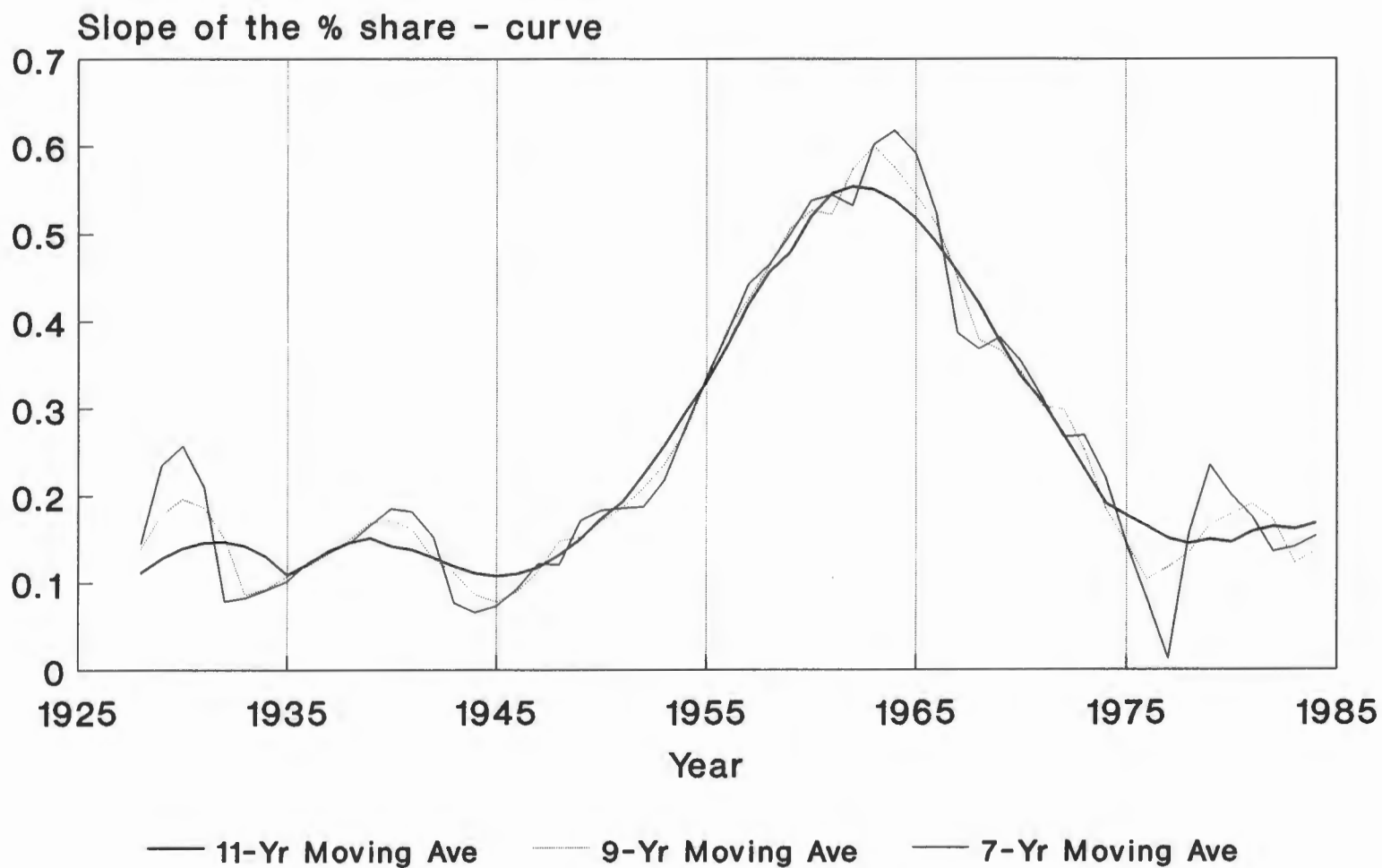


Figure 27 United Kingdom - Electricity

UKSLPEL

FIGURE 28 U.K. - (GAS + OIL)
Slope of Market Share Curve

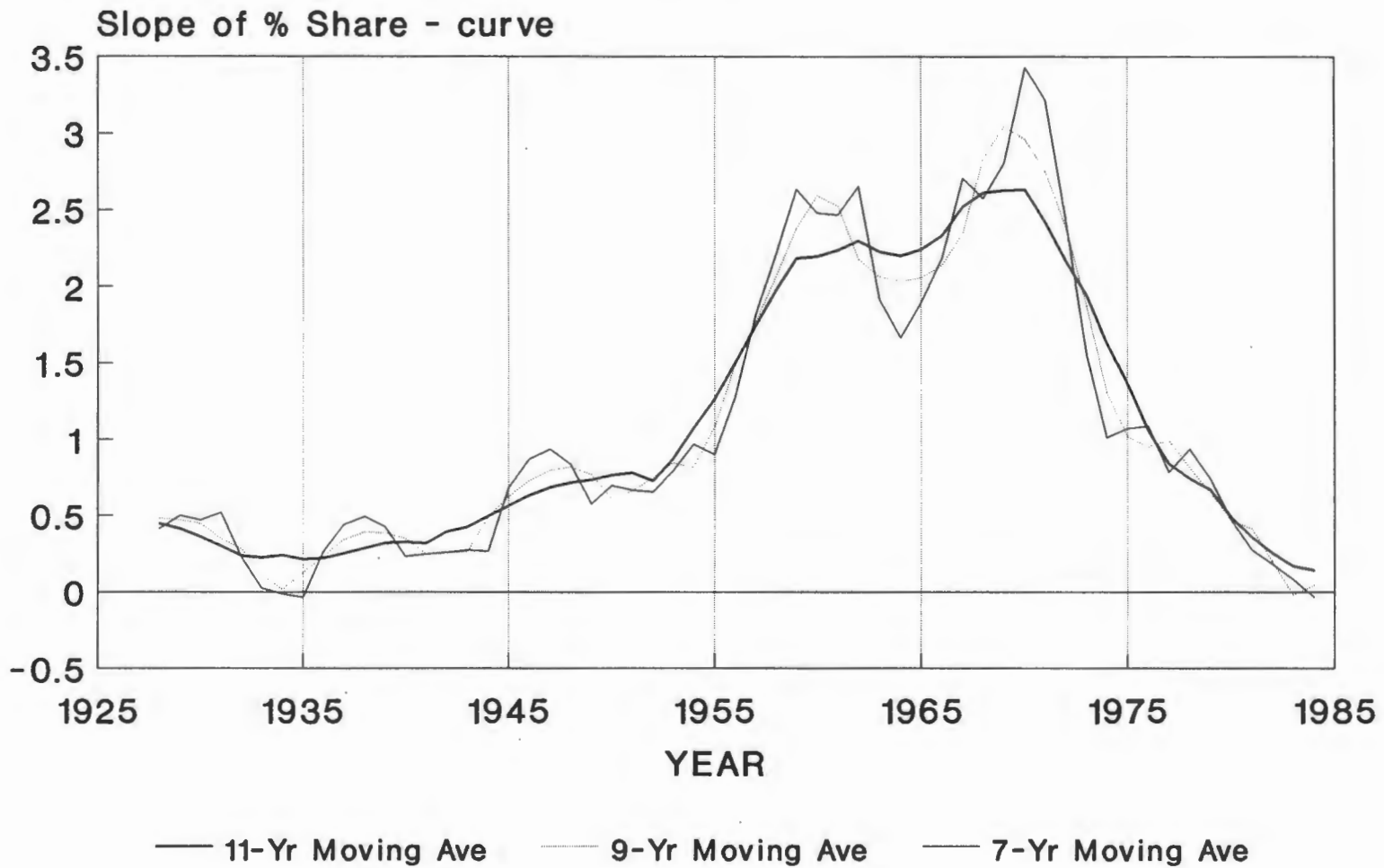


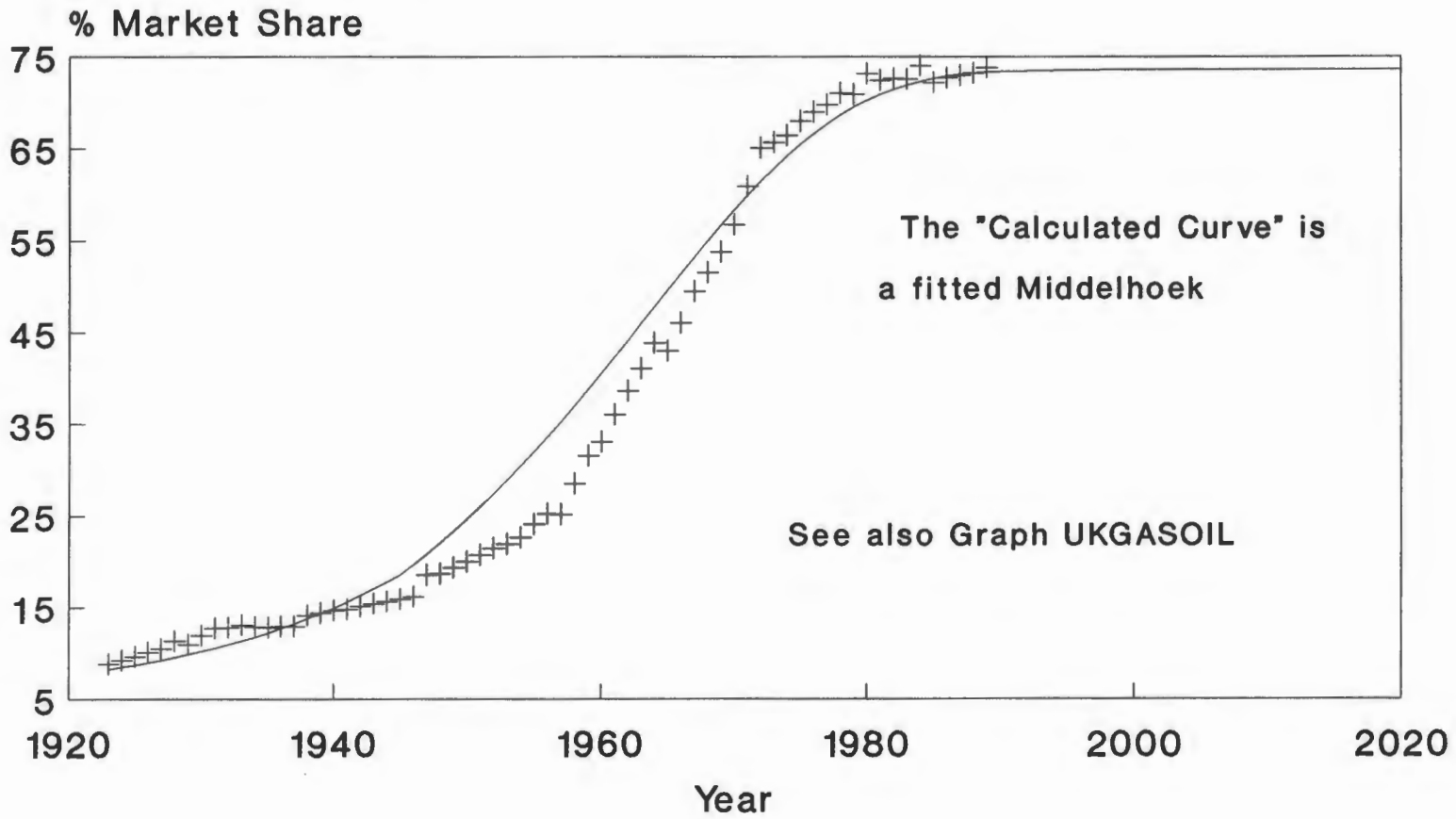
Figure 28 United Kingdom - (Gas & oil)

- 100 -

UKSLPGO

Electricity Saturation

FIGURE 29 U.K. - (OIL + GAS)
(Oil and Gas) share of final demand



— Calculated Curve + Actual Values

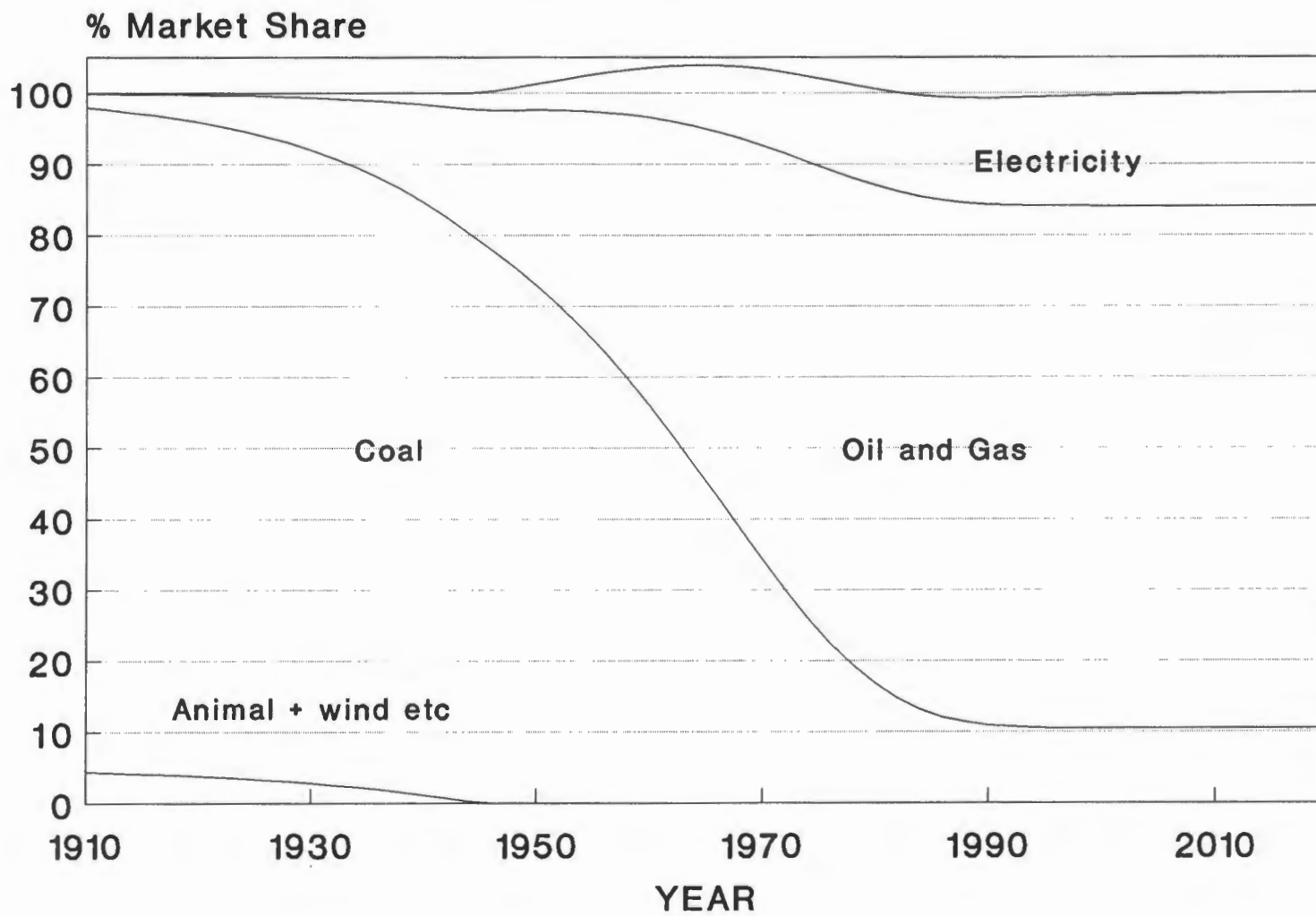
UKGASO12

Figure 29 United Kingdom - (Oil & gas)

- 101 -

Electricity Saturation

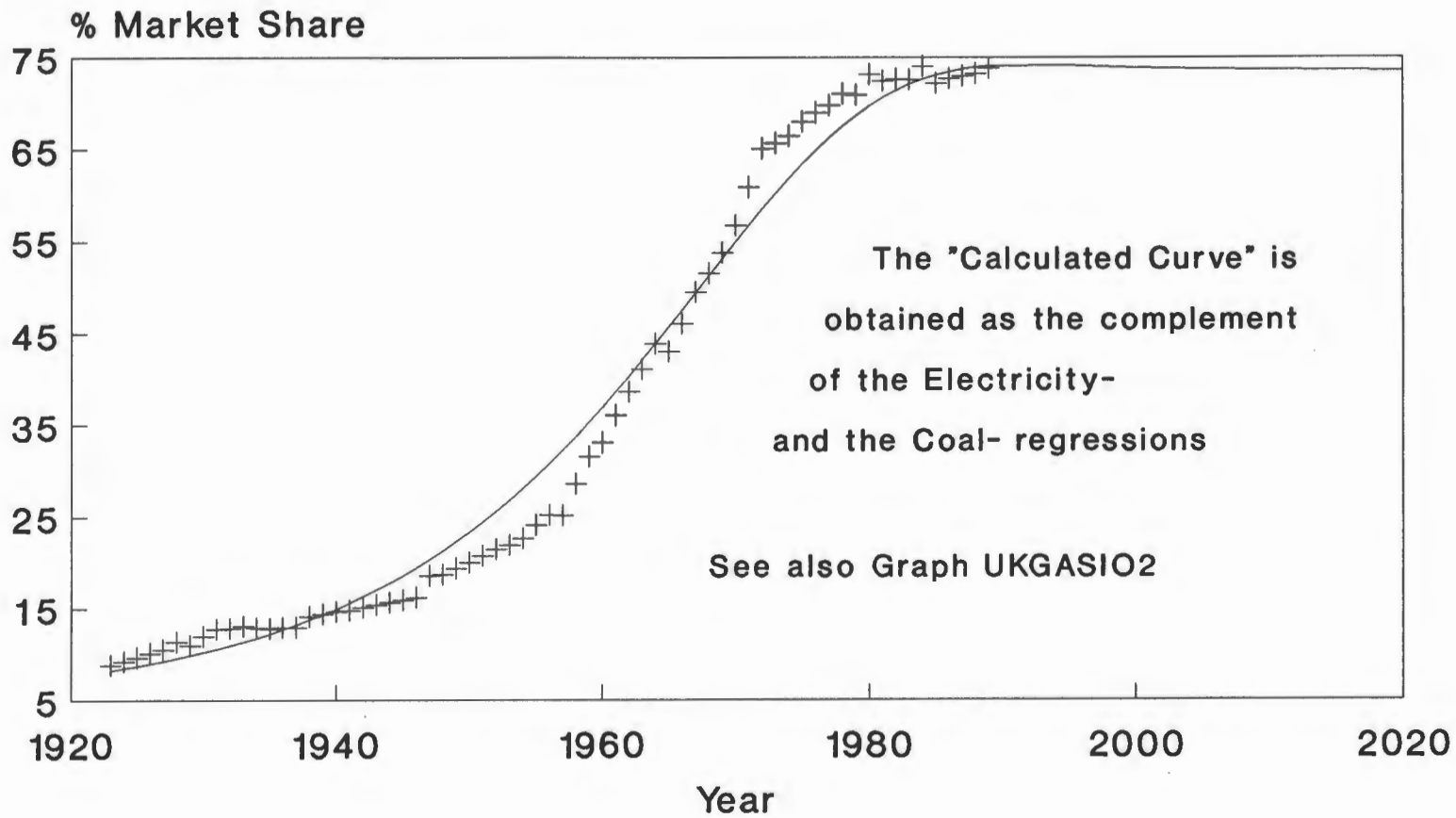
FIGURE 30 U.K. - FINAL DEMAND
Total Final Energy Consumption



UKTOTAL2

Figure 30 United Kingdom - Final demand

FIGURE 31 U.K. - (GAS + OIL)
(Gas & Oil) share of final demand

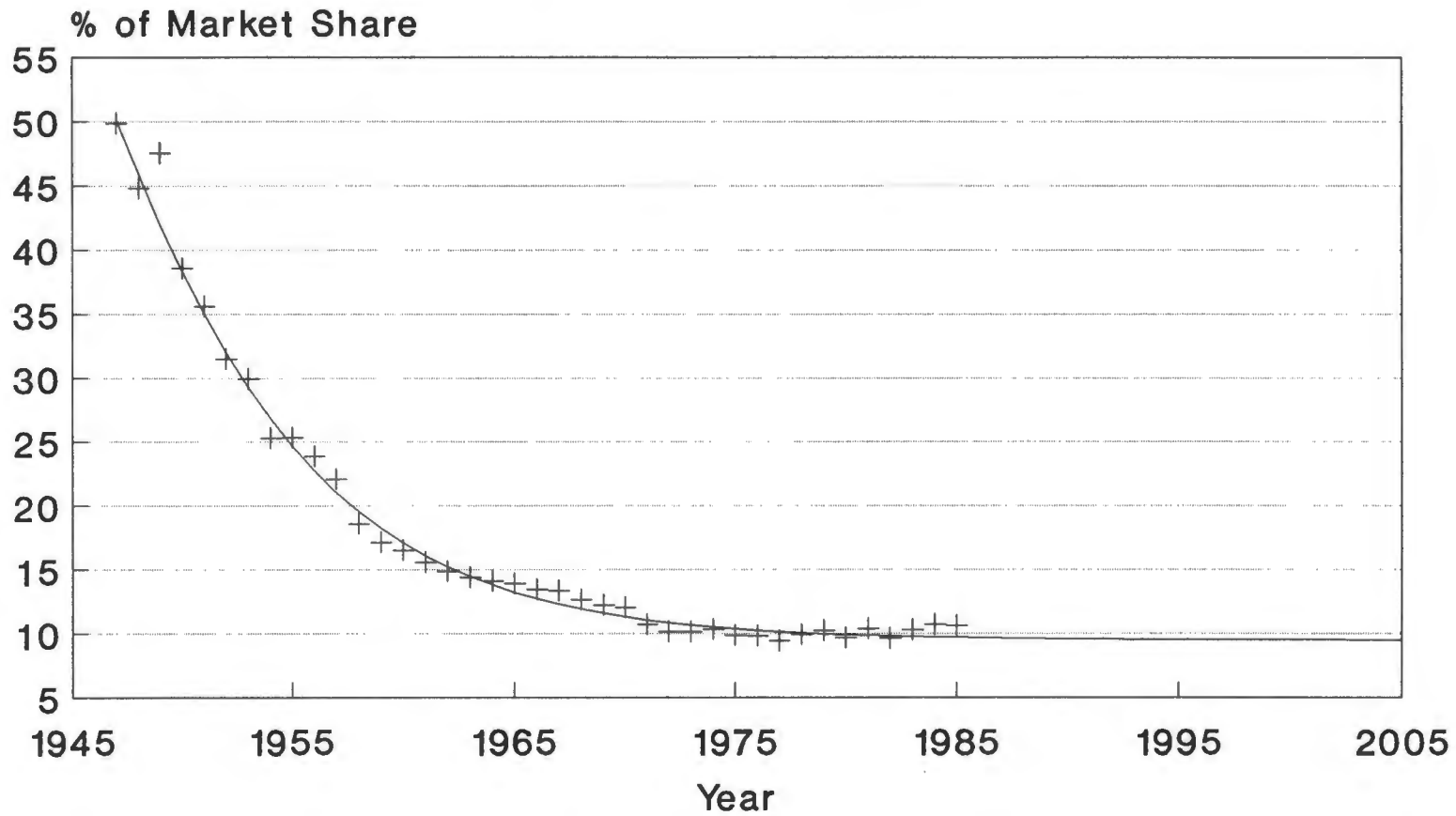


— "Calculated" Curve + Actual Values

UKGASOIL

Figure 31 United Kingdom - (Gas & oil)

FIGURE 32 USA - COAL
Coal share of final demand

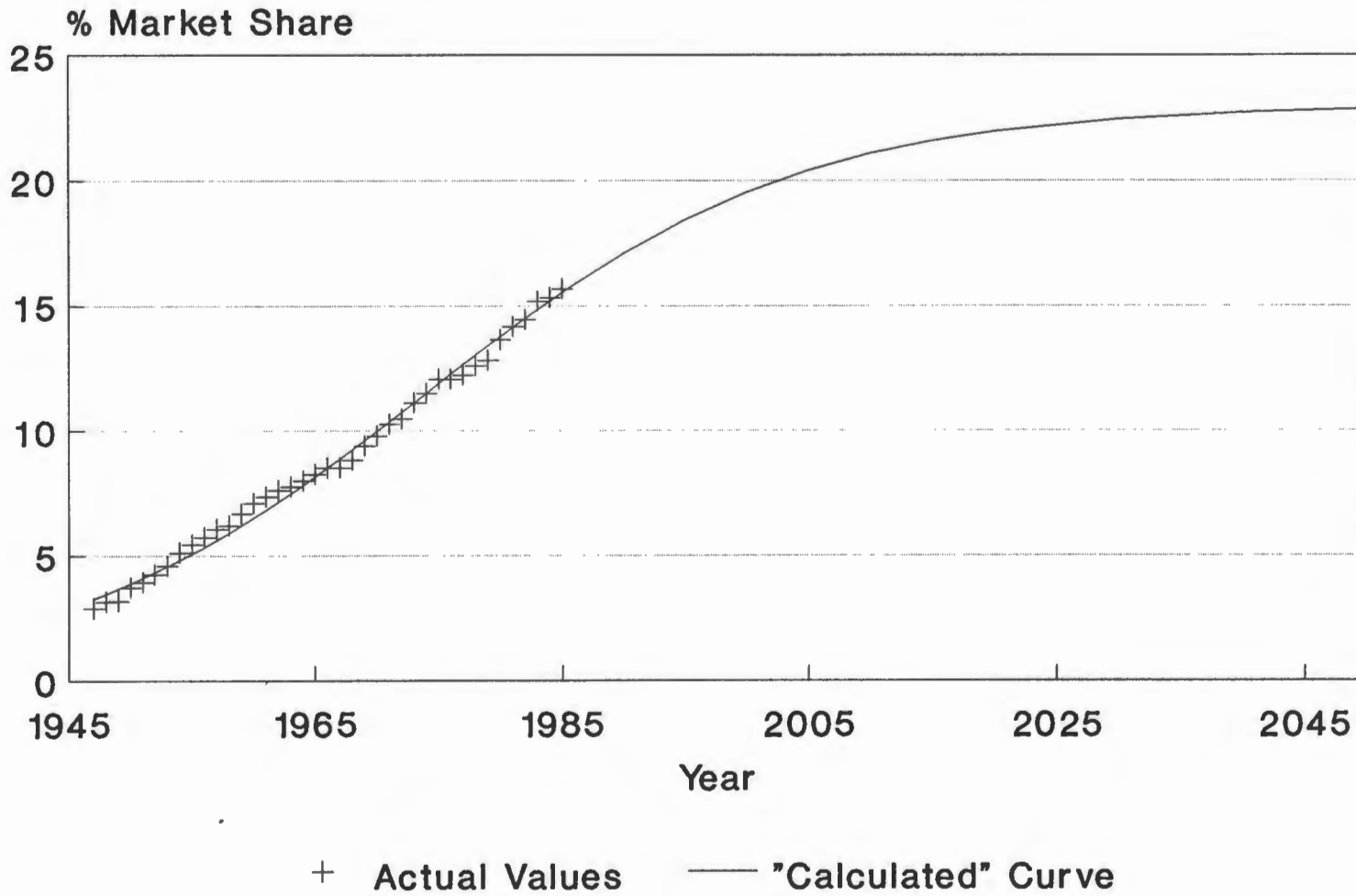


+ Actual Values — "Calculated" Curve

USCOAL

Figure 32 USA - Coal

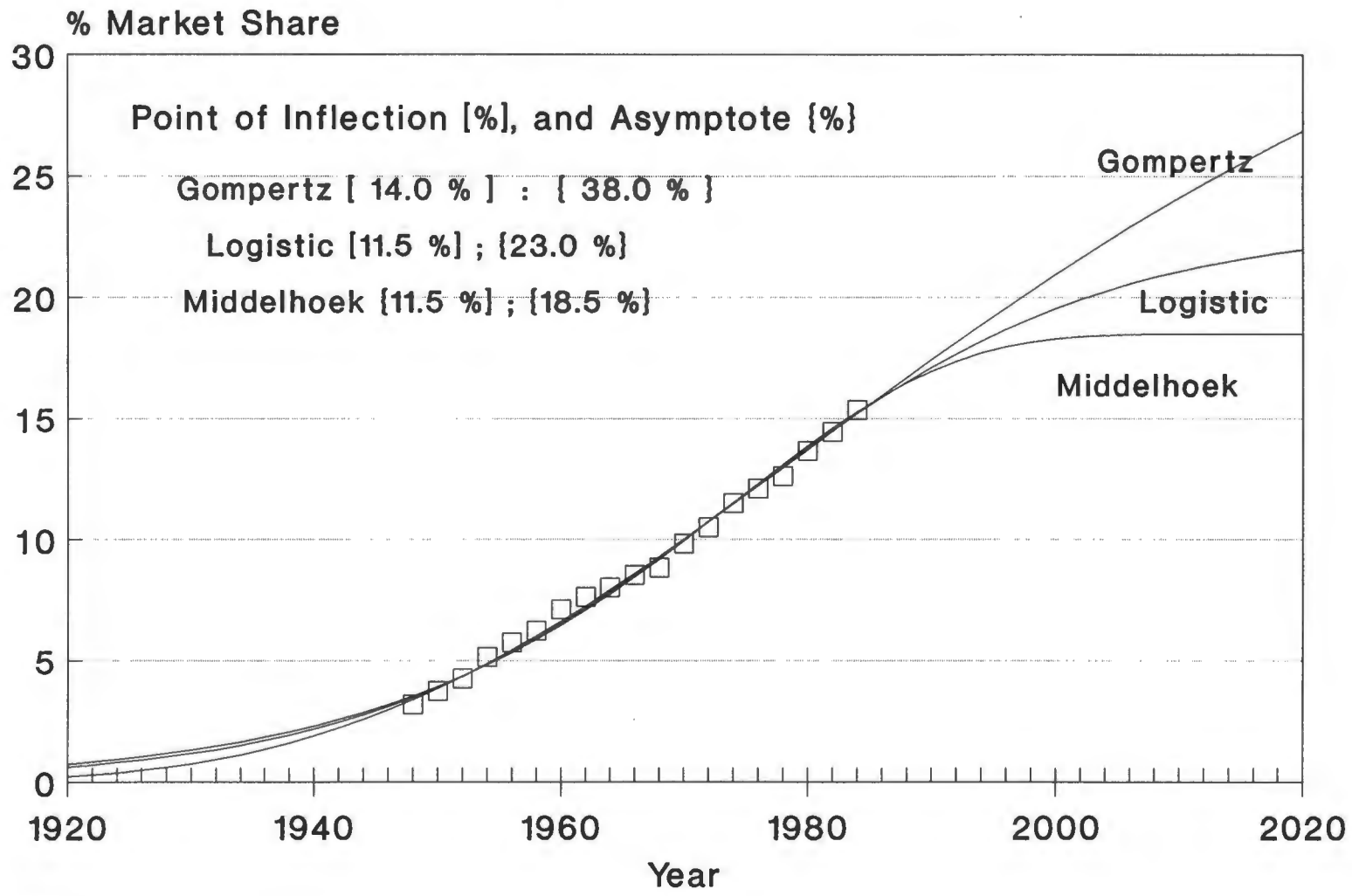
FIGURE 33 USA - ELECTRICITY
Electricity share of final demand



USAELEC

Figure 33 USA - Electricity

FIGURE 34 USA - ELECTRICITY
Electricity share of final demand



USELECTR

Figure 34 USA - Electricity

FIGURE 35 USA - (OIL AND GAS)
(Oil & Gas) share of final demand

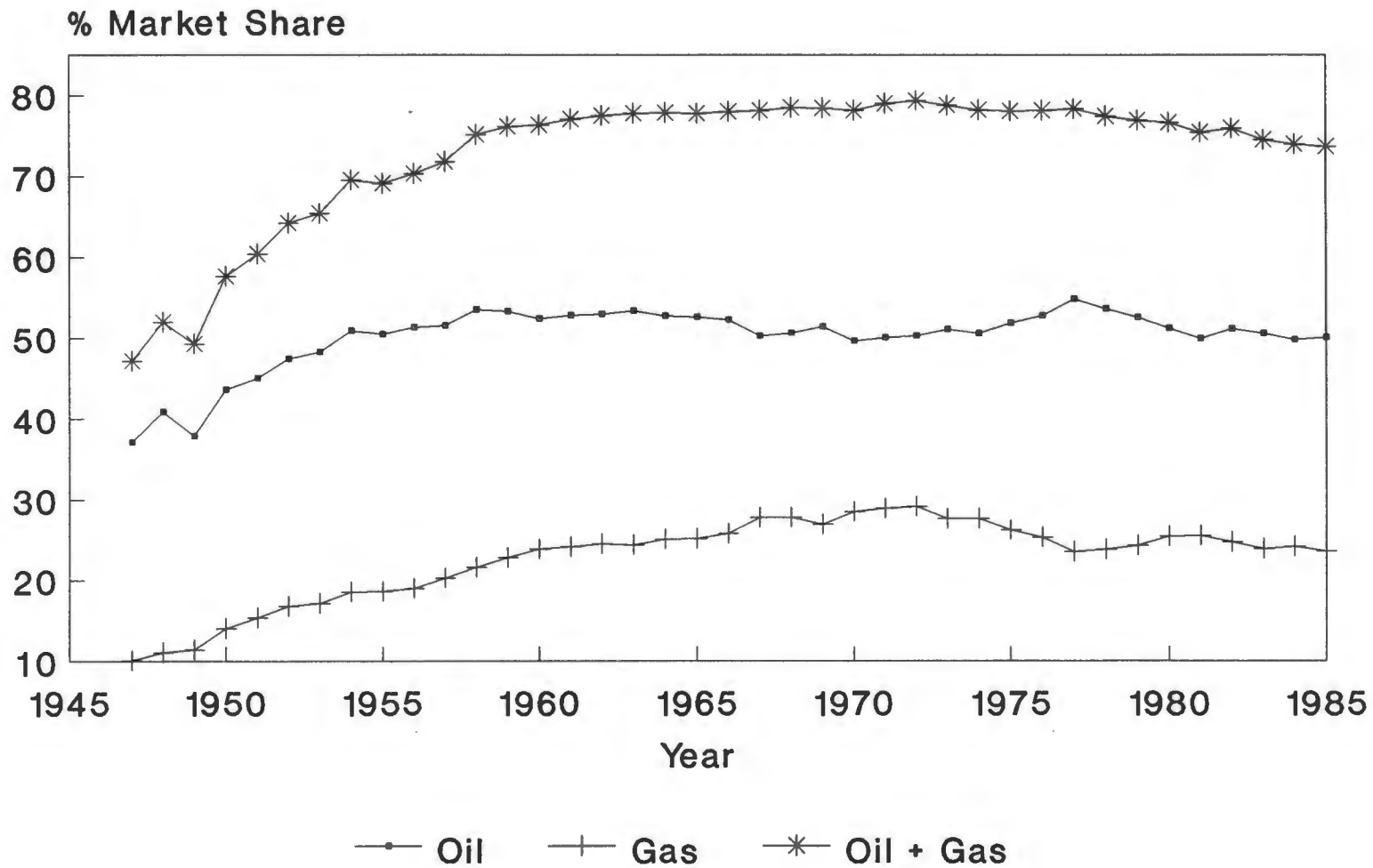
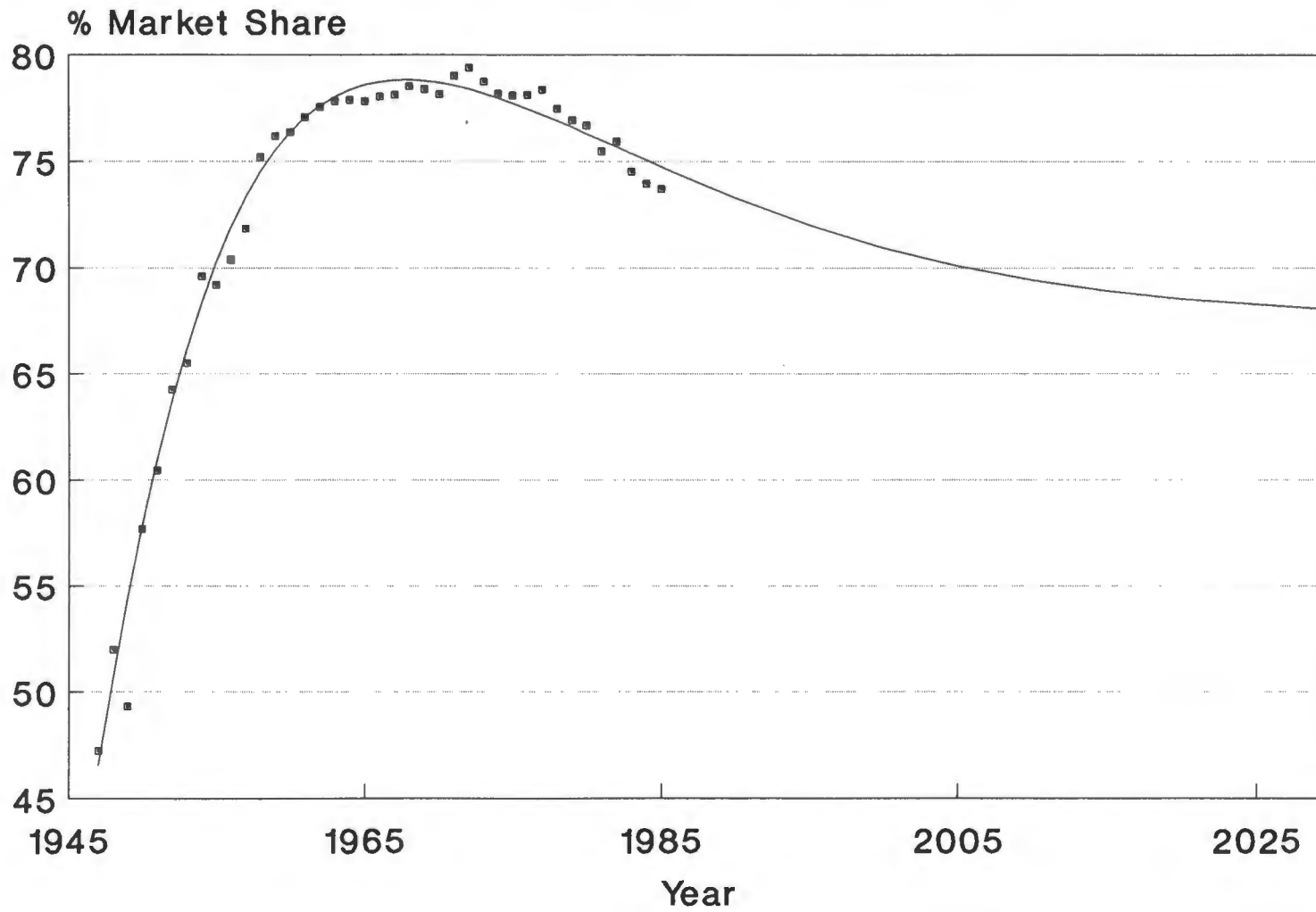


Figure 35 USA - (Oil and gas)

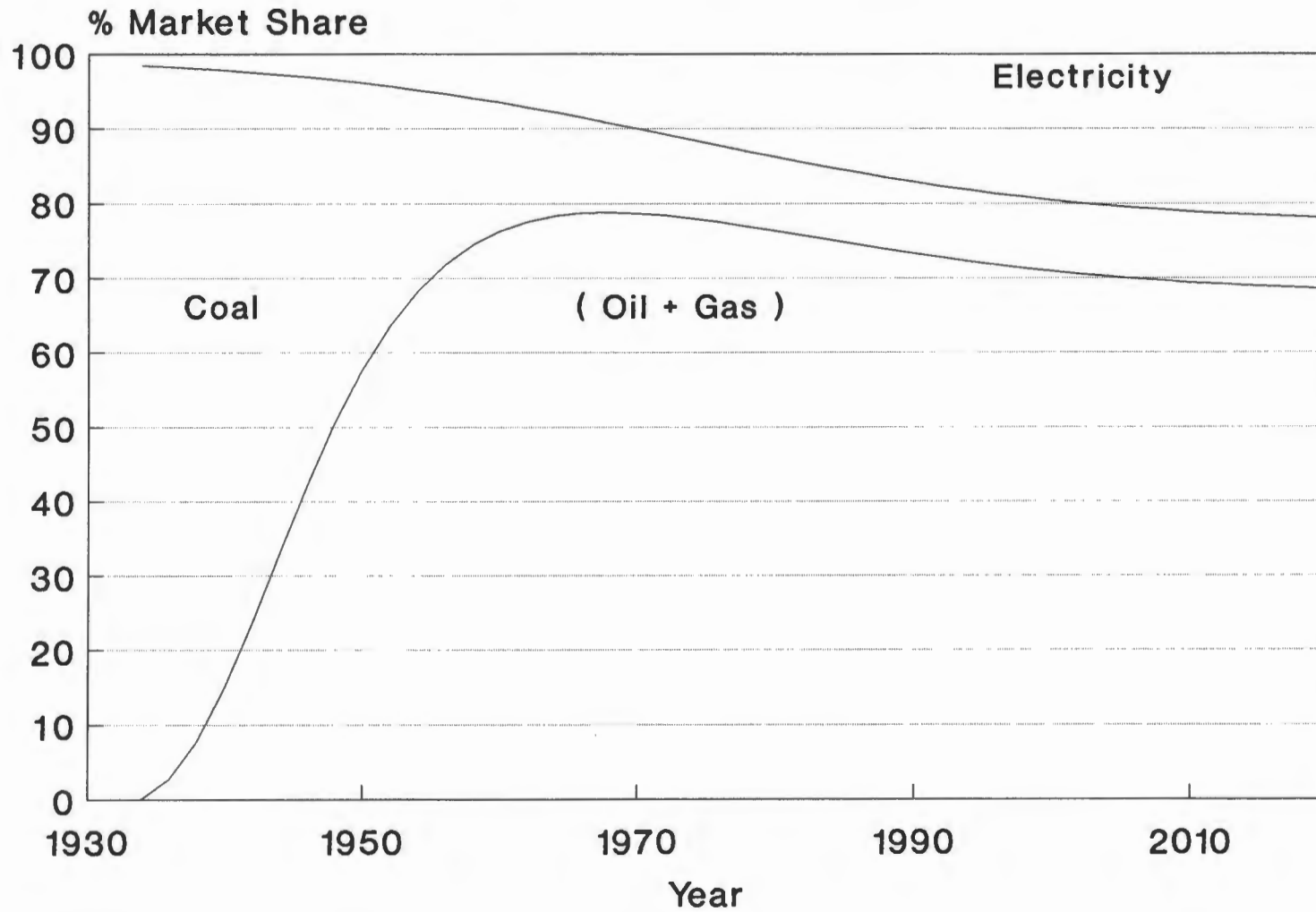
FIGURE 36 USA - (OIL AND GAS)
(Oil & Gas) share of final demand



USOILGAS

Figure 36 USA - (Oil and gas)

FIGURE 37 USA - TOTAL ENERGY
Total final energy demand



USATOTAL

Figure 37 USA - Total energy

FIGURE 38. COMPARISON OF CURVES

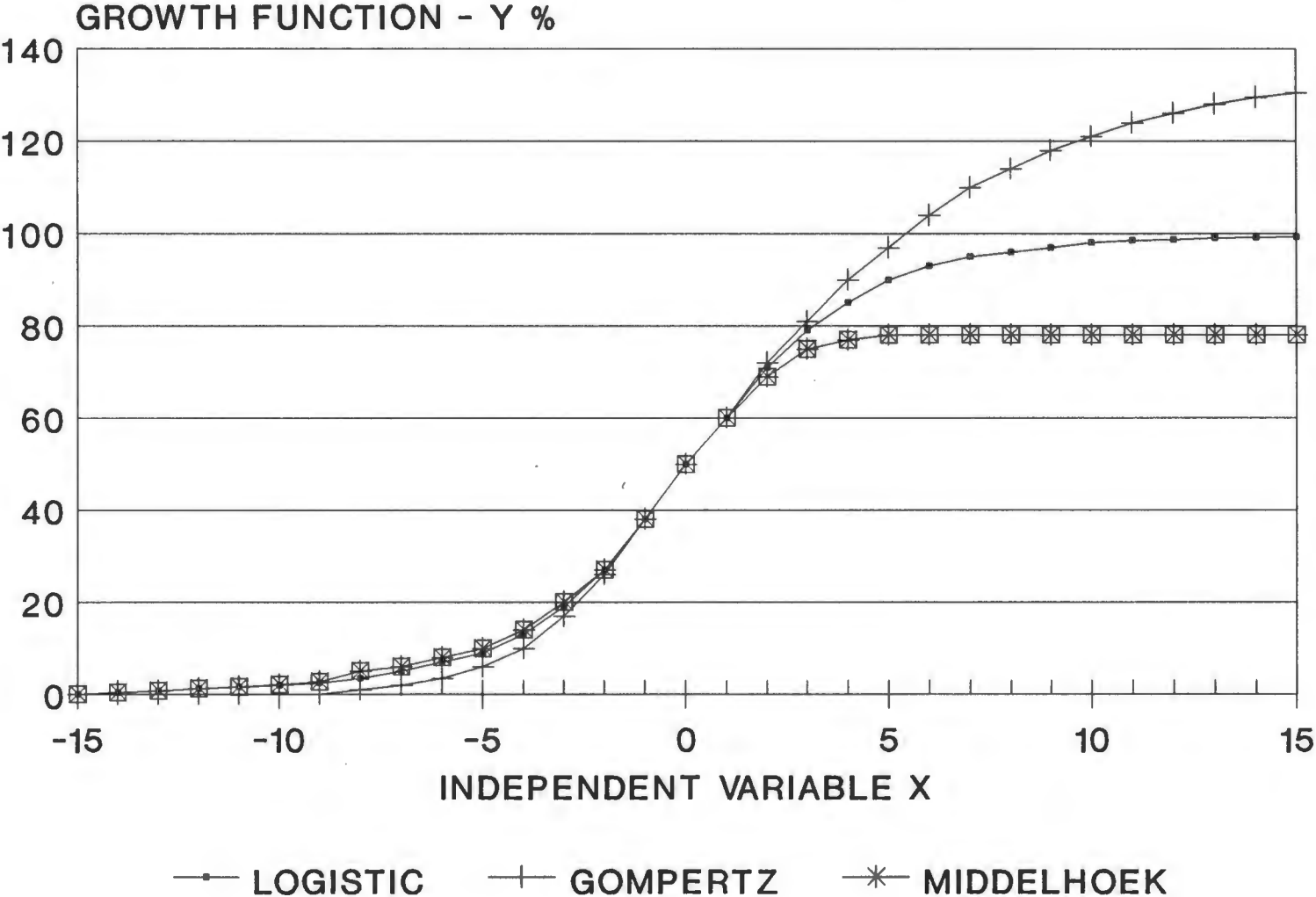


Figure 38 Comparison of curves



REPORT NO. GEN 146

ELECTRICITY SATURATION IN
SOUTH AFRICA

FINAL REPORT

R K DUTKIEWICZ

T C STOFFBERG

NOVEMBER 1991



ENERGY RESEARCH INSTITUTE