

FINAL REPORT

ENERGY PROFILE: SOUTH AFRICA

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1. INTRODUCTION

This report is one of a series summarizing the energy situation in sub-equatorial Africa. The purpose of the series is to analyze the energy position for those organizations trading or intending to trade with these countries, or for organizations entering into joint ventures with these countries. It is also the intention to use the individual reports to determine the possibility of energy interchange in the region and the potential for energy supply and demand in the region.

Use has been made of a number of sources for the statistical information and the various sources do not always agree because of differences in definitions used for the various components of energy and national accounts. Therefore a perfect match in the resultant data should not necessarily be expected.

2. COUNTRY PROFILE

2.1 Introduction

Interest was first shown in the southern part of Africa by the Dutch East India Company who established a refreshment station at the site of present day Cape Town in 1652. After a number of years some company servants were allowed to leave its service and became permanent settlers. The original small nucleus of settlers was expanded by assisted immigration and natural increase. The absorption of local inhabitants as farm workers allowed a pattern of farming to develop which depended on the exploitation of non-white labour by white landowners.

Many whites moved to the hinterland and established themselves as cattle ranchers due to the difficulties of making a living as crop farmers. This together with the increase in the settler population required large areas of land and thus with each generation the settlers took more and more land from the indigenous population who were absorbed as farm labourers or driven further into the

interior. Stratification of society developed along the lines of colour and was reflected in a pattern of racial attitudes, beliefs and prejudices. The expansion of the white settlers into the hinterland led to a number of long frontier wars, especially along the well watered east coast.

In 1795 the Cape was captured by the British. In 1803 it was returned to the Netherlands but was again taken by the British in 1806. The result of the British occupation was the arrival of a substantial number of British settlers on the eastern frontier in 1820, which exacerbated the lack of land caused by the slow advancement of the frontier due to the border conflict. This together with the philanthropic pressures of the British government denied the frontier farmers the prospect of sufficient new land. They began to leave the colony in large numbers and headed on a great northward trek after the frontier war of 1834-35.

Military successes against the various indigenous tribes ensured the permanence of white settlements in Natal, the Orange Free State and the Transvaal. Each of these areas became a growth point at the expense of the native population.

Thus the conflict in the Eastern Cape had expanded to the whole of South Africa. However the white settlers were not always victorious and many bitter wars were fought.

Initially the British policy was one of annexing the new white areas in order to protect the native population. However, after the signing of the Sand River Convention of 1850, and the Bloemfontein Convention of 1852, freedom from British interference was guaranteed to the Orange River sovereignty and the Transvaal. There followed a general move towards withdrawal of British responsibility in South Africa, though the annexation of Natal was not rescinded.

The discovery of diamonds in West Griqualand led to the annexation of the diamond fields by the British, and the idea of a federation of white states under the leadership of the Cape was promulgated by the British. To make this possible the Transvaal was annexed. The British then forced war on the powerful Zulu nation, which began with a major disaster for the British at Isandhlwana. Although the British were eventually victorious, the prestige of the British troops was undermined and British confidence in their South African policy was severely

shaken. Thus when the Transvaal farmers rose in rebellion and defeated the British in a number of engagements, Britain reverted to a policy of withdrawal and restored the Transvaal to effective internal independence. This episode marked the beginning of the South African Afrikaner nationalist movement.

The discovery of gold in the Transvaal once again reversed the British policy of withdrawal and the extension of their control over the Transvaal was seen as essential. Britain brought increasing pressures to bear on the Transvaal in an attempt to destroy the Republic's independence. Realizing that the British would not relent, the Boer Republic declared war and invaded the British colonies on 12 October 1899. The war ended in 1902 with the British as victors, and measures were taken to ensure that South Africa would remain firmly within the British empire. These measures raised intense fears amongst the Afrikaans-speaking population and intensified Afrikaner nationalism which began to be reflected in political, educational, religious and social spheres.

The election defeat of the Conservative Party by the Liberal Party in Britain in 1906 saw a radical change in policy towards South Africa, and the Transvaal and Orange River colonies were returned to responsible government. In 1907 the administration of the Cape was replaced by the South Africa Party which drew its main support from the Afrikaner. These political victories by the Boers led to the idea of unification and culminated in the National Convention of 1908. This resulted in the formation of the Union of South Africa under the British crown in 1910, with a constitution which gave the white minority an almost complete monopoly on political authority.

In 1912 the South African Native National Congress (later renamed the African National Congress - ANC) was founded. At first its membership and demands were restricted. However the measures begun by the Union government to consolidate white land ownership (namely the 1913 Native Land Act) and to force local peasant farmers into the cheap labour market caused an increase in ANC protests and membership.

The outbreak of the First World War saw South Africa actively participating on the side of Britain. This caused a strain on the loyalties of many Afrikaners who were against South African participation in the war. The post-war economic depression had a severe impact on the Afrikaner, and especially on the farmers, and many

were reduced to the status of 'poor whites'. The measures taken by the 'pact government' (an alliance between the Labour and National parties) elected in 1924 under the leadership of Hertzog to deal with the poverty of these whites laid the foundations for what was later to be known as 'apartheid'.

The 1934 elections were won by the United Party which was a fusion of the South Africa Party and the National Party. The United Party was led by J.B.M. Hertzog and J.C. Smuts. The fusion of these two parties was unacceptable to a number of extreme nationalists and they broke away to form the 'Purified' Nationalist Party led by Dr Daniel Malan which had considerable support in the country at large as it expressed the bitter nationalist feeling born of the Afrikaner sense of disinheritance in the new industrial society. Malan was a member of the Broederbond, an extreme secret society formed to fight for the Afrikaner language and culture and for political power for true Afrikaners.

The outbreak of war in 1939 saw increased support for the 'Purified' Nationalist Party. The decision to support Britain or to remain neutral found white South Africans deeply divided. A large section of the United Party together with Hertzog wanted to remain neutral, while Smuts and another section wished to enter on the British side. Smuts won and South Africa went to war leaving the United Party split. Hertzog went into opposition alongside the 'purified' Nationalists. The ensuing relaxation of the industrial colour bar due to a shortage of labour entrenched the opposition's racial prejudices which it began to systematize in terms of apartheid.

The 1948 election were fought by the National Party on the issue of race relations under the concept of apartheid and to everyone's surprise they won a parliamentary majority. Malan formed a government and the National Party has won every subsequent election.

Under the rule of the National Party, the system of apartheid has undergone successive significant modifications. Apartheid was entrenched in Acts such as the Population Registration Act, the Group Areas Act, the Separate Amenities Act, the Bantu Education Act, the Extension of University Education Act, the Bantu

Authorities Act, and the Suppression of Communism Act. A by-product of apartheid was the establishment of several so-called 'homelands' under the policy of separate development. Four of these have attained political independence, although they are recognised only by themselves and the South Africa government.

International pressure, including comprehensive economic, cultural and sporting sanctions on South Africa, resulted in a move towards democracy in the country. Outlawed political parties were unbanned in 1990 and the corner-stones of apartheid - population racial registration and land reservation on racial grounds - were repealed in 1991.

2.2 Demography

South Africa has a multiracial society made up of five major ethnic groups. The Khoisan people are survivors of the country's earliest inhabitants and include the Bushman. The Negroid Bantu-speaking people fall into a number of tribal groupings. The major groups are formed by the Nguni, the Sotho and the Tswana. The European population who dominate the political, social and economic organizations are descended from, amongst others, the original Dutch settlers in the Cape, the French Huguenots, British settlers from 1820 onwards, Germans, and more recent immigrants from Europe and ex-colonial African territories. The major languages amongst this European ethnic grouping are English (35%) and Afrikaans (65%). These are also the official languages. The remainder of the population is made up of 'Cape Coloureds' and Asians who are mainly of Indian origin.

Political boundaries have been changing in recent years, especially in regard to the so-called independent 'Homelands', of which there are presently four. The independence of Namibia in 1990 adds to the complexity. It has also been claimed that inaccuracies have occurred in every population census due to non-whites avoiding the count, although official figures have been revised in an attempt to compensate for these errors. Official data exclude the independent

'Homelands' who are responsible for their own statistics. To date, comprehensive population statistics have not been published by these 'Homelands'. Thus population data vary from source to source depending on whether the 'Homelands' and/or Namibia have been included and to what extent the figures have been adjusted.

In 1985 the population of the Republic of South Africa was estimated at 33,8 million which included an estimated 6 million residing in the 'Homelands'. By 1989 the population had risen to an estimated 37,1 million. In 1989 the population, excluding the 'Homelands', was estimated at 30,2 million, of which 21,2 million (69,9%) were black, 5,0 million (16,5%) were white, 3,2 million (10,5%) were 'coloured', and 0,9 million (3,1%) were Asians. Since the 'Homeland' population is mainly black, these percentages would translate to 75,0% black, 13,7% white, 8,7% 'Coloured' and 2,6% Asian.

Table 2.1 shows the estimated population growth rates of the various ethnic groups over the periods 1980-1985 and 1985-1990 and includes the 'Homelands'. The population growth rate of the 'Homelands' was estimated to be 4,7% between 1970 and 1980⁽¹⁾ which can partially be attributed to the redefinition of boundaries, the influx control laws and the forced removals of this period.

Table 2.1 Population growth rates⁽²³⁾

	Percentage Average Annual Growth		
	1980-1985	1985-1990	1980-1990
Black	2,75	2,76	2,76
White	0,84	0,63	0,73
Coloured	1,70	1,65	1,68
Asian	1,83	1,57	1,70
TOTAL	2,33	2,33	2,33

The crude birth rate is 31,7 per 1000 population and the infant mortality rate is 72 per 1000 births. Life expectancy at birth is 55,5 years which is higher than the African average of 51,9 but much lower than the European average of 74.

Although the South Africa population is young relative to First World countries, it is older than the average for the region. In 1990 it was estimated that 37% of the population (including the 'Homelands') was under the age of 15 and 56% was under the age of 25⁽¹⁷⁾. In 1985 it was estimated that 25% of the white population was under the age of 15, while 43,1% of the black population was under the age of 15 in the same year⁽²³⁾.

The white, 'Coloured', and Asian populations have traditionally been predominantly urban dwellers, and the black population is urbanizing rapidly. Official data indicate that in 1911 24,7% of the population was urbanized. By 1980 this figure had increased to 48,3%, and in 1985 it was estimated to be 55,9%⁽¹⁶⁾. These figures understate reality as informal urban settlements in the 'Homelands' are not considered urbanised. The rate of urbanization increased in subsequent years due to the abolishment of influx control laws in 1986. The dismantling of apartheid and the abolition of the land acts and group areas acts could see a further rapid increase in urbanisation.

The overall population density including the 'Homelands' was 30,3 per km² in 1989. The population distribution is uneven and is in general related to agricultural resources, with more than two-thirds living in the wetter eastern third of the country and in the southern Cape Province. High densities are found in the urban areas, with the heaviest concentrations being found in the Witwatersrand mining area. However, rural densities are also relatively high in the 'Homelands' due in part to the influx control laws (which were relaxed in 1986). In contrast, densities are below average in the white rural areas and particularly low in the large arid areas to the west.

2.3 Economy

South Africa is unique in sub-Saharan Africa in that it has a large developed sector which is more comparable with Western developed nations than with Third World developing countries. This large developed sector is based on mining and manufacture. An important formal and informal Third World economy also exists, based on subsistence farming and marginal services.

Officially a strong free market ideology is represented, although in reality a large degree of government intervention is practised and the public sector is large. The government committed itself in principal to privatisation and deregulation with the passing of the Deregulation Act of 1986. This has not yet produced much in the way of concrete results other than the privatisation of the steel producer, ISCOR, in 1989, mainly due to the contingency plans required in the wake of sanctions which resulted in increased central control. The impending lifting of sanctions could pave the way for deregulation depending on future government policies and ideals. Fear exists amongst white South Africans that a 'black' government would enforce policies aimed at redistribution of wealth, resulting in the nationalization of certain sub-sectors of the economy.

In 1989 the GDP at factor prices was R206,95 billion or US\$78,99 billion. This far exceeds any other country in the region. Table 2.2 compares the GDP of selected countries to that of South Africa. South Africa has the highest GDP per capita in Africa after Gabon and Libya but is poor relative to western countries. Figure 1 shows the GDP (factor) in current and real 1985 prices during the period 1910-1989. In current terms GDP has been increasing exponentially. Real GDP displays the effects of the First and Second World wars, the 1930 depression and the oil crises of the early 1970's on the economy, and was characterised by an upward trend until 1980, after which the effects of sanctions imposed against the country took effect. These trends are also reflected in Figure 2 which shows the real GDP growth rate per year during the period 1920-1989. The average real GDP growth rate per year for the period 1961-1970 was 5,9%, declining to 3,8% for the period 1971-1980. The effects of sanctions saw this figure drop to 1,2% for

the period 1981-1989, although in 1988 the growth rate was 3,8%, dropping back to 2,2% in 1989. The annual average population growth during this period was greater than the GDP growth rate, resulting in a fall in real GDP per capita after 1980, which seems to have stabilised at 1968 levels, as shown in Figure 3 of current and real GDP per capita.

Table 2.2 GDP of selected countries in 1988

Country	GDP billion US\$	GDP/Capita US\$/capita
RSA	88,36	2441
Lesotho	0,41	245
Somalia	0,95	160
Mozambique	1,25	85
Malawi	1,39	180
Botswana	1,87	1550
Tanzania	3,14	130
Gabon	3,32	3080
Zimbabwe	6,32	680
Egypt	36,01	700
UK	828,57	14500
USA	4847,30	19700

Figures 4 and 5 show GDP and GDP/capita in US\$ terms during the period 1950-1989. It should be noted that the Rand/Dollar exchange rate has been greatly influenced by politics and the resulting perceived instability. An example is a sharp drop in GDP in US\$ in 1985 due to political developments.

Figure 6 shows the contribution by the various sectors to GDP in percentage terms during the period 1911-1989. The most important sectors are manufacturing, mining and agriculture. Their relative contributions to GDP have changed markedly. In 1911 mining contributed 27,1% of the GDP, agriculture 21% and manufacture 4%. Manufacturing steadily increased and by the Second World War it had surpassed the contribution by mining. By 1989 its contribution had risen to 24,6%. In contrast, mining's relative importance has steadily decreased and in 1989 its contribution was 12%. The sudden peak in the mining sector in 1980, which equaled the contribution by manufacturing, was due to the high gold price in that year. This demonstrates the dependence of the mining sector and the economy on the price of gold. Mining is more significant to the economy than the figures suggest as almost 70% of all exports come from mining, with gold alone accounting for 40% of all exports⁽¹⁾. Coal exports have increased significantly since 1975 and make a large contribution to export earnings. In 1988 coal to the value of R2,8 billion was exported and in 1989 this figure rose to R3,5 billion.

Agriculture's importance has declined and in 1989 its contribution was 5,6%. Agriculture is however more important than these figures suggest as it is one of the largest employers of labour due to the large number of subsistence farmers in the 'Homelands' who form part of the informal economy. This economic dualism was encouraged by the restrictions on the permanent entry of many Africans into the modern economy and the related migratory labour system. Industry as a whole has shown a steady increase in contribution from 33,3% in 1911 to 46,7% in 1987, declining to 44,1 in 1989.

The expansion of manufacturing from relative insignificance in 1911 to 24,6% of GDP in 1989 has been the most important structural change in the economy. This is clearly shown in Figure 6.

3. ENERGY GENERAL

3.1 Introduction

In the energy context South Africa is a regional power which has a well developed energy infrastructure compared with the other African countries. Its commercial energy usage per capita is higher than any other country on the continent and the contribution by traditional fuels to total energy used is low. The energy sector has been greatly influenced by the abundance of relatively cheap coal, as well as the imposition of oil embargoes and sanctions (Sasol, Mossgas, coal exports).

Although South Africa has large reserves of coal and uranium, hydro-potential is limited. Yet the Southern African region has considerable hydro-potential which could be exploited to the benefit of the whole region if political stability and sustained economic growth could be attained in the region.

South Africa's commercial energy intensity is high relative to the region as well as to more developed countries. This is mainly as a result of South Africa's greater level of development relative to the region, as well as low energy costs, the Government policy of supporting energy supply actions in the face of sanction threats, the large primary industry components of the economy, and the limited attention by the Government to the efficient use of energy. Thus scope exists for conserving and increasing the efficiency of production and use of energy in South Africa.

3.2 Energy Institutions

The South African energy scene is characterized by a mixture of centrally controlled and private sectors. Whilst most of the resources are in the hands of private industry, there is substantial control of price and supply. The central control is via the Minister of Mineral and Energy Affairs who has direct and indirect control of a range of energy supply and demand sectors.

Until recently the Department of Mineral and Energy Affairs was responsible for the procurement of oil and for the price of petroleum products, especially gasoline and diesel fuel. There was also control on, for instance, the number of gasoline filling stations in terms of a rationalization policy. Oil was purchased via a

procurement board and distributed to the various oil companies operating in the country. The distribution and sales of petroleum products were carried out by oil companies which represent most of the international majors. Refining is also carried out by individual oil companies, though Shell and BP share a refinery in Durban. In terms of the Petroleum Act the dissemination of any information concerning the procurement or supply of petroleum is prohibited. The move is currently to deregulation and significant steps in this connection are expected shortly.

The oil-from-coal process was originally funded by the Government and under the operational control of Sasol, a company set up by the Government for this purpose. Sasol is in the process of being privatized and shares in part of the company have been sold to the public. A pricing structure for Sasol ensures that the company is protected against competition from imported crude up to a certain international oil price; above this price Sasol has to start repaying the loan granted to it.

The second synthetic fuel plant, the Mossgas oil-from-gas plant, is similarly administered and funded from a levy on all gasoline sold. The company is administered and operated by Engen, the energy arm of the General Mining Company. Provision is made for a buy-out of the company by private enterprise in due course.

SOEKOR, a Government owned company, was formed to undertake the exploration for oil both on land and offshore. This company was responsible for the extensive drilling which was undertaken off the south and west coasts of South Africa and which led to the discovery of gas off Mossel Bay on the south coast.

Electricity generation and distribution is mainly in the hands of ESKOM, a parastatal body which was formed in 1925 and has gradually absorbed most of the other utilities and to-day it accounts for 96% of all power generation in the country. The other main suppliers are some of the municipalities and smaller private producers who supply mainly in-house power demands. The price set by

ESKOM is based on the principle that it has to be a self-financing body making neither a profit nor a loss. In practice there has in the past been Government intervention, not only through the Government's nominations on the Board Of ESKOM, but also by direct intervention by the Minister of Mineral and Energy Affairs.

A Government-appointed Electricity Council acts as a watch-dog over the electricity industry and is responsible for awarding licenses for the various producers or distributors to provide services to a designated area. It also has to approve any increase in electricity tariffs.

Coal production and distribution is in the hands of private mining houses. Government control has been via the setting of trade prices of the various grades of coal, and by the issue of limited licences for the export of coal. The coal industry has recently been deregulated and the licence system has been abandoned. In the past local sales of coal were co-ordinated by a joint body of the coal mining houses, the Transvaal Coal Owners' Association. This body kept statistics and carried out testing for the industry and also funded a limited amount of research. It was disbanded by the Government as a monopolistic body which was not in the national interest. Co-operation between some of the mining houses still exists, especially in the operation of the export coal-loading installation at Richards Bay on the South African east coast.

Whilst ESKOM is responsible for the operation of any nuclear power station, the Atomic Energy Corporation (AEC) (previously the Atomic Energy Board) was formed by the Government to undertake a study of the potential for nuclear power in South Africa and to carry out research work and development in the area of nuclear power and in the application of nuclear techniques. This organization is responsible for the operation of the research reactor and was also responsible for the design and operation of the uranium enrichment process which has supplied nuclear fuel to the Koeberg Nuclear Power Station of ESKOM.

Licensing and safety of nuclear installations is under the control of the Council for Nuclear Safety (CNS) which is a statutory body directly responsible to the Minister of Mineral and Energy Affairs. The Board members of the CNS are appointed by the Minister and are chosen as being independent of the licensees.

Energy policy formulation and the funding of energy research in the country is the responsibility of the National Energy Council. This body was until recently an independent statutory body directly responsible to the Minister of Mineral and Energy Affairs. Funding for this body was from levies on coal, electricity and gasoline. This body has now been incorporated into the Department of Mineral and Energy Affairs and the funding system is being changed to be directly from Treasury.

Another body involved in the sphere of energy is the Department of Water Affairs which is responsible for the provision of dams for hydro-power stations and for cooling-water supply to thermal power stations.

4. ENERGY RESOURCES

4.1 Fuelwood

Fuelwood supply is based on six sources: commercial exotic plantations, alien vegetation eradication, self-seeded exotics, woodlots, indigenous forests, and natural shrubland or woodland. The extent to which the first five meet fuelwood demand is negligible. Demand is exceeding supply with devastating effects and it has been estimated that by the year 2000 natural woodland would be almost entirely denuded⁽⁴⁾.

4.2 Petroleum and Gas

Although South Africa imports all its crude oil requirements, indigenous coal and gas are also used as feedstocks for the country's liquid fuel requirements.

No major oil reserves have been discovered. A number of small offshore oil fields have been located by the government financed Southern Oil Exploration Company, SOEKOR. At present their exploitation is not economical, although movement in the oil price and/or technical advancements could reverse the situation in the future.

A substantial amount of gas was discovered off Mossel Bay in 1985. Recoverable reserves amount to 28 000 million m³ (10). These reserves form the feedstock for the Moss gas project in which it will be converted into synfuel. The plant is due to come on stream in 1992 and is expected to supply 10% of South Africa's liquid fuel requirements(13). However, controversy surrounds its economic viability and cost to the taxpayer.

4.3 Coal

South Africa has extensive deposits of bituminous coal, which occur mainly in the eastern Transvaal, the northern Orange Free State, and northern Natal. These deposits are mostly in thick, easily worked seams fairly near to the surface which allows mining at exceptionally low cost. This, together with low pay rates of miners, short transport distances to the ocean, and dependability and reliability of supply give South African coal a competitive edge in the export market(11).

Proven reserves in place amount to 121 000 million tons, of which 55 333 million tons are currently estimated to be economically recoverable reserves. They are the fourth largest reserves in the world and 10% of the estimated world inventory(9,10).

More than 50% of these reserves are situated in the eastern Transvaal Highveld and are mainly exploited by pithead power stations and by Sasol synfuel plants, as well as for export. It should be noted that coal used for electricity and synfuel production is lower grade run of mine coal, while export coal is better quality washed coal.

Considerable quantities of discards are generated by the mining and beneficiation processes and are presently not exploited. Research is being undertaken to investigate the possibility of utilizing these coal discards in gasification or other processes which, if successful, would improve the efficiency of coal utilization and extend the coal reserves.

4.4 Hydro-electricity

South Africa has a hydro-electric potential of 3 500 MW, of which 540 MW have been exploited⁽¹²⁾. This potential is limited because the river flow rates are relatively small (as shown in Table 4.1), there are long droughts lasting up to 8 years interspersed with floods of short duration confined to a few days, and large costly dams are required to regulate the highly variable volumes of water. Thus this potential would be suitable only for low load factor operation. The existing conventional hydro-electric schemes are mainly used as peaking stations and for synchronous condenser operation⁽¹⁵⁾.

Table 4.1 Average flows of main rivers in the subcontinent

River	m ³ per second
Orange (Hendrik Verwoerd Dam)	216
Tugela (at mouth)	146
Umzimvubu (at mouth)	94
Cunene (at Ruacana)	180
Zambesi (at Cahora Bassa)	2 370
Zaire (at Inga)	25 000

(Source: ESKOM)

4.5 Uranium

South Africa has 432 000 tons of uranium reserves recoverable at less than 130 US\$/kg, forming 15% of the western world's reserves⁽⁹⁾.

In 1989 uranium production was 3 500 tons, of which 90% was available for export. Ninety-eight percent of uranium production is recovered as a by-product of gold mining. The low uranium prices of the 1980's led to production cut-backs and stopped all planned expansion of the nuclear industry⁽¹⁾.

The Atomic Energy Corporation of South Africa produces enriched fuel elements, using a locally developed process, for the two reactors of the Koeberg Nuclear power station.

The availability of uranium resources is dependent to a large extent on gold production. It has been forecast that gold production will drop sharply in about 2005 and will terminate in 2035⁽⁹⁾. This could have a large impact on any future nuclear programme based on local resources.

4.6 Biomass

Dung is used to supplement and in some cases substitute for fuelwood in a number of rural areas. It has been estimated that the net use of dung in underdeveloped areas amounts to 34 kgoe (1,42 GJ) per capita per year⁽⁴⁾.

Potential exists for the use of organic refuse as a source of energy either by direct combustion or by conversion to biogas via microbiological processes. Methane gas from sewerage treatment works is another potential source of energy. The AECI company in Johannesburg utilizes methane gas originating from sewerage purification works, as well as from a refuse dump, for use in its cyanide factory at Klipspruit.

Anaerobic digestion of animal and human waste in the production of biogas could contribute greatly to providing thermal energy in remote areas, especially where afforestation is not feasible⁽⁷⁾. The National Energy Council (NEC) and the Council for Scientific and Industrial Research (CSIR) are evaluating this resource under local conditions.

4.7 Solar and Wind

South Africa lies within the bounds of 40° of the equator, which is considered a suitable region for the utilization of solar energy. Table 4.2 shows the average yearly insolation for selected cities. With the exception of the coastal areas, South Africa generally has a sunny climate. Besides the winter rainfall region of the southern Cape, the sunniest days occur in winter when the demand for water and space heating is at a maximum.

The average annual insolation is highest in the north-western semi-arid portion of the country where it averages 6000 Wh/m²/day, and declines towards the southern coastal areas (5000 Wh/m²/day) and eastern coastal areas (4500 Wh/m²/day)⁽¹⁹⁾. Virtually the entire interior of the country has an average insolation in excess of 5000 Wh/m²/day and a large portion has an average insolation of between 5500 and 6000 Wh/m²/day⁽¹⁹⁾.

Table 4.2 Average yearly insolation⁽¹⁸⁾

City	Watt hours/m ² /day	Percentage of maximum possible
Alexander Bay	6274	
Bloemfontein	5797	78
Cape Town	5433	67
Durban	4540	54
Kimberley	5914	78
Pietersburg	5966	
Port Elizabeth	5048	
Pretoria	5443	74
Upington	5850	
London		33
Miami		65
Sydney		49
Washington		57

There is a large potential for further exploitation of solar energy. The wider use of solar water heaters could make considerable savings on the domestic use of electricity, especially in low cost housing schemes. Photovoltaic electricity can play an important role in remote areas far from the grid.

South Africa is in general not a windy country. Most of the coastal areas show some potential, particularly along the southern and south-western Cape coasts. Table 4.3 shows the mean annual wind speed (normalised to 10 m) for a number of sites. Almost the entire eastern, southern and south-western coasts have

mean annual wind speeds in excess of 4 m/s, with the highest speeds recorded at Cape Point. The inland regions have relatively little wind potential and only three isolated small areas, namely, Kroonstad, Victoria West and Matroosberg, have mean annual wind speeds in excess of 4 m/s⁽²⁰⁾.

Table 4.3 Mean annual wind speed Normalised to 10m)^(20,21)

Site	Type	Mean Speed (M/S)
Cape Columbine	C	6,7
Cape Town	C	4,0
Cape Point	C	9,7
Cape Agulhas	C	7,2
Cape St Francis	C	6,9
Port Elizabeth	C	4,1
Port St Johns	C	5,1
Durban	C	3,3
Cape St Lucia	C	6,6
Matroosberg	I	4,3
Victoria West	I	5,1
Kroonstad	I	4,6
Robertson	I	2,9
Beaufort West	I	3,8
Calvinia	I	2,6
Aliwal North	I	3,7
Bloemfontein	I	2,5
Jan Smuts (Jhb)	I	3,1

C = coastal

I = inland

Wind energy in South Africa has been used extensively for the pumping of water in rural areas⁽²²⁾. Although large scale wind-farms are not viable in South Africa, due mainly to the availability of cheap grid electricity⁽²²⁾, wind generation in the form of stand-alone systems can play an important role in remote areas where they can be used on their own or in PV/wind/diesel hybrid systems.

4.8 Geothermal

South Africa is tectonically stable and does not possess any geothermal potential.

5. ENERGY SUPPLY AND DEMAND

5.1 General

Unlike other countries in the region, South Africa relies mainly on commercial fuels for its energy requirements. This can be attributed to the high level of development of the industrial and manufacturing sectors of the economy (see section 2.3 Economy). The ratio of traditional fuel to total energy final consumption has remained fairly constant over the period 1950-1988 at an average of 13,5%. In 1988 this figure was 14,1%.

Total final consumption (TFC) of commercial energy has shown an upward trend (as shown in Figure 7) and has increased almost fourfold from 1950 to 1988. In 1988 TFC of commercial energy amounted to 41,841 million toe. A comparison of the TFC of selected countries is given in Table 5.1. Figure 8, drawn for commercial energy carriers as a percentage of TFC of commercial energy, shows that electricity and oil have been increasing in relative importance since 1950 at the expense of coal. In 1988 coal was still the largest single commercial energy carrier, accounting for 38,3% of TFC, although in 1950 the corresponding figure was 76,9%. In 1988 electricity accounted for 33,7% of TFC, oil 27,2% and gas 0,71%. The importance of coal in the energy economy is much greater than these figures suggest as electricity is mainly coal based and a proportion (estimated at 25%⁽²⁾) of local liquid fuel needs are derived from coal.

Thus coal forms the basis of South Africa's primary commercial energy requirements, its contribution being 81,6% in 1988, followed by oil at 14,7%, nuclear (uranium) at 2,5% and hydro at 1,1%⁽²⁾. While secondary energy usage patterns are changing, coal remains the most important primary energy form.

Table 5.1 Total final consumption of commercial energy for selected countries (1988)

Country	TOE (000's)	kgoe/capita
South Africa	41841	1128
Tanzania	581	24
Malawi	205	26
Mozambique	457	31
Kenya	1936	86
Zambia	1380	184
Zimbabwe	2875	310
Botswana	415	343
Egypt	20190	390
UK(1986)	144340	2545
USA (1986)	1278620	5283

Figure 9 shows the sectorial breakdown of the total final consumption of commercial energy in percentage terms over the period 1971-1988. Since the OPEC oil embargo of 1973 oil statistics have been classified and sectorial data are not complete. Thus the TFC of the agriculture and residential sectors do not include consumption of oil, having been included in 'other'. In 1988 sectorial consumption (as discussed above) was as follows: industry 63,7%, transport 21,1%, and residential 6,6%. Mining alone accounted for 7,6% of TFC.

Energy usage correlates with economic activity, as shown in Figure 10. Energy usage can be approximated by a straight line function of the wealth of a country, although some scatter is evident.

The relationship between TFC of commercial energy and real GDP growth rates is shown in Figure 11 over the period 1955-1988 in a 3-point moving average form. Although similar trends can be identified, they are complicated by the oil crises/embargo as well as the implementation of sanctions. The relationship

between the growth of the contribution to GDP by the industrial and agricultural sectors and the mining sub-sector in real terms to the growth of their TFC of commercial energy is shown in Figures 12, 13 and 14. In each sector similar trends can be seen. In the mining sector the influence of the price of gold affects the relationship. The high price of gold in 1980 is reflected in a large peak in 1979 (3-point moving average), though the associated peak in energy consumption growth is much lower. The effect of the decrease in gold price and decreasing ore quality in the latter part of the 1980's is reflected in a decrease in contribution to GDP and an increase in TFC of energy.

Figure 15 shows the intensity of total final consumption of commercial energy over the period 1950-1988. TFC intensity showed a downward trend until 1980 due mainly to increased efficiency. Subsequently the trend has been upward due to the downturn in the economy, the fall in the gold price and the advanced age of much industrial technology⁽³⁾. It should be noted that overall the trend has been downward. In contrast, primary energy intensity has increased considerably since 1981 mainly due to the rapid increase in production by Sasol whose coal-to-oil process has a lower conversion efficiency than the conventional refining of crude petroleum.

On a US dollar basis South Africa's net commercial energy intensity is the highest in the region at 0,53 kgoe per US\$ in 1988. The primary energy intensity amounts to some 1,1 kgoe per US\$. These high energy intensities can be ascribed to South Africa's greater economic development relative to the rest of the region, low energy costs, large coal resources, the large size of the country, and the government policy of supporting energy supply actions and its limited attention to the efficient use of energy⁽³⁾.

Figure 16 shows the energy intensity of the main commercial carriers and traditional fuel during the period 1950-1988. The declining importance of coal and the converse increase in importance of electricity and oil as secondary energy sources is evident.

TFC of commercial energy per capita amounted to 1128 kgoe which is closer to western per capita consumption than to countries in the region (see Table 5.1). Figure 17 of TFC of energy per capita for the period 1950-1988 shows that TFC per capita of commercial fuel increased until 1971, as would be expected from an economy whose sectorial mix was shifting away from agriculture towards

industry. Since 1971 the per capita consumption has shown an overall downward trend which can be mainly attributed to the oil crises, the implementation of oil embargoes and economic sanctions, and the consequent effect on the economy. The consumption of traditional energy per capita has shown a linear increase with time, which possibly reflects the manner in which the data were collected and calculated.

5.2 Fuelwood

In 1988 fuelwood consumption amounted to 6876 Ttoe⁽²⁾ representing 14,1% of TFC of energy in South Africa, which is very low for the sub-continent.

Over half the population live on farms and in underdeveloped rural areas where wood is the principal fuel for cooking and heating. A further fifth of the population living in or near black townships also rely on fuelwood⁽⁴⁾. However, the consumption of fuelwood per capita declines markedly from rural areas to peri-urban areas to townships, being substituted by coal in peri-urban areas and electricity and gas in a number of townships. Eberhard⁽⁵⁾ gives the mean annual per capita consumption of firewood in 1986 in rural areas as 604 kg and in peri-urban areas as 334 kg.

Fuelwood is obtained from six sources: commercial exotic plantations, alien vegetation eradication, self-seeded exotics, woodlots, indigenous forests, and natural shrubland or woodland. The natural shrubland or woodland is the only significant source of fuelwood⁽⁴⁾.

Fuelwood demand is exceeding supply⁽⁴⁾ with devastating social, economic and environmental effects. Studies have indicated growing fuelwood shortages in rural villages and women and other members of the household are having to walk increasingly further and are spending more time collecting fuelwood. Eberhard⁽⁴⁾ estimated that if demand were to remain at 1990 levels, natural woodlands would be almost entirely denuded by the year 2020.

South Africa is experiencing increasing urbanization, especially since the abolition of the influx control laws in 1986 and the Group Areas Act in 1991. This, together with ESKOM's slogan of 'electricity for all' and the NEC's call for it to be extended to 'energy for all', has the potential for causing a major shift in energy consumption patterns in the rural and especially the peri-urban and township areas, with electricity, coal and gas increasingly substituting for fuelwood over the next few decades.

5.3 Petroleum products

Since the implementation by OPEC of an oil embargo on South Africa in 1973 information concerning oil and oil products has been classified. The following discussion is based on estimates by the International Energy Agency (IEA)⁽²⁾ and the Energy Research Institute of the University of Cape Town.

South Africa does not produce any crude oil and was entirely dependent on imported crude until the mid-1950's. In the face of sanction threats and to make South Africa less dependent on imported crude oil three plants were built to convert coal into oil. The first and by far the smallest plant, Sasol 1, started up in 1956. The last plant, Sasol 3, was completed in 1983. It is estimated by the IEA that the combined production of these plants amounts to 25% of TFC of oil in 1988. (The Economist Intelligence Unit⁽¹⁾ puts this figure at 40%.) In addition, to further safeguard against interruptions in supply, large stockpiles of imported oil were built up, which were estimated to be 17-18 million tons in 1989/90⁽¹⁾ or approximately equivalent to one year's supply. In 1991 following the political reform initiatives begun by President de Klerk and the resulting easing of international pressure on South Africa these stockpiles started to be sold to finance social programmes.

Figure 18 shows the IEA estimates of coal consumption and oil production by the Sasol plants in terms of tons of oil equivalent (toe) over the period 1971-1988. The rapid increase in output from 1979 to 1987 was due to the startup of Sasol 2 & 3. The overall energy transformation efficiency in terms of toe of oil produced per toe of coal consumed averaged 21% over the period 1979-1988 according to IEA data. It should be noted that a number of important by-products are produced by Sasol, thus increasing the utilization of the coal in the transformation process.

In 1985 the go-ahead was given to build a plant to exploit gas from the offshore Mossel Bay gas field. This plant will convert the gas into liquid fuel and is due to start up in 1991/92.

South Africa has four conventional refineries. The Caltex refinery is situated in Cape Town, the Genref (Mobil) refinery in Durban, the Natref refinery in Sasolberg, and the SAPREF (Shell/BP) refinery in Durban. The IEA estimated that refinery consumption of oil as a percentage of through-put was 11% in 1988. All the refineries are to undergo expansion programmes to meet the expected increased internal demand as well as increased exports to other countries in the region as a result of the dismantling of apartheid and the anticipated acceptance of South Africa back into the economic arena of the region.

Figure 19 shows the TFC of oil over the period 1950-1988. In general, consumption has shown an upward trend, with a TFC of 14,1 million toe in 1988 compared to 1,7 million toe in 1950. The effects of the oil crises, oil embargo and economic downturn can be seen. Figure 20 shows the oil product consumption by type over the period 1971-1988. Gasoline and diesel together are the dominant oil product forms. This is reflected in Figure 21 which gives the sectorial breakdown of TFC of oil, where transport accounts for almost 60% of consumption.

Figure 22 shows the ratio of diesel to petrol according to IEA data⁽²⁾. Since 1979 the trend has been away from diesel towards petrol, the ratio changing from 1,08 in 1979 to 0,94 in 1988. According to the National Energy Council the shift was greater than these data suggest, with the ratio changing from 0,92 in 1979 to 0,66 in 1989⁽⁷⁾. The higher growth rate in the demand for petrol could be partially explained by the proliferation of so-called black taxis which consume petrol and are in direct competition with conventional buses using diesel. The continuation of this trend is worrying as it could result in an over production of diesel due to the limit in the flexibility of the refineries.

5.4 Coal

South Africa has large reserves of coal and supplies all its own needs except for a negligible amount of coking coal imported from Zimbabwe. It also exports large quantities of coal in spite of the imposition of sanctions against the country.

Figure 23 shows the TFC of coal over the period 1950-1988. In general, TFC showed an upward trend until early in the 1970's. Since then it has oscillated around 16 million toe per year. This can be attributed to the increasing substitution by electricity and liquid fuels as secondary energy carriers and the related demise of the steam locomotive. As electricity is mainly based on coal and liquid fuels are partly based on coal, primary consumption of coal has displayed a steady increase over the same period, reaching 74,5 million toe in 1988 and 76,8 million toe in 1989. Figure 24 shows the coal energy balance for 1971 and 1988. (For the purposes of this Figure, production includes changes in stock.) Total final consumption of coal (1971 figures in brackets) accounted for only 21% (46,5%) of primary consumption in 1988, while liquefaction accounted for 25,6% (2,5%), transformation into electricity 47,1% (45,3%) and gasification 3,9% (3,7%). Primary consumption absorbed 69,8% (101,2%) of production, exports 26,7% (2,7%), and the remainder was stockpiled (in 1971 the deficit was obtained from the stockpiles). It is interesting to note that as a result of the demise of the steam locomotive transport's importance has diminished from 21,8% of TFC of coal in 1971 to 1,7% in 1988.

Figure 25 shows the production and export of coal during the period 1971-1988. The rapid increase in production since the mid 1970's is mainly due to increased exports, Sasol production and electricity production.

Figure 26 shows the sectorial TFC of coal in percentage values. It should be noted that consumption by SASOL is not included as its consumption does not fall into the definition of TFC because it is an energy transformation process.

5.5 Electricity

South Africa is the greatest single producer of electricity in Africa, accounting for 56% of all electricity generated on the continent in 1988⁽¹⁵⁾. In 1990 the total of all electricity generated on a sent-out basis amounted to 147 244 GWh, of which 92,3% was based on coal, 5,7% on nuclear, 1,3% on pumped storage, 0,7% on hydro and a negligible amount on diesel and gas turbines. ESKOM's sent-out electricity amounted to 97,4% of all electricity sent out in South Africa and over half of all the electricity generated in Africa⁽⁸⁾.

Roughly one-third of South Africa's population has access to electricity, which is high by regional standards, it being estimated that on average only 10% of Africa's population has access to electricity^(24,25), but low relative to the West. Large-scale urbanisation is making the supply of electricity to many more people economically feasible. However, the implementation of any electrification programmes is being hampered by lack of funding, legal constraints, political constraints, and consumers boycotting payments. The government's reform initiatives are paving the way for the easing of political constraints, but funding remains a major problem and the electricity supply industry needs to be rationalized.

Figure 27 shows electricity consumption over the period 1950-1988. Consumption displayed an exponential growth until 1980. From 1980 to 1983 growth was low, recovering somewhat in the period ending in 1988. In 1975 consumption amounted to 5488 Ttoe and by 1988 it had more than doubled to 11410 Ttoe.

The sectorial consumption of electricity during the period 1971-1988 is shown in Figure 28. In all sectors consumption has been increasing, with the greatest growth shown by agriculture. This is a result of the growing number of farms being connected to the grid and the resultant substitution by electricity as a source of energy. The transport sector achieved the lowest growth. In 1988 industry absorbed 68,1% of all electricity consumption, residential 14,8%, transport 3,1% and agriculture 2,4%. South Africa's consumption pattern differs from that of the USA and Europe due to the differing climatic conditions and South Africa's reliance on heavy primary industry.

All ESKOM undertakings were connected to form an integrated transmission system in 1973. It is comprised of 220 000 km of power lines, of which 22 000 km form the national grid. In 1990 ESKOM's total power station installed capacity was 35 673 MW and the peak demand on the integrated system was 21 863 MW⁽⁸⁾. Figure 29 shows the installed capacity on an assigned sent-out basis and maximum demand on the integrated system over the period 1950-1990. In 1989, 87,5% of ESKOM's installed capacity was based on coal and 5,65% on nuclear. (ESKOM operates the only nuclear power station in Africa.) ESKOM's

coal-fired stations are mostly located in the Eastern Transvaal where coal reserves are large. Figure 30 shows the contribution to electricity generation by the various types of power stations on a sent-out basis. (It should be noted that the pumped storage stations consume more electricity than they generate.)

Figure 31 shows the average yearly growth in ESKOM's electricity sales during the period 1929-1990. When ESKOM's latest power stations were planned and orders placed, electricity demand was growing at 7-8% per year, but over the last five years growth has averaged at 3,9% due to local and international conditions (i.e. sanctions) and as a result ESKOM had 4 686 MW of surplus generating capacity in 1990⁽⁸⁾. This does not include 5 260 MW of older less efficient plant which has been mothballed or reserve-stored since 1989 as part of ESKOM's excess capacity management programme. This excess is expected to be absorbed only by the year 2000⁽⁹⁾.

Due to long lead times and prohibitive penalties which would be incurred if various contracts already in place were cancelled, 8 199 MW of generating plant were on order as of 31 December 1990⁽⁸⁾. Of this, 4 095 MW are due for completion in 1993 and the remainder by 2001. All of this plant is coal-fired and coal as a source of electricity generation will continue to dominate well into the next century⁽⁹⁾. The excess capacity excludes the Cahora Bassa scheme in Mozambique, which was built to supply power to South Africa but has been out of action for a number of years due to sabotage of the power lines within Mozambique.

6. PRICING AND MARKETING

6.1 Oil and oil products

The price of gasoline diesel and kerosene are fixed by the Department of Mineral and Energy Affairs, although the tax on gasoline is under the control of the Department of Economic Affairs. Whilst price increases are supposed to be carried out with the co-operation of both Departments, this does not always occur and tax increases have been announced by the Department of Economic Affairs without the Energy section being aware of the intention. Part of the tax is meant

as a levy for the Strategic Fuel Fund, from which projects such as Sasol and Mossgas are funded, and other components are intended for road development, etc. The tendency is now however to classify all the tax as part of Treasury income without earmarking any of it for particular purposes.

The controlled price of fuels is based on the landed price of Middle East crude. The subsidy paid to Sasol is also based on this price. When the equivalent price of landed crude reaches R22 per barrel, then the subsidy falls away.

Marketing of products is carried out by the individual oil companies in competition with each other.

6.2 Coal

In the past the price of the various grades of coal was controlled by the Government. The prices were set in such a way as to give an adequate return to the mining houses but at the same time to protect the consumer against exploitation. In fact the consumer who needed protection, the low-income user usually in the Black townships, did not receive protection since, whilst the pit-head price of coal in bulk was controlled, there was no control of merchant prices for sales in very small quantities, which were often of an order of magnitude greater than the controlled price.

The prices of the various grades of coal, based on calorific value, were also inadequately researched, with the price of the lower grades of coal being for a long time higher than that of the higher grade coals on a heating value basis.

The marketing of coal used to be mainly under the control of the Transvaal Coal Owners' Association, but since that body's disbandment it has been under the control of each mining house. The price of coal for power stations and steel production was not controlled, with supplies being from the utility's own mine or more often from a tied-colliery operated by a mining house. Whilst the price was not controlled, there was a close correlation between the Government controlled price and that negotiated by ESKOM or one of the other power producers or ISCOR (the Government-owned steel producer).

6.3 Electricity

Electricity tariffs are set by the electricity producers or distributors such as ESKOM or the municipalities. The ESKOM tariff has been set, in general, on the basis of recovering costs. However, within this criterion there is room for manoeuvring in terms of how long-term loans will be paid off. This has been used in the past by the Government to limit price increases in order to decrease the national inflation rate.

Municipalities set their own tariffs and a significant cross-subsidization of municipal rates occurs.

Tariff changes have to be approved by the Electricity Council or, in the case of the municipalities, by the Provincial Administrator.

6.4 Other energy

There is no price control on other energy sources such fuelwood for instance and prices are dictated by supply and demand considerations.

7. DISCUSSION

South Africa has large reserves of coal and most of the energy consumption is based on coal, with most of the electricity, some of the oil requirement, and most of the boiler fuel being coal-based. The price of coal is very low compared with other energy forms and compared with international coal prices. Imported petroleum is used mainly in the transport sector. A long-term oil exploration programme has not uncovered any payable quantities of oil but has found significant gas off the south coast, and this gas is currently being developed as a source of gasoline and diesel fuel.

There is little direct control of the energy industry, with most of the production capacity being in the hands of private enterprise or parastatal bodies. There is however significant indirect control with pricing of liquid fuels being carried out by the Government and until recently the price of coal was controlled. The

Government is aiming at a general deregulation of energy. However, there is still significant control in terms of soft loans being made available for projects of strategic importance such as the oil-from-gas Moss gas project. There is also indirect control of the parastatal electricity utility, ESKOM, with Government appointments on the Board of that organization.

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TABLES

TABLE A: ECONOMIC INDICATORS

YEAR	POPULATION		GROSS DOMESTIC PRODUCT AT FACTOR COST									GDP DEFLATOR (1985=100)	GDP AT 1985 PRICES (FACTOR)	GDP/CAPITA		EXCHANGE RATE RANDBS PER US\$	GDP US\$ CURRENT MILLION	GDP PER CAPITA (US\$/CAPITA)
	MILLIONS (INCLUDES HOMEISLANDS)	POPULATION GROWTH RATE %	MILLIONS OF NATIONAL CURRENCY UNLESS INDICATED											CURRENT (RANDBS)	REAL 1985 (RANDBS)			
			AGRICULTURE	INDUSTRY					OTHER SERVICES	TOTAL								
				TOTAL INDUSTRY	MINING QUARRY	MANUFACTURE	ELEC, WTR, GAS	CONSTRUCT-ION										
25	7.56	2.2	108	146	87	42	7	10	283	537	5.6	9617.5	71.07	1272.82	NA	NA	NA	
26	7.72	2.2	105	156	93	45	8	10	294	555	5.4	10308.9	71.87	1335.01	NA	NA	NA	
27	7.89	2.2	109	166	97	49	9	11	305	580	5.4	10716.1	73.50	1358.01	NA	NA	NA	
28	8.06	2.2	113	168	95	52	10	11	320	601	5.3	11404.1	74.53	1414.19	NA	NA	NA	
29	8.24	2.2	97	177	100	54	11	12	325	599	5.1	11811.2	72.69	1433.40	NA	NA	NA	
30	8.42	2.2	78	160	86	52	12	10	313	551	4.5	12239.4	65.43	1453.44	NA	NA	NA	
31	8.61	2.2	66	143	78	46	12	7	288	497	4.4	11400.5	57.76	1324.87	NA	NA	NA	
32	8.79	2.2	62	140	77	46	12	5	264	466	4.0	11600.6	52.99	1319.15	NA	NA	NA	
33	8.99	2.2	70	187	113	54	13	7	274	531	4.0	13218.7	59.09	1471.04	NA	NA	NA	
34	9.18	2.2	74	211	125	63	13	10	316	601	4.4	13524.1	65.45	1472.73	NA	NA	NA	
35	9.38	2.2	97	239	135	74	15	15	352	688	4.2	16539.2	73.32	1762.49	NA	NA	NA	
36	9.59	2.2	111	262	144	84	17	17	394	767	4.3	17827.4	79.98	1858.96	NA	NA	NA	
37	9.76	1.8	106	282	151	93	18	20	426	814	4.4	18434.6	83.41	1888.99	NA	NA	NA	
38	9.93	1.8	110	294	154	99	20	21	440	844	4.6	18515.4	84.99	1864.40	NA	NA	NA	
39	10.11	1.8	121	313	164	107	22	20	458	892	4.4	20070.3	88.27	1986.17	NA	NA	NA	
40	10.28	1.8	125	350	185	123	23	19	512	987	5.0	19908.8	95.98	1936.09	NA	NA	NA	
41	10.46	1.8	135	389	201	143	25	20	591	1115	5.4	20491.5	106.56	1958.29	NA	NA	NA	
42	10.65	1.8	171	411	201	164	26	20	654	1236	6.1	20273.9	116.08	1904.01	NA	NA	NA	
43	10.84	1.8	197	419	190	183	27	19	706	1322	6.6	19915.9	122.00	1837.93	NA	NA	NA	
44	11.03	1.8	194	442	185	207	28	22	766	1402	6.9	20417.8	127.15	1851.79	NA	NA	NA	
45	11.22	1.8	188	486	198	232	29	27	841	1515	7.0	21706.0	135.01	1934.41	NA	NA	NA	
46	11.42	1.8	212	542	194	280	32	36	883	1637	7.2	22867.8	143.37	2002.78	NA	NA	NA	
47	11.66	2.1	283	587	190	314	34	49	942	1812	7.6	23727.7	155.43	2035.32	NA	NA	NA	
48	11.90	2.1	340	702	239	366	37	59	1016	2058	8.0	25622.6	172.86	2152.44	NA	NA	NA	
49	12.15	2.1	397	817	289	418	41	70	1089	2303	8.5	27081.5	189.51	2228.20	NA	NA	NA	
50	12.41	2.1	454	932	338	470	44	80	1163	2549	9.4	27185.1	205.40	2190.58	0.71	3590.14	289.29	
51	12.67	2.1	513	1014	366	511	47	90	1245	2772	9.7	28501.4	218.77	2249.34	0.71	3904.23	308.12	
52	13.00	2.6	483	1110	371	572	51	116	1383	2976	10.1	29533.3	228.85	2271.09	0.71	4191.55	322.33	
53	13.35	2.6	574	1238	365	698	62	113	1561	3373	10.9	30954.9	252.73	2319.41	0.71	4750.70	355.96	
54	13.70	2.6	594	1336	399	760	71	106	1694	3624	10.5	34563.2	264.60	2523.60	0.71	5104.23	372.68	
55	14.06	2.6	578	1442	470	780	83	109	1799	3819	11.1	34408.7	271.70	2447.97	0.71	5378.87	382.67	
56	14.43	2.6	619	1587	531	843	90	123	1917	4123	11.4	36279.6	285.80	2514.87	0.71	5807.04	402.54	
57	14.81	2.6	620	1678	572	875	97	134	2044	4342	11.5	37641.5	293.28	2542.48	0.71	6115.49	413.07	
58	15.19	2.6	561	1742	576	912	105	149	2142	4445	11.6	38438.2	292.55	2529.83	0.71	6260.56	412.04	
59	15.59	2.6	589	1842	630	942	115	155	2263	4694	11.7	40052.8	301.03	2568.64	0.71	6611.27	423.99	
60	16.00	2.6	615	1982	684	1023	123	152	2386	4983	11.9	41979.8	311.38	2623.25	0.71	7018.31	438.56	
61	16.52	3.2	680	2101	709	1111	134	147	2499	5280	12.1	43794.5	319.63	2651.16	0.71	7436.62	450.19	
62	17.05	3.2	696	2233	742	1190	144	157	2702	5631	12.2	46234.0	330.24	2711.51	0.71	7930.99	465.13	
63	17.60	3.2	765	2491	788	1363	157	183	3005	6261	12.6	49758.0	355.74	2827.16	0.71	8818.31	501.04	
64	18.17	3.2	728	2827	879	1542	169	237	3317	6872	12.9	53271.6	378.25	2932.16	0.71	9678.87	532.74	
65	18.75	3.2	770	3169	944	1745	181	299	3601	7540	13.1	57374.8	402.07	3059.50	0.71	10619.72	566.29	
66	19.36	3.2	861	3409	1012	1875	200	322	3936	8206	13.7	59842.3	423.93	3091.51	0.71	11557.75	597.08	
67	19.98	3.2	1051	3639	1036	2028	227	348	4483	9173	14.3	63956.1	459.09	3200.84	0.71	12919.72	646.60	
68	20.63	3.2	965	3918	1092	2197	252	377	5001	9884	14.8	66718.5	479.22	3234.83	0.71	13921.13	674.96	
69	21.29	3.2	1014	4428	1215	2512	277	424	5557	10999	15.5	70790.1	516.63	3325.04	0.71	15491.55	727.64	
70	22.00	3.3	973	4817	1207	2796	307	507	6247	12037	16.2	74468.6	547.16	3385.09	0.71	16953.52	770.65	
71	22.64	2.9	1168	5087	1164	2983	351	589	7010	13265	16.9	78463.0	585.99	3466.14	0.72	18423.61	813.87	
72	23.29	2.9	1320	5949	1513	3268	408	760	7783	15052	18.8	80182.9	646.17	3442.21	0.77	19548.05	839.19	
73	23.96	2.9	1531	7802	2244	4092	478	988	9380	18713	22.6	82945.3	781.08	3462.11	0.69	27120.29	1131.99	
74	24.64	2.8	2214	9735	3068	4896	537	1234	11167	23116	26.1	88645.6	938.19	3597.77	0.68	33994.12	1379.69	
75	25.34	2.9	2129	11145	3182	5991	610	1362	12590	25864	28.5	90783.2	1020.56	3582.18	0.74	34951.35	1379.13	
76	26.06	2.8	2237	12517	3471	6841	780	1425	14242	28996	31.4	92304.8	1112.88	3542.69	0.87	33328.74	1279.17	
77	26.17	0.4	2532	13694	4155	6963	1140	1436	15757	31983	33.1	96521.0	1222.12	3688.23	0.87	36762.07	1404.74	
78	27.42	4.8	2830	16424	5496	7886	1570	1472	18040	37294	37.6	99217.0	1360.05	3618.29	0.87	42866.67	1563.28	
79	28.35	3.4	3251	20920	7783	9767	1784	1586	20398	44569	43.4	102617.0	1572.04	3619.52	0.84	53058.33	1871.48	
80	29.62	4.5	4216	29693	12742	12991	1809	2151	25256	59165	54.6	108294.0	1997.60	3656.36	0.78	75852.56	2561.03	
81	30.34	2.4	4924	32085	10490	16620	2191	2784	30899	67908	60.0	113200.0	2238.09	3730.80	0.88	77168.18	2543.28	
82	31.67	4.4	4854	34632	10471	18403	2652	3106	36046	75532	67.3	112253.0	2385.35	3545.02	1.08	69937.04	2208.65	
83	32.64	3.1	4316	40149	12392	20937	3270	3550	41688	86153	78.4	109850.0	2639.90	3366.02	1.11	77615.32	2378.28	
84	33.08	1.4	5261	44420	12952	23801	3883	3784	48713	98394	87.2	112796.0	2974.43	3409.79	1.44	68329.17	2065.57	
85	33.68	1.8	6526	51580	16671	25928	4837	4144	54341	112447	100.0	112447.0	3338.99	3338.99	2.19	51345.66	1524.65	
86	34.49	2.4	7287	60536	20213	30260	5556	4507	61837	129660	115.1	112680.0	3759.90	3267.51	2.27	57118.94	1656.34	
87	35.31	2.4	9216	66457	19194	35689	6661	4913	74240	149913	130.6	114805.0	4245.14	3250.98	2.03	73848.77	2091.20	
88	36.19	2.5	9986	78737	22078	43125	7700	5834	87553	176276	147.9	119179.0	4870.44	3292.87	2.27	77654.63	2145.57	
89	37.09	2.5	11629	91258	24936	50896	8923	6503	104061	206948	169.9	121790.0	5579.02	3283.28	2.62	78987.79	2129.40	

TABLE B: ENERGY DATA

YEAR	COMMERCIAL ENERGY FORMS								TRADITIONAL ENERGY 000'S TOE	TRADITIONAL AND COMMERCIAL			COMMERCIAL ENERGY	
	TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP TOE/REAL 1985 RANDS			COMM/ TRADIT	TRADITIONAL + COMMERCIAL 000'S TOE	TRADITIONAL AS % OF TOTAL	PRIMARY CONSUMPTION 000'S TOE	EFFICIENCY TFC/PRIMARY ENERGY
	COAL	OIL	HYDRO	GAS	ELECT	TOTAL	1PT	3PT MA						
950	8634	1767	0	0	826	11227	4.13E-04	NA	1799.5	6.2	13026.4	13.8	NA	NA
951	9234	2001	0	0	878	12113	4.25E-04	4.2E-04	1880.7	6.4	13993.8	13.4	NA	NA
952	9794	2101	0	0	924	12818	4.34E-04	4.2E-04	1964.2	6.5	14782.2	13.3	NA	NA
953	9650	2121	0	0	1014	12785	4.13E-04	4.1E-04	2045.3	6.3	14830.5	13.8	NA	NA
954	9638	2250	0	0	1121	13009	3.76E-04	4.0E-04	2126.5	6.1	15135.2	14.1	NA	NA
955	10584	2470	0	0	1267	14322	4.16E-04	4.0E-04	2207.6	6.5	16529.7	13.4	NA	NA
956	10944	2699	0	0	1368	15011	4.14E-04	4.1E-04	2291.2	6.6	17301.8	13.2	NA	NA
957	11201	2855	0	0	1481	15537	4.13E-04	4.2E-04	2372.3	6.5	17909.8	13.2	NA	NA
958	11788	3050	0	0	1564	16402	4.27E-04	4.1E-04	2453.5	6.7	18855.8	13.0	NA	NA
959	11357	3168	0	0	1665	16190	4.04E-04	4.1E-04	2534.6	6.4	18725.0	13.5	NA	NA
960	11525	3286	0	0	1797	16608	3.96E-04	4.0E-04	2615.8	6.3	19223.4	13.6	NA	NA
961	11920	3507	0	0	1880	17307	3.95E-04	3.9E-04	2720.8	6.4	20027.9	13.6	NA	NA
962	12046	3782	0	0	2025	17853	3.86E-04	3.9E-04	2825.8	6.3	20678.9	13.7	NA	NA
963	12573	3979	0	0	2162	18714	3.76E-04	3.8E-04	2930.8	6.4	21644.8	13.5	NA	NA
964	13322	4948	0	0	2337	20607	3.87E-04	3.8E-04	3035.8	6.8	23642.6	12.8	NA	NA
965	14508	5121	0	0	2527	22155	3.86E-04	3.8E-04	3140.8	7.1	25296.2	12.4	NA	NA
966	14130	5819	0	0	2684	22634	3.78E-04	3.8E-04	3245.8	7.0	25879.6	12.5	NA	NA
967	14005	6183	0	0	2919	23106	3.61E-04	3.6E-04	3350.8	6.9	26456.7	12.7	NA	NA
968	14400	5977	0	0	3145	23522	3.53E-04	3.5E-04	3455.8	6.8	26978.3	12.8	NA	NA
969	14017	6580	0	0	3389	23986	3.39E-04	3.4E-04	3560.9	6.7	27547.3	12.9	NA	NA
970	14202	7230	0	0	3754	25186	3.38E-04	3.5E-04	3665.9	6.9	28851.7	12.7	NA	NA
971	16490	9036	0	139	4008	29673	3.78E-04	3.6E-04	3871.1	7.7	33544.2	11.5	46034.5	64.5
972	15466	8951	0	139	4403	28959	3.61E-04	3.7E-04	4076.4	7.1	34745.3	12.3	44339.9	65.3
973	15603	9969	0	150	4742	30464	3.67E-04	3.6E-04	4281.6	7.1	34745.2	12.3	47299.3	64.4
974	15771	9680	0	176	5116	30743	3.47E-04	3.6E-04	4486.9	6.9	35229.4	12.7	48407.5	63.5
975	16396	10288	0	231	5488	32403	3.57E-04	3.5E-04	4692.1	6.9	37094.6	12.6	52068.7	62.2
976	16681	10480	0	234	5923	33317	3.61E-04	3.5E-04	4897.4	6.8	38214.8	12.8	54539.6	61.1
977	16189	10372	0	224	6253	33037	3.42E-04	3.5E-04	5102.6	6.5	38139.7	13.4	54638.9	60.5
978	15924	10568	0	230	6724	33446	3.37E-04	3.3E-04	5107.4	6.5	38553.6	13.2	55806.1	59.9
979	14746	10168	0	284	7371	32569	3.17E-04	3.2E-04	5312.6	6.1	37881.7	14.0	56781.6	57.4
980	15564	10345	0	321	7959	34190	3.16E-04	3.2E-04	5718.4	6.0	39907.9	14.3	61542.0	55.6
981	16959	11347	0	312	8439	37057	3.27E-04	3.2E-04	5849.6	6.3	42906.3	13.6	68793.6	53.9
982	16225	11615	0	284	8597	36721	3.27E-04	3.3E-04	5988.1	6.1	42709.2	14.0	74521.6	49.3
983	14818	11825	0	322	8830	35795	3.26E-04	3.3E-04	6128.9	5.8	41923.5	14.6	78293.8	45.7
984	16433	12729	0	323	9671	39156	3.47E-04	3.4E-04	6272.1	6.2	45428.4	13.8	83360.0	47.0
985	15506	12651	0	305	10116	38578	3.43E-04	3.5E-04	6415.3	6.0	44993.2	14.3	83740.0	46.1
986	15207	12814	0	302	10646	38969	3.46E-04	3.5E-04	6570.4	5.9	45539.8	14.4	84637.5	46.0
987	15349	13177	0	296	10955	39776	3.46E-04	3.5E-04	6787.6	5.9	46563.6	14.6	88208.1	45.1
988	16033	14100	0	298	11410	41841	3.51E-04	NA	6875.9	6.1	48717.1	14.1	91190.8	45.9

TABLE C: ENERGY INDICATORS

YEAR	ENERGY PER CAPITA TOE/CAPITA			ENERGY PER CAPITA TOE/CAPITA			ENERGY/GDP			
	COMMERCIAL	TRADITIONAL	TOTAL	ELECTRICITY	COAL	OIL	ELECTRICITY	COAL	OIL	TRADITIONAL
1950	0.90	0.15	1.05	0.067	0.696	0.142	3.04E-05	3.18E-04	6.50E-05	6.62E-05
1951	0.96	0.15	1.10	0.069	0.729	0.158	3.08E-05	3.24E-04	7.02E-05	6.60E-05
1952	0.99	0.15	1.14	0.071	0.753	0.162	3.13E-05	3.32E-04	7.11E-05	6.65E-05
1953	0.96	0.15	1.11	0.076	0.723	0.159	3.28E-05	3.12E-04	6.85E-05	6.61E-05
1954	0.95	0.16	1.11	0.082	0.704	0.164	3.24E-05	2.79E-04	6.51E-05	6.15E-05
1955	1.02	0.16	1.18	0.090	0.753	0.176	3.68E-05	3.08E-04	7.18E-05	6.42E-05
1956	1.04	0.16	1.20	0.095	0.759	0.187	3.77E-05	3.02E-04	7.44E-05	6.32E-05
1957	1.05	0.16	1.21	0.100	0.757	0.193	3.93E-05	2.98E-04	7.59E-05	6.30E-05
1958	1.08	0.16	1.24	0.103	0.776	0.201	4.07E-05	3.07E-04	7.94E-05	6.38E-05
1959	1.04	0.16	1.20	0.107	0.728	0.203	4.16E-05	2.84E-04	7.91E-05	6.33E-05
1960	1.04	0.16	1.20	0.112	0.720	0.205	4.28E-05	2.75E-04	7.83E-05	6.23E-05
1961	1.05	0.16	1.21	0.114	0.722	0.212	4.29E-05	2.72E-04	8.01E-05	6.21E-05
1962	1.05	0.17	1.21	0.119	0.706	0.222	4.38E-05	2.61E-04	8.18E-05	6.11E-05
1963	1.06	0.17	1.23	0.123	0.714	0.226	4.35E-05	2.53E-04	8.00E-05	5.89E-05
1964	1.13	0.17	1.30	0.129	0.733	0.272	4.39E-05	2.50E-04	9.29E-05	5.70E-05
1965	1.18	0.17	1.35	0.135	0.774	0.273	4.40E-05	2.53E-04	8.93E-05	5.47E-05
1966	1.17	0.17	1.34	0.139	0.730	0.301	4.49E-05	2.36E-04	9.72E-05	5.42E-05
1967	1.16	0.17	1.32	0.146	0.701	0.309	4.56E-05	2.19E-04	9.67E-05	5.24E-05
1968	1.14	0.17	1.31	0.153	0.698	0.290	4.71E-05	2.16E-04	8.96E-05	5.18E-05
1969	1.13	0.17	1.29	0.159	0.658	0.309	4.79E-05	1.98E-04	9.30E-05	5.03E-05
1970	1.14	0.17	1.31	0.171	0.646	0.329	5.04E-05	1.91E-04	9.71E-05	4.92E-05
1971	1.31	0.17	1.48	0.177	0.728	0.399	5.11E-05	2.10E-04	1.15E-04	4.93E-05
1972	1.24	0.17	1.42	0.189	0.664	0.384	5.49E-05	1.93E-04	1.12E-04	5.08E-05
1973	1.27	0.18	1.45	0.198	0.651	0.416	5.72E-05	1.88E-04	1.20E-04	5.16E-05
1974	1.25	0.18	1.43	0.208	0.640	0.393	5.77E-05	1.78E-04	1.09E-04	5.06E-05
1975	1.28	0.19	1.46	0.217	0.647	0.406	6.04E-05	1.81E-04	1.13E-04	5.17E-05
1976	1.28	0.19	1.47	0.227	0.640	0.402	6.42E-05	1.81E-04	1.14E-04	5.31E-05
1977	1.26	0.19	1.46	0.239	0.619	0.396	6.48E-05	1.68E-04	1.07E-04	5.29E-05
1978	1.22	0.19	1.41	0.245	0.581	0.385	6.78E-05	1.60E-04	1.07E-04	5.15E-05
1979	1.15	0.19	1.34	0.260	0.520	0.359	7.18E-05	1.44E-04	9.91E-05	5.18E-05
1980	1.15	0.19	1.35	0.269	0.525	0.349	7.35E-05	1.44E-04	9.55E-05	5.28E-05
1981	1.22	0.19	1.41	0.278	0.559	0.374	7.45E-05	1.50E-04	1.00E-04	5.17E-05
1982	1.16	0.19	1.35	0.272	0.512	0.367	7.66E-05	1.45E-04	1.03E-04	5.33E-05
1983	1.10	0.19	1.28	0.271	0.454	0.362	8.04E-05	1.35E-04	1.08E-04	5.58E-05
1984	1.18	0.19	1.37	0.292	0.497	0.385	8.57E-05	1.46E-04	1.13E-04	5.56E-05
1985	1.15	0.19	1.34	0.300	0.460	0.376	9.00E-05	1.38E-04	1.13E-04	5.71E-05
1986	1.13	0.19	1.32	0.309	0.441	0.372	9.45E-05	1.35E-04	1.14E-04	5.83E-05
1987	1.13	0.19	1.32	0.310	0.435	0.373	9.54E-05	1.34E-04	1.15E-04	5.91E-05
1988	1.16	0.19	1.35	0.315	0.443	0.390	9.57E-05	1.35E-04	1.18E-04	5.77E-05

TABLE D: SECTORIAL DISTRIBUTION OF TOTAL FINAL CONSUMPTION

000'S TOE

YEAR	COAL							OIL						
	INDUSTRY		TRANSPORT	AGRICULTURE	RESIDENTIAL	OTHER	TOTAL	INDUSTRY		TRANSPORT	AGRICULTURE	RESIDENTIAL	OTHER**	TOTAL
	TOTAL	MINING						TOTAL	MINING					
1971	11395.0	958.0	3602.0	84.0	634.0	775.4	16490.4	2918.0	NA	5239.0	NA	NA	879.0	9036.0
1972	10910.7	891.2	3015.1	82.7	639.6	817.9	15466.0	2775.6	NA	5133.7	NA	NA	1041.7	8951.0
1973	11215.0	734.6	2823.9	83.5	642.0	838.6	15603.0	2968.1	NA	5952.5	NA	NA	1048.4	9969.0
1974	11761.7	761.6	2397.4	86.7	657.3	867.9	15771.0	2806.9	NA	5847.3	NA	NA	1025.4	9679.6
1975	12004.5	494.1	2662.2	96.5	687.2	945.6	16396.0	3589.3	NA	5658.2	NA	NA	1040.0	10287.5
1976	12945.9	549.8	1998.0	97.7	725.9	913.5	16681.0	3802.4	NA	5651.3	NA	NA	1025.9	10479.6
1977	12913.8	837.6	1773.1	68.8	672.3	761.0	16189.0	3818.5	NA	5569.7	NA	NA	983.4	10371.6
1978	12783.8	738.5	1546.7	50.5	713.0	830.0	15924.0	3878.0	NA	5732.5	NA	NA	957.9	10568.4
1979	11932.4	548.1	1349.5	49.1	691.5	723.5	14746.0	3879.9	NA	5334.0	NA	NA	954.3	10168.2
1980	12678.3	603.8	1246.9	59.7	819.5	759.6	15564.0	3917.6	NA	5470.1	NA	NA	957.3	10345.0
1981	13938.8	729.9	1171.1	41.5	943.0	864.6	16959.0	3909.8	NA	6324.7	NA	NA	1112.9	11347.4
1982	13525.2	571.4	978.6	23.4	905.8	792.0	16225.0	4181.0	NA	6402.5	NA	NA	1031.4	11614.9
1983	12438.6	675.1	838.4	19.7	758.8	762.5	14818.0	4642.1	NA	6185.2	NA	NA	998.1	11825.4
1984	13752.2	556.1	741.0	17.7	955.6	966.5	16433.0	4444.3	NA	7150.0	NA	NA	1134.9	12729.2
1985	13062.9	441.1	604.9	31.6	949.3	857.3	15506.0	4446.8	NA	7101.8	NA	NA	1102.8	12651.4
1986	12992.6	455.2	560.7	31.3	918.8	703.6	15207.0	4496.0	NA	7199.5	NA	NA	1118.7	12814.2
1987	13098.9	434.2	497.0	21.4	1022.3	709.4	15349.0	4535.7	NA	7528.5	NA	NA	1112.5	13176.7
1988	13855.1	407.5	280.0	20.3	1078.7	798.9	16033.0	4731.5	NA	8202.2	NA	NA	1166.1	14099.8

YEAR	ELECTRICITY							GAS						
	INDUSTRY		TRANSPORT	AGRICULTURE	RESIDENTIAL	OTHER	TOTAL	INDUSTRY		TRANSPORT	AGRICULTURE	RESIDENTIAL	OTHER	TOTAL
	TOTAL	MINING						TOTAL	MINING					
1971	2798.0	1191.0	282.0	51.7	696.0	180.5	4008.2	133.0	0.0	0.0	0.0	4.1	1.4	138.5
1972	2853.0	1197.1	239.3	54.8	721.4	534.9	4403.4	133.0	0.0	0.0	0.0	4.1	1.4	138.5
1973	3057.9	1305.5	249.1	59.8	796.8	578.0	4741.6	144.5	0.0	0.0	0.0	4.1	1.4	150.0
1974	3275.1	1401.2	267.2	65.3	839.9	668.4	5115.9	169.9	0.0	0.0	0.0	4.3	1.8	176.0
1975	3596.2	1439.6	271.7	71.4	859.2	689.1	5487.6	224.4	0.0	0.0	0.0	5.2	1.8	231.4
1976	3899.7	1542.3	288.6	77.2	900.8	756.9	5923.2	227.0	0.0	0.0	0.0	4.9	1.7	233.6
1977	4090.5	1651.0	304.3	84.6	972.0	801.3	6252.7	218.1	0.0	0.0	0.0	4.1	1.6	223.8
1978	4547.3	1818.1	302.5	88.6	1007.7	778.2	6724.3	223.5	0.0	0.0	0.0	4.3	1.7	229.5
1979	5050.7	1956.7	320.8	92.6	1060.4	846.4	7370.9	275.9	0.0	0.0	0.0	5.8	2.3	284.0
1980	5396.8	2103.2	371.8	139.4	1162.9	888.2	7959.1	310.4	0.0	0.0	0.0	8.1	2.9	321.4
1981	5656.3	2202.4	400.1	151.1	1267.5	963.5	8438.5	301.4	0.0	0.0	0.0	7.5	2.9	311.8
1982	5779.8	2208.6	419.9	166.6	1257.1	973.8	8597.2	275.3	0.0	0.0	0.0	6.4	2.3	284.0
1983	5985.4	2233.9	373.2	176.4	1246.1	1048.5	8829.6	310.1	0.0	0.0	0.0	8.4	3.1	321.6
1984	6654.3	2376.4	395.2	197.4	1349.9	1073.9	9670.7	311.9	0.0	0.0	0.0	8.4	3.1	323.4
1985	6984.7	2512.4	394.5	229.2	1410.0	1097.4	10115.8	293.9	0.0	0.0	0.0	7.8	3.0	304.7
1986	7326.4	2563.5	387.1	246.2	1517.7	1168.5	10645.9	291.6	0.0	0.0	0.0	8.4	2.3	302.3
1987	7535.8	2647.5	348.2	243.6	1606.1	1220.9	10954.6	284.9	0.0	0.0	0.0	8.4	2.4	295.7
1988	7771.3	2756.3	354.3	272.0	1684.0	1328.5	11410.1	287.0	0.0	0.0	0.0	8.6	2.7	298.3

** INCLUDES CONSUMPTION OF OIL BY THE RESIDENTIAL AND AGRICULTURAL SECTORS

TABLE D CONTINUED

000'S TOE

YEAR	TOTAL						TOTAL
	INDUSTRY		TRANSPORT	AGRICULTURE*	RESIDENTIAL*	OTHER**	
	TOTAL	MINING					
1971	17244.0	2149.0	9123.0	135.7	1334.1	1836.3	29673.1
1972	16672.3	2088.3	8388.1	137.5	1365.1	2395.9	28958.9
1973	17385.5	2040.1	9025.5	143.3	1442.9	2466.4	30463.6
1974	18013.6	2162.8	8511.9	152.0	1501.5	2563.5	30742.5
1975	19414.4	1933.7	8592.1	167.9	1551.6	2676.5	32402.5
1976	20875.0	2092.1	7937.9	174.9	1631.6	2698.0	33317.4
1977	21040.9	2488.6	7647.1	153.4	1648.4	2547.3	33037.1
1978	21432.6	2556.6	7581.7	139.1	1725.0	2567.8	33446.2
1979	21138.9	2504.8	7004.3	141.7	1757.7	2526.5	32569.1
1980	22303.1	2707.0	7088.8	199.1	1990.5	2608.0	34189.5
1981	23806.3	2932.3	7895.9	192.6	2218.0	2943.9	37056.7
1982	23761.3	2780.0	7801.0	190.0	2169.3	2799.5	36721.1
1983	23376.2	2909.0	7396.8	196.1	2013.3	2812.2	35794.6
1984	25162.7	2932.5	8286.2	215.1	2313.9	3178.4	39156.3
1985	24788.3	2953.5	8101.2	260.8	2367.1	3060.5	38577.9
1986	25106.6	3018.7	8147.3	277.5	2444.9	2993.1	38969.4
1987	25455.3	3081.7	8373.7	265.0	2636.8	3045.2	39776.0
1988	26644.9	3163.8	8836.5	292.3	2771.3	3296.2	41841.2
1989	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA

* EXCLUDES CONSUMPTION OF OIL

** INCLUDES CONSUMPTION OF OIL BY THE RESIDENTIAL AND AGRICULTURAL SECTORS

FIGURES

FIGURE 1. GROSS DOMESTIC PRODUCT
(FACTOR)

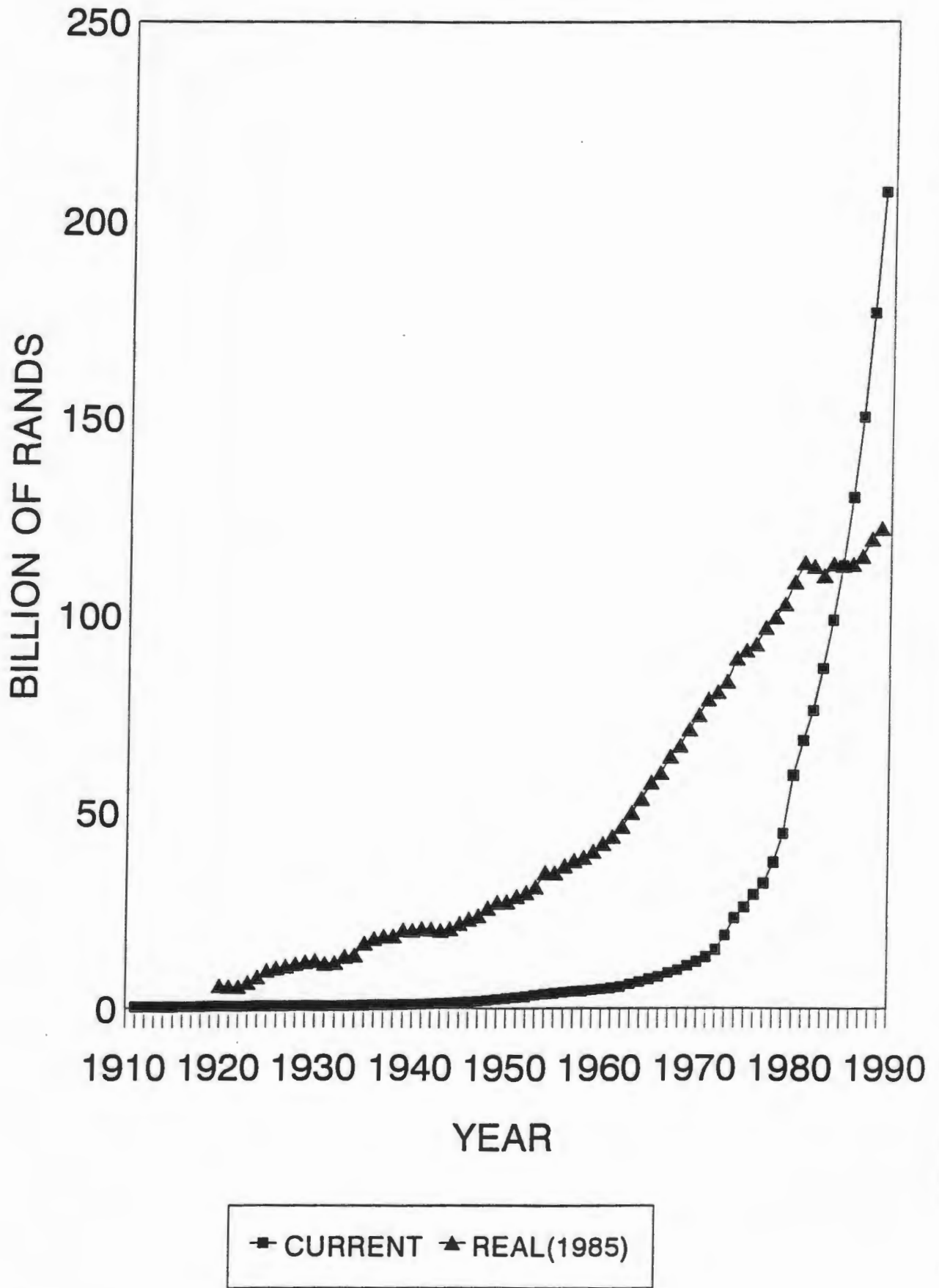


FIGURE 2 GROSS DOMESTIC PRODUCT GROWTH RATE PERCENT PER YEAR (REAL 1985 VALUES)

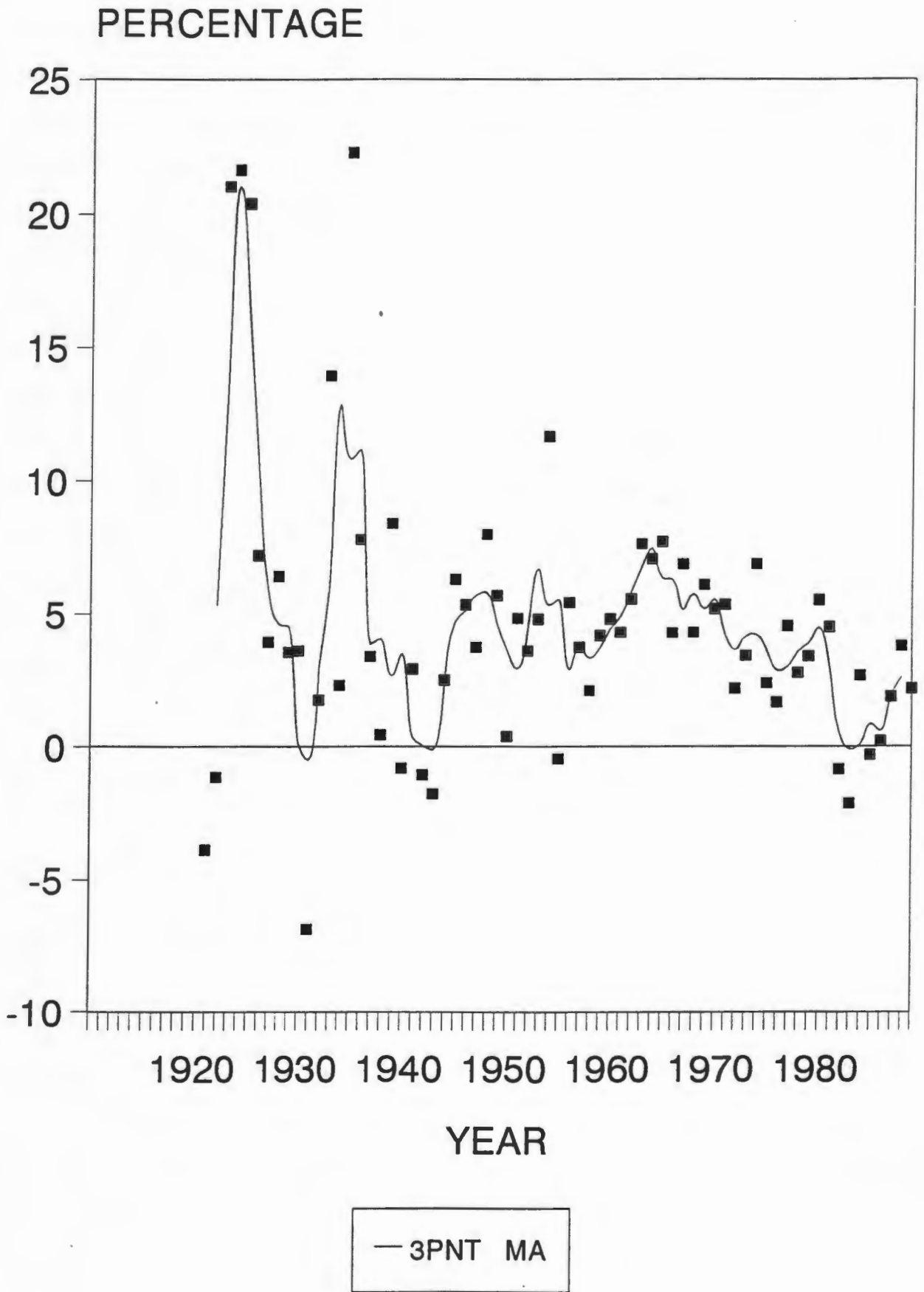


FIGURE 3. GDP PER CAPITA

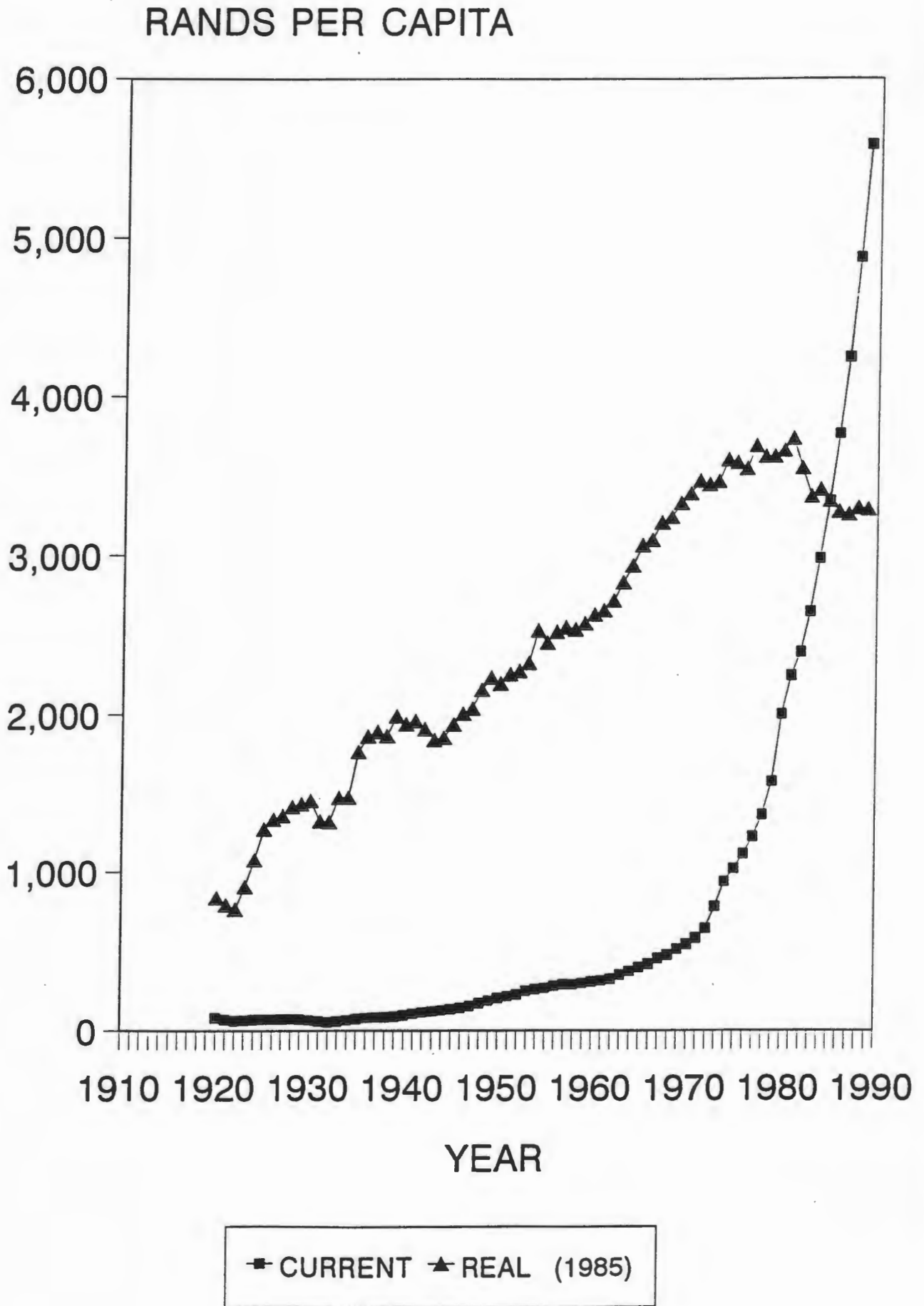
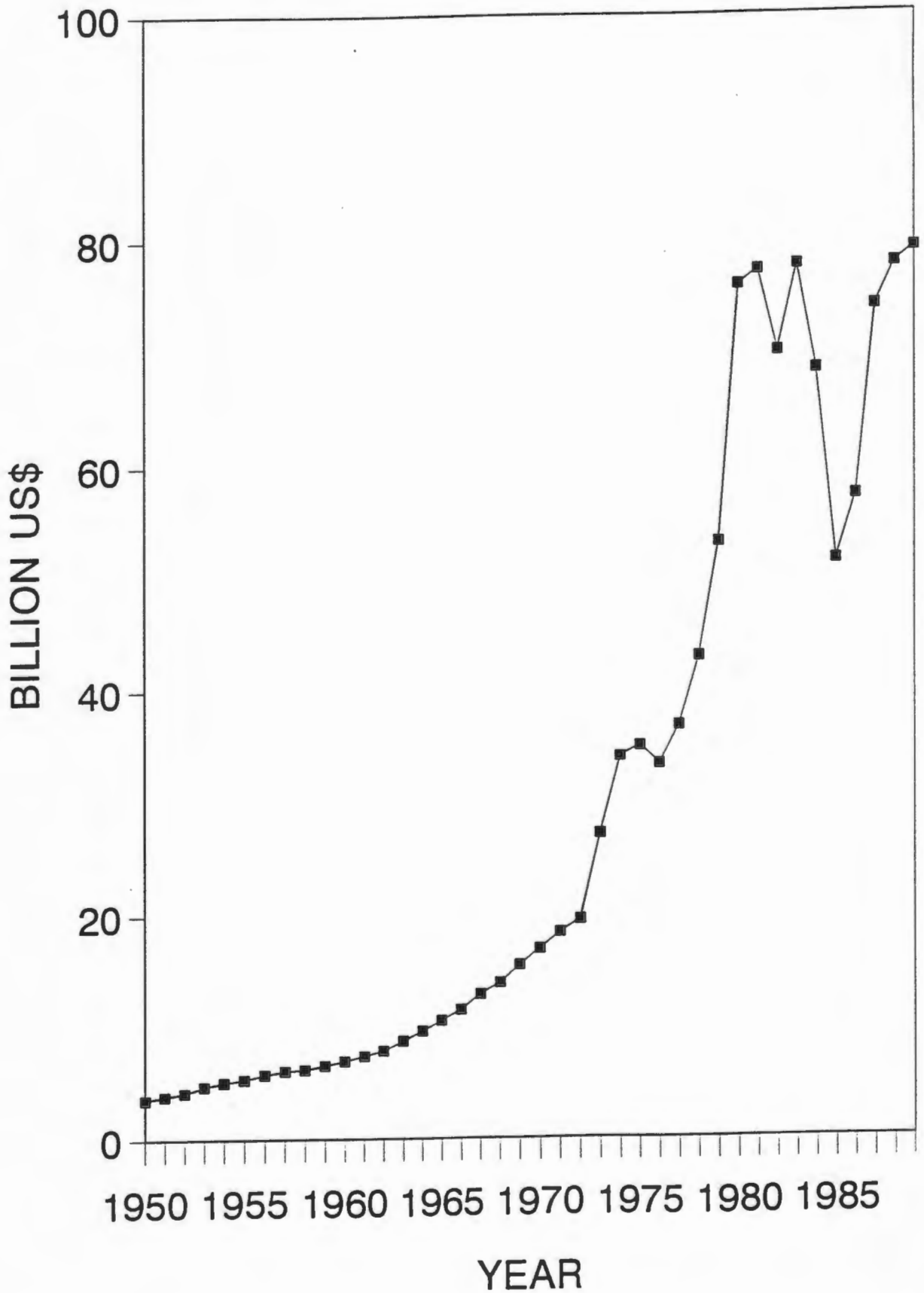


FIGURE 4. GDP IN US\$*



* CURRENT RANDS CONVERTED TO US\$ AT CURRENT EXCHANGE RATES

FIGURE 5. GDP PER CAPITA - US\$*

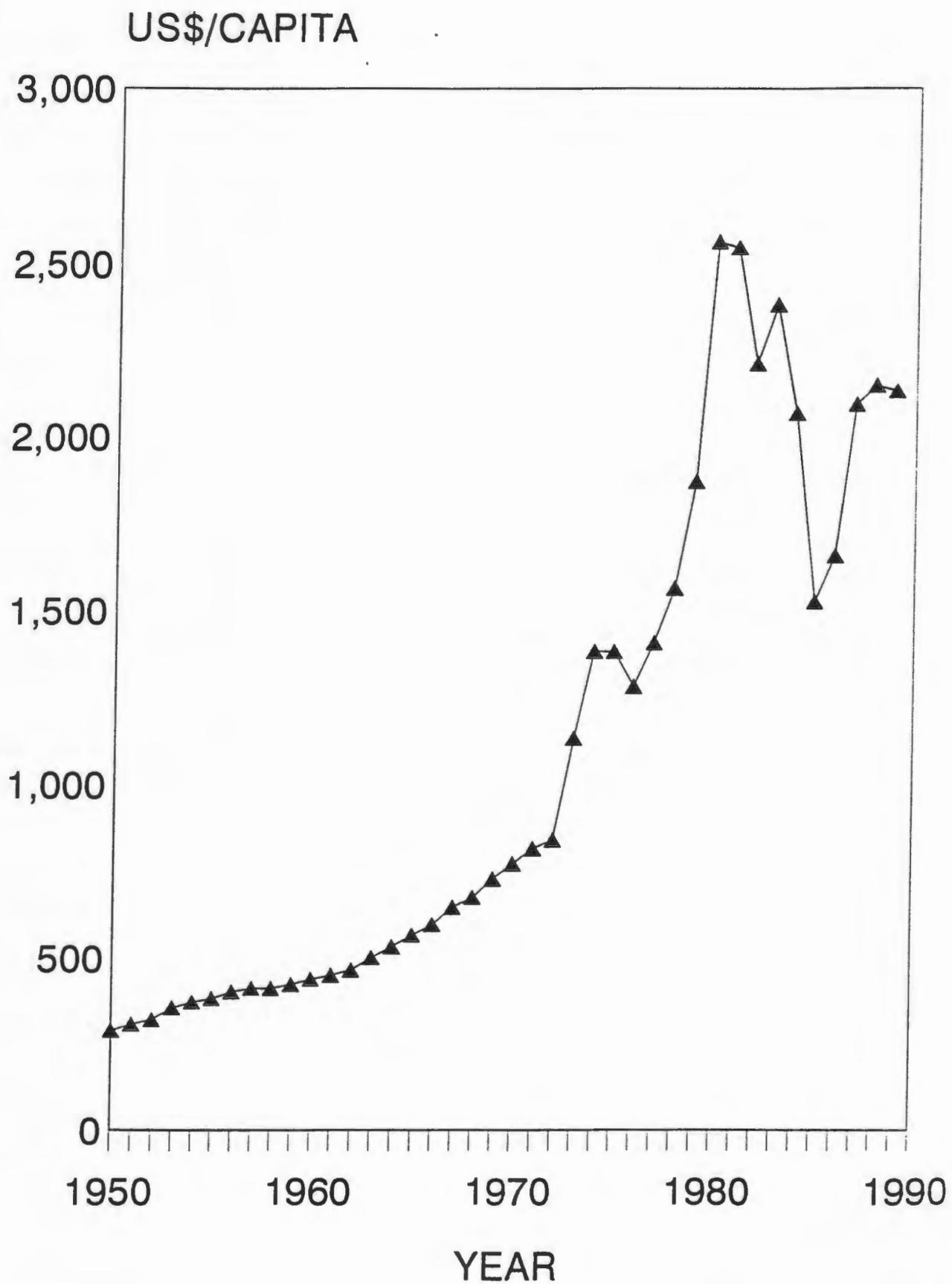


FIGURE 6 GDP COMPONENTS AS PERCENT OF TOTAL

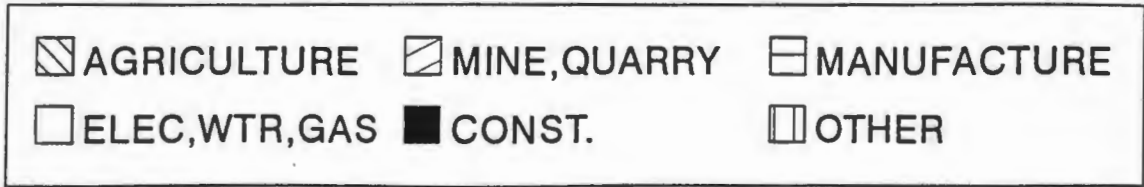
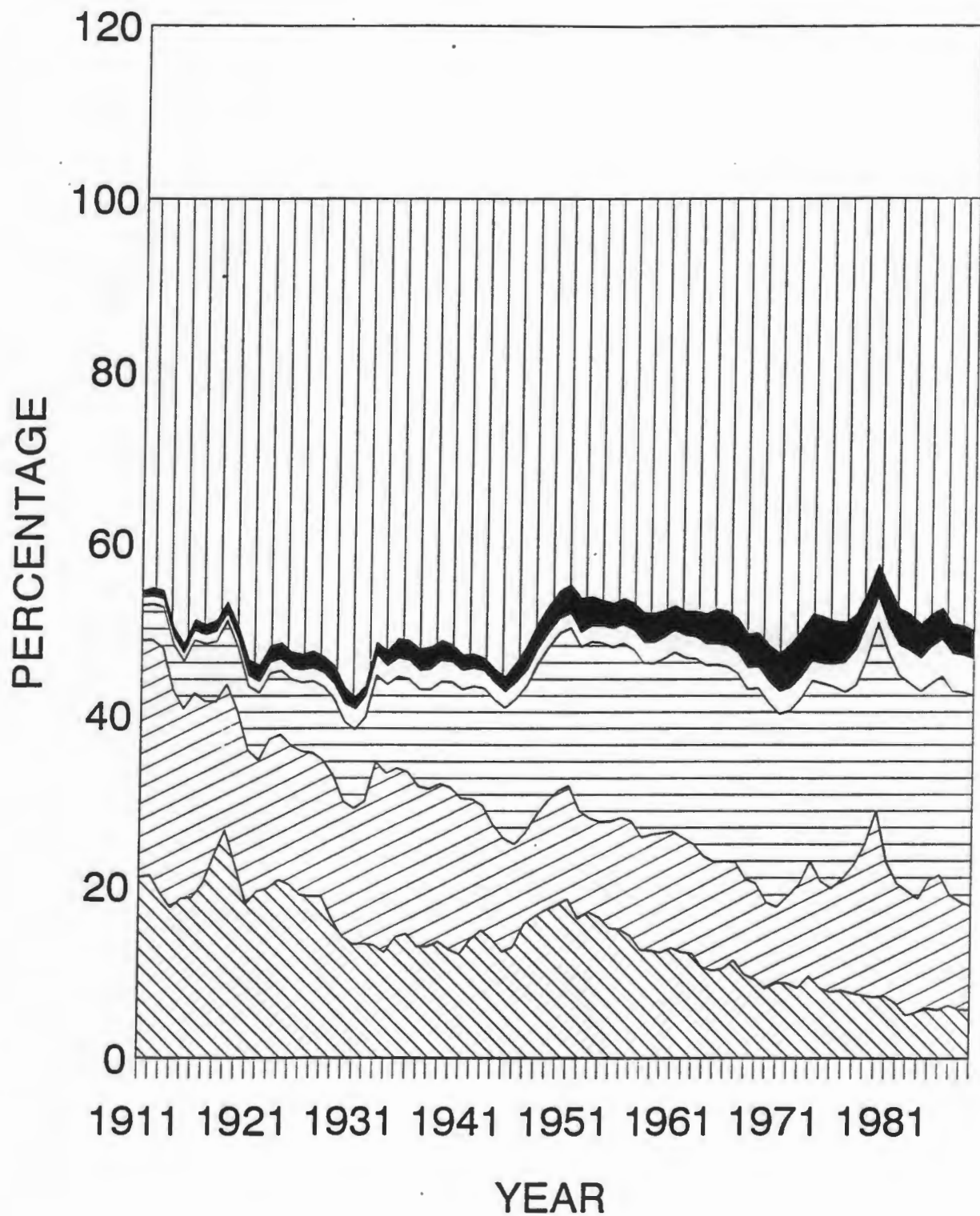


FIGURE 7 TOTAL FINAL CONSUMPTION OF COMMERCIAL ENERGY

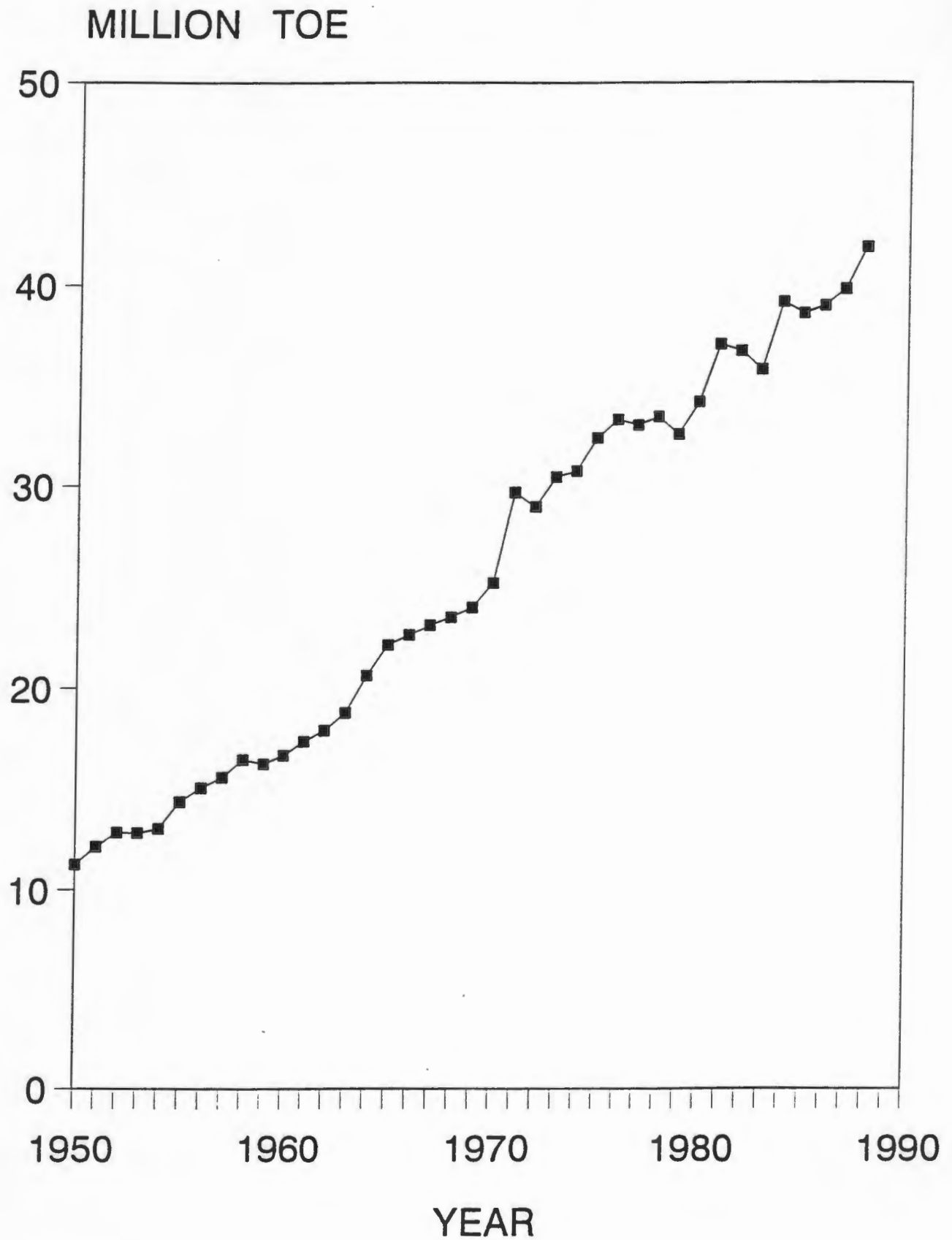
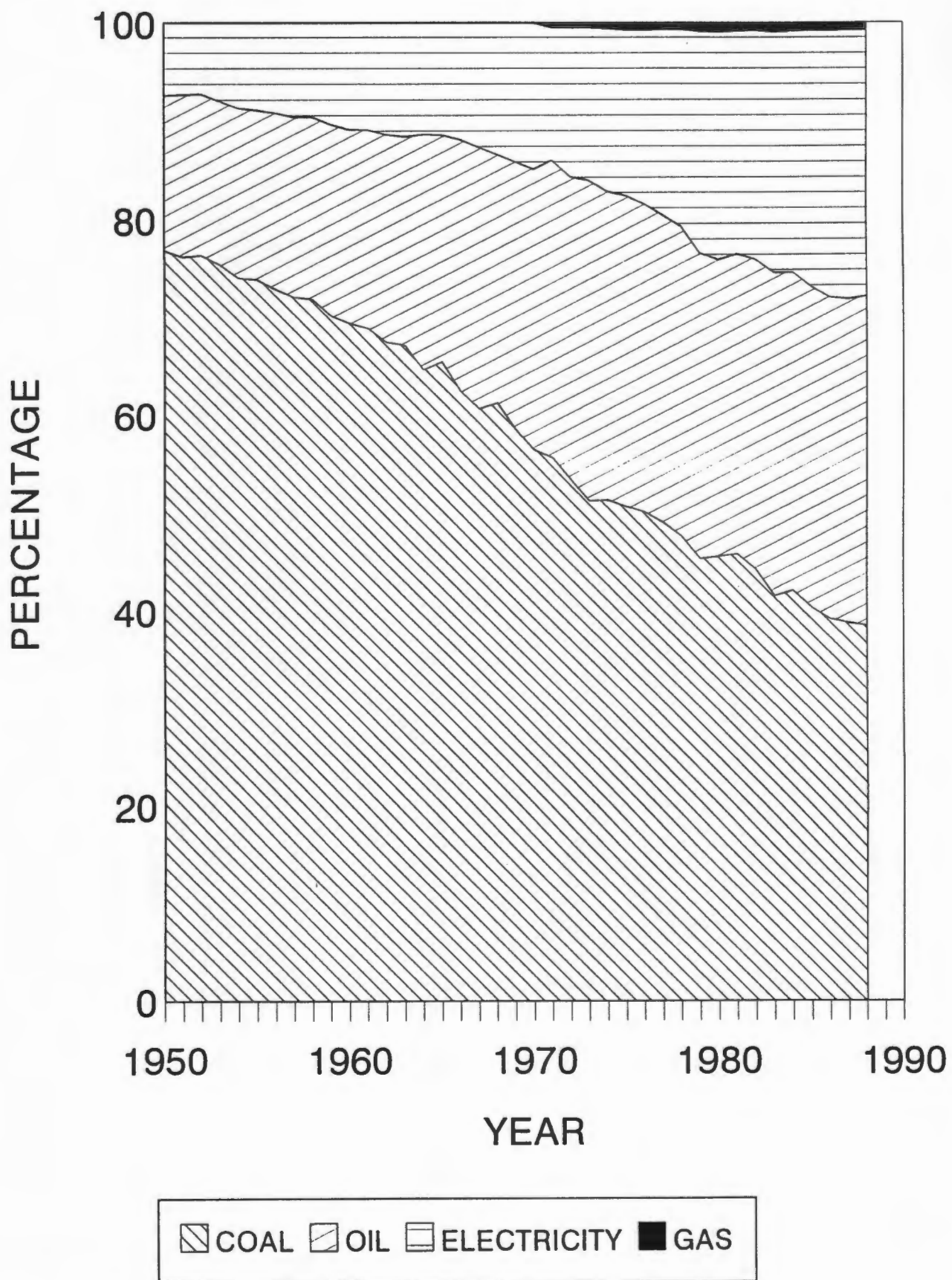
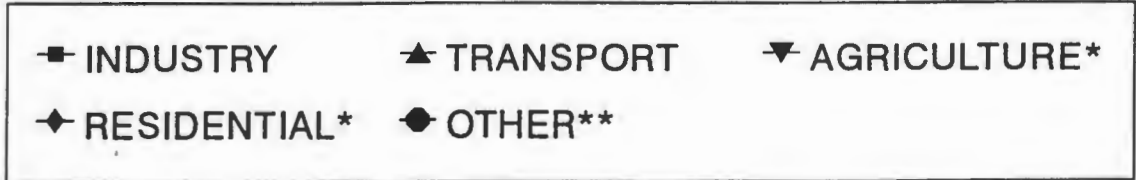
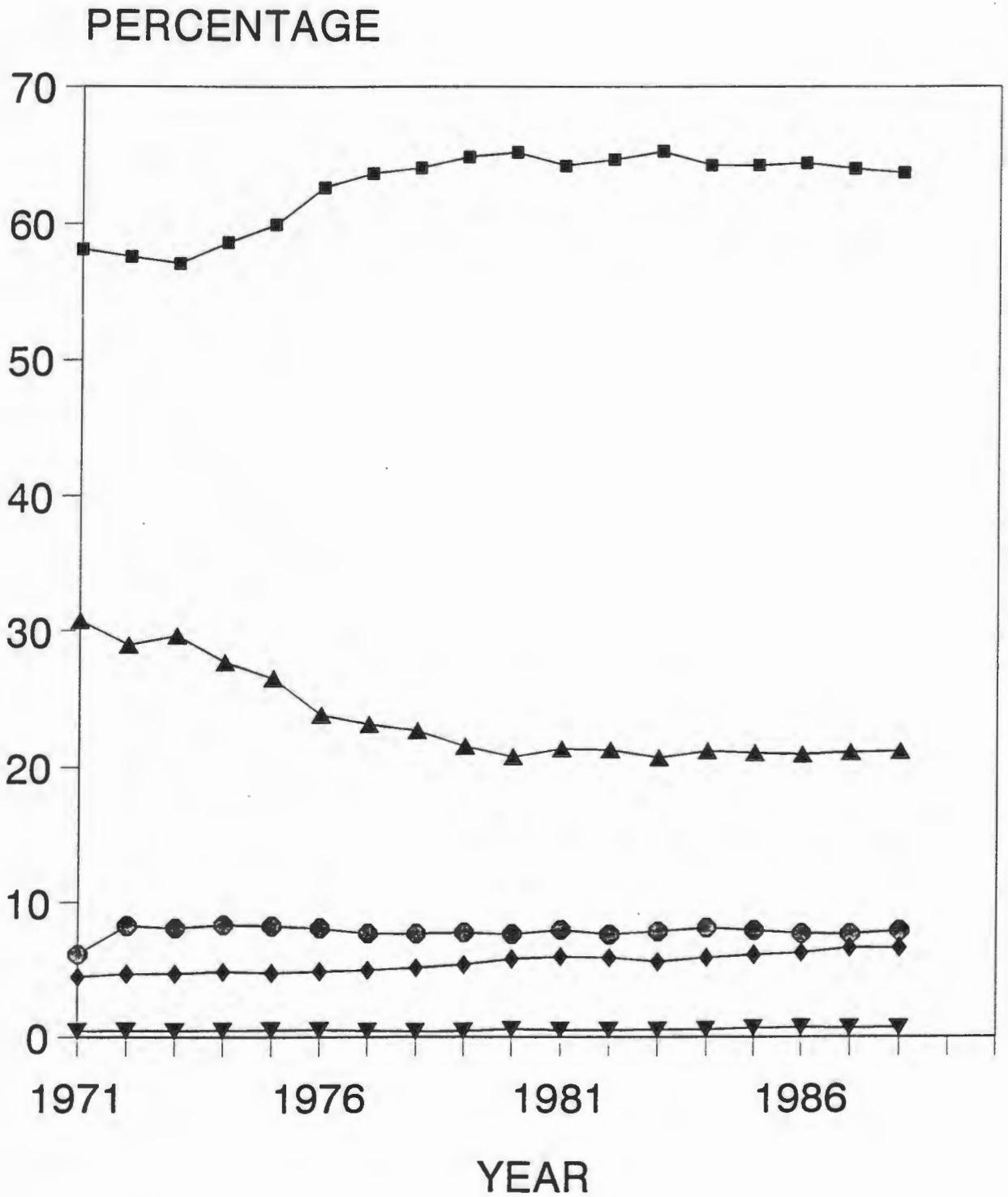


FIGURE 8 TFC OF COMMERCIAL ENERGY COMPONENTS AS A PERCENTAGE OF TOTAL



TFC - TOTAL FINAL CONSUMPTION
SA2/TFC20

FIGURE 9 TOTAL FINAL CONSUMPTION OF COMMERCIAL ENERGY
SECTORIAL BREAKDOWN (AS A PERCENTAGE OF TOTAL)



* EXCLUDES CONSUMPTION OF OIL

** INCLUDES CONSUMPTION OF OIL BY THE AGRICULTURAL AND RESIDENTIAL SECTORS

FIGURE 10 ENERGY PER CAPITA vs GDP PER CAPITA
(TRADITIONAL + COMMERCIAL ENERGY)

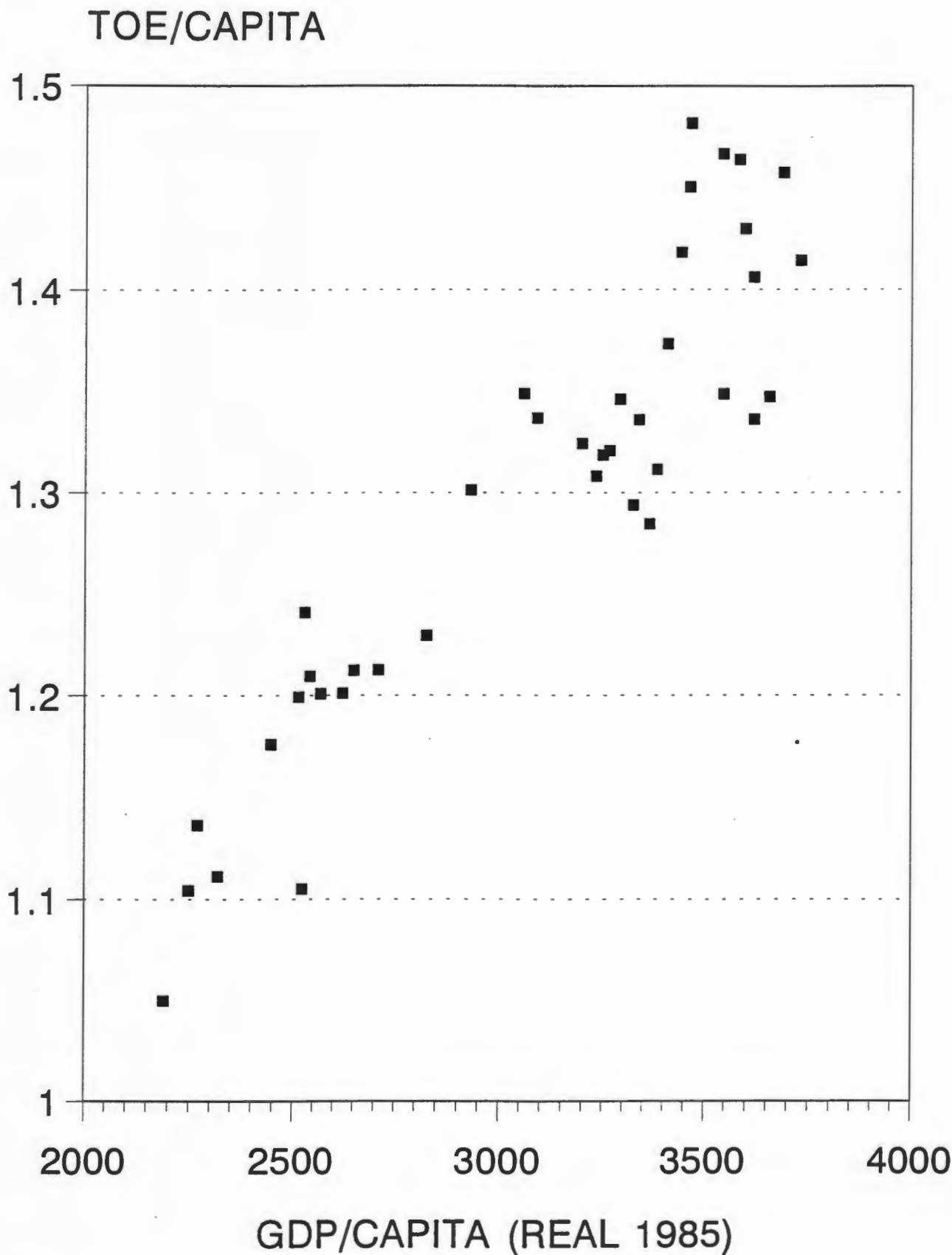
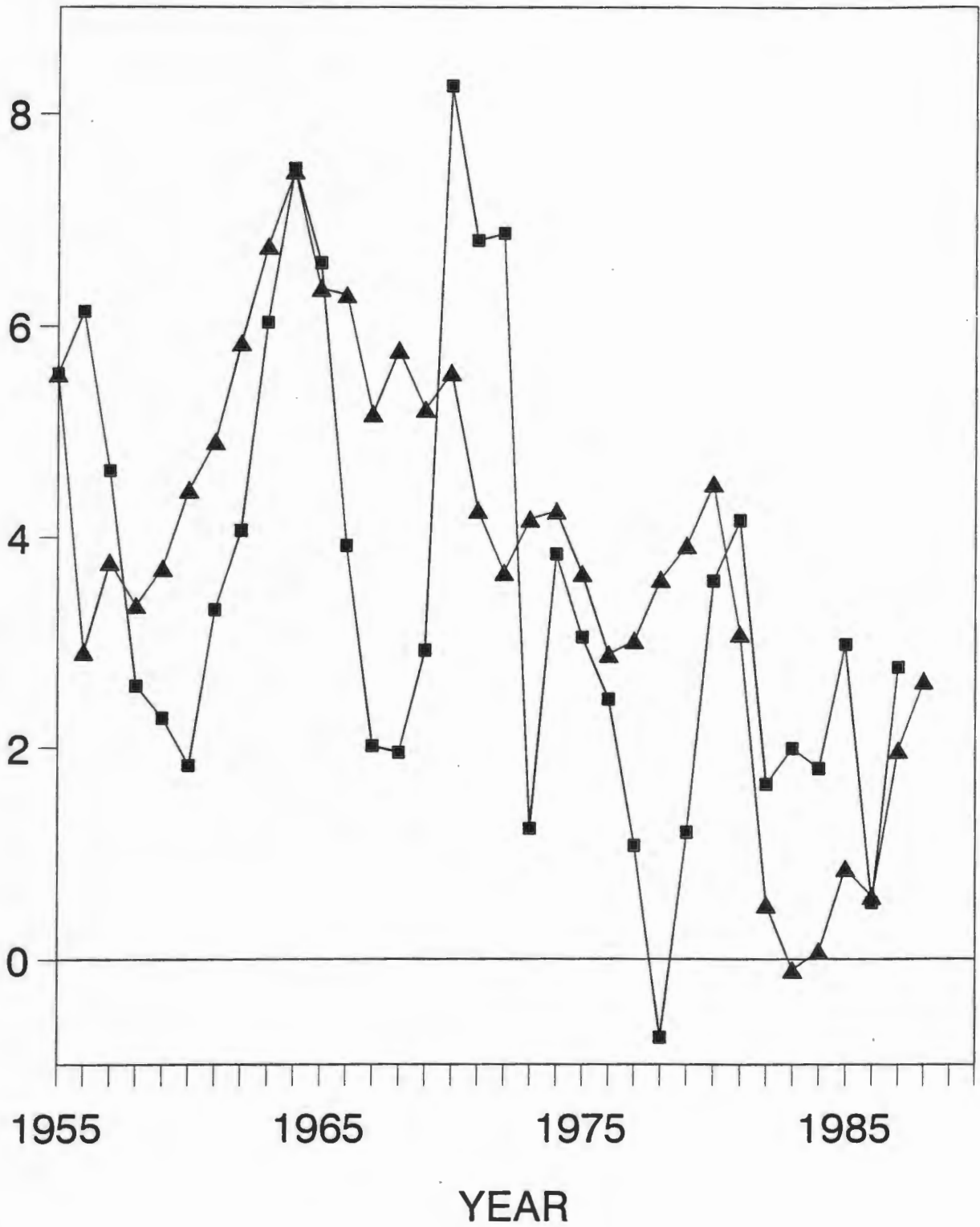


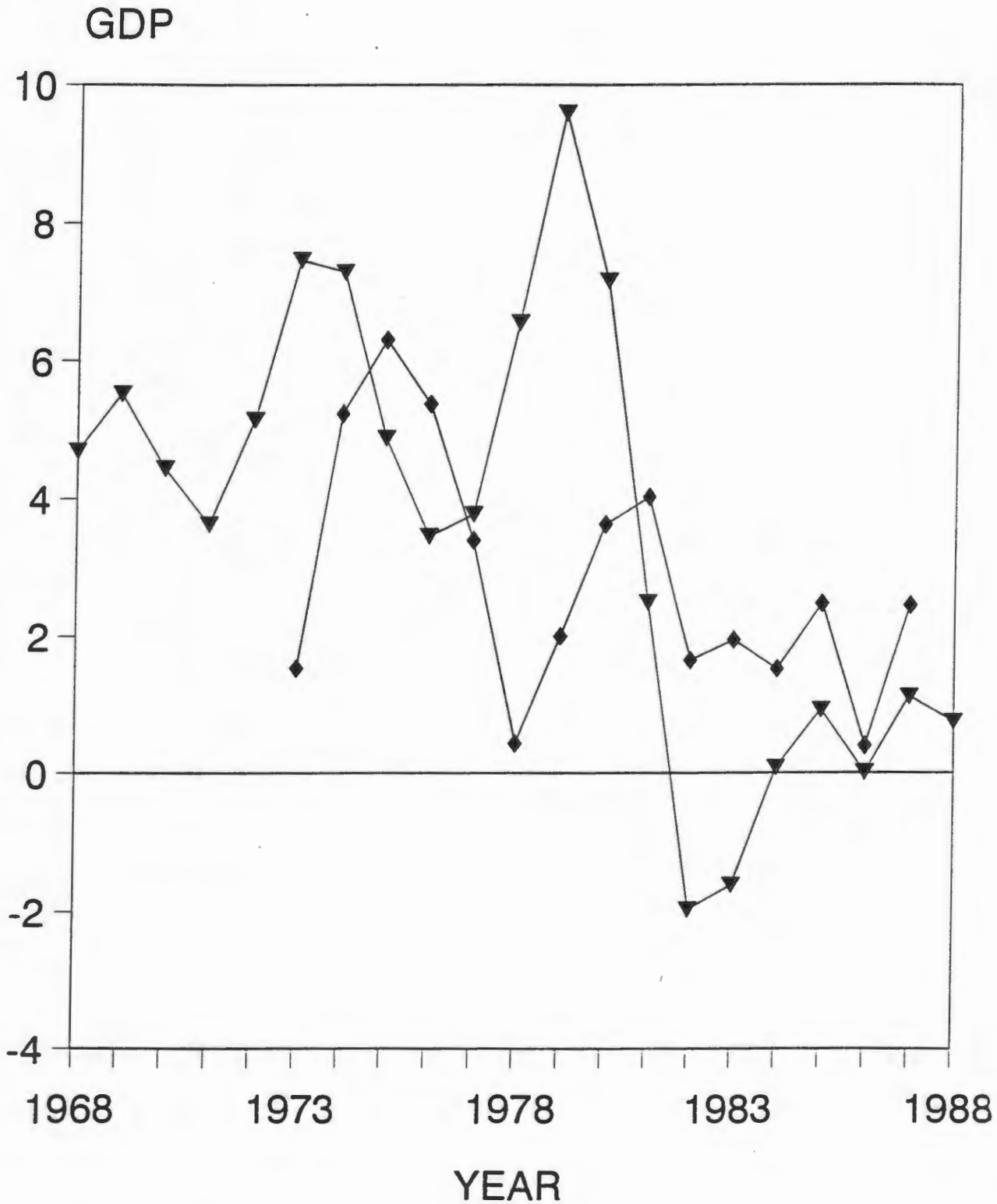
FIGURE 11 TOTAL FINAL CONSUMPTION OF COMMERCIAL ENERGY AND GDP GROWTH RATES (3 PT. M.A.)

GROWTH RATE, PERCENT PER ANNUM



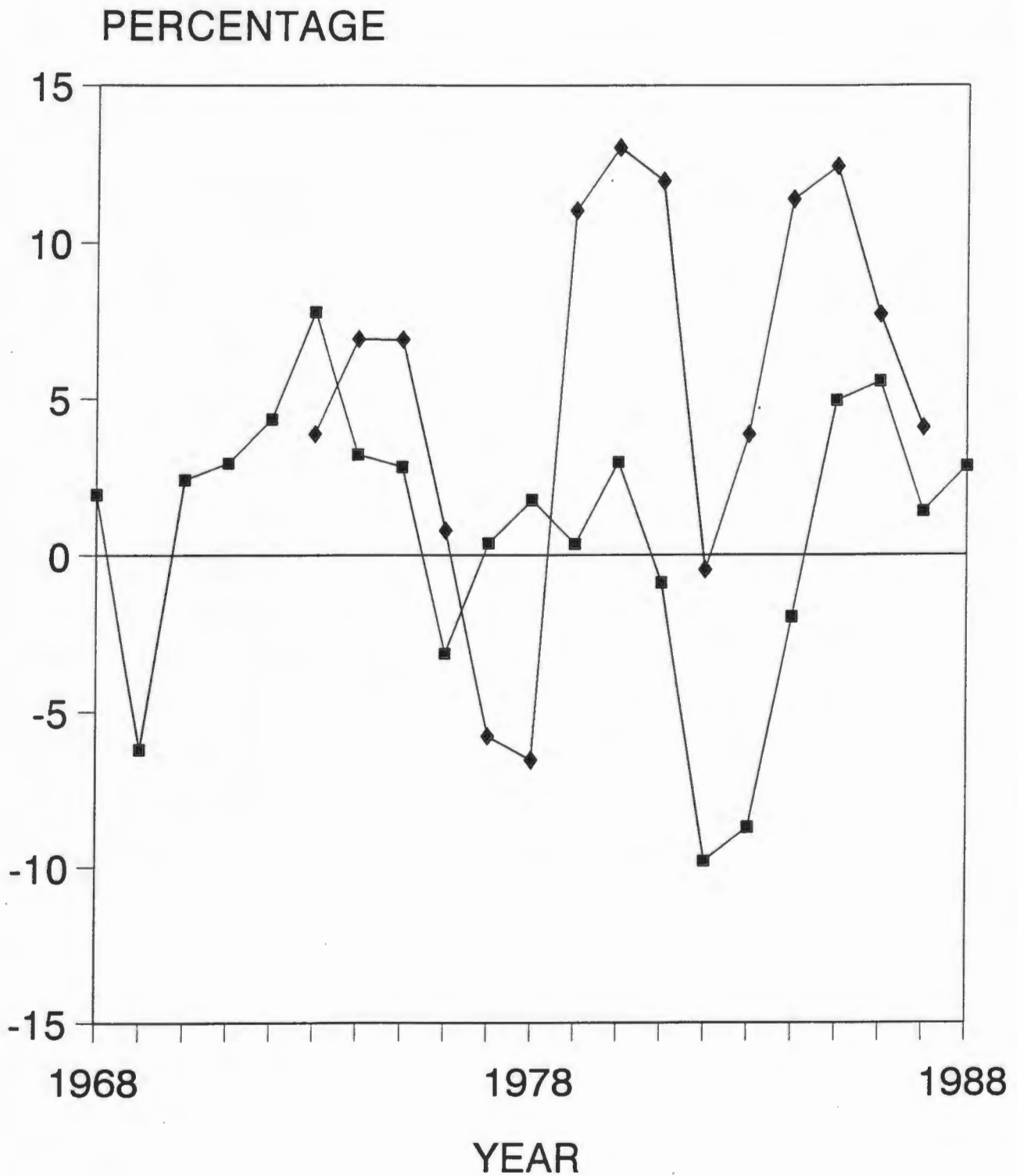
■ ENERGY CONSUMPTIO ▲ GDP

FIGURE 12 INDUSTRIAL SECTOR GROWTH RATES
PERCENTAGE (3 PT. M.A.)



▼ CONTRIBUTION TO GDP ◆ TFC OF ENERGY

FIGURE 13 AGRICULTURAL SECTOR GROWTH RATES
3 PT. M.A



■ CONTRIBUTION TO GDP ◆ TFC OF ENERGY **

TFC - TOTAL FINAL CONSUMPTION

** TFC OF ENERGY EXCLUDES CONSUMPTION OF OIL

CA2/CROWTH11

FIGURE 14 MINING SECTOR GROWTH RATES
3 PT. M.A (TFC EXCLUDES OIL CONSUMPTION)

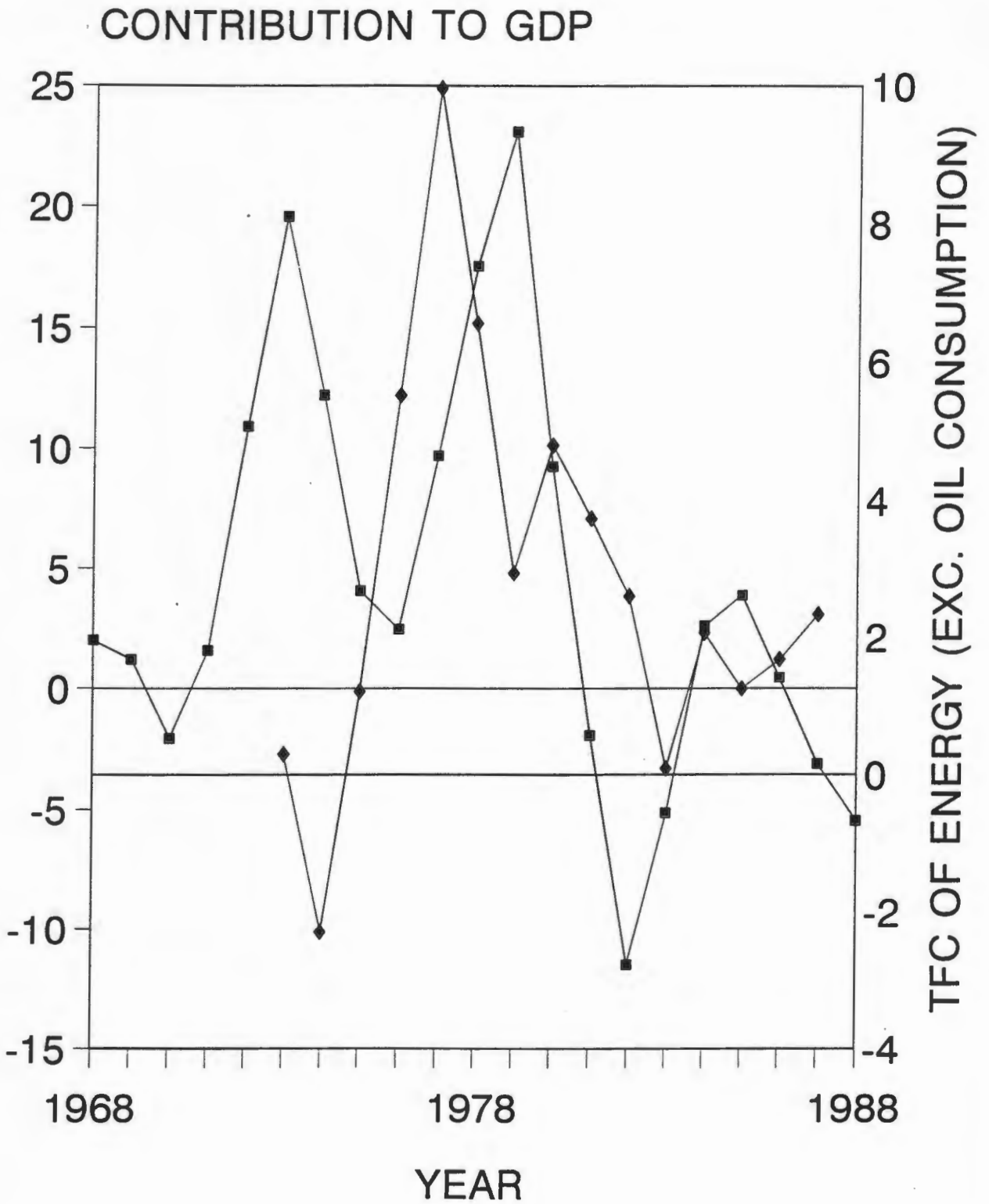


FIGURE 15 COMMERCIAL ENERGY INTENSITY
TOTAL FINAL CONSUMPTION OF ENERGY PER UNIT
REAL GDP (1985)

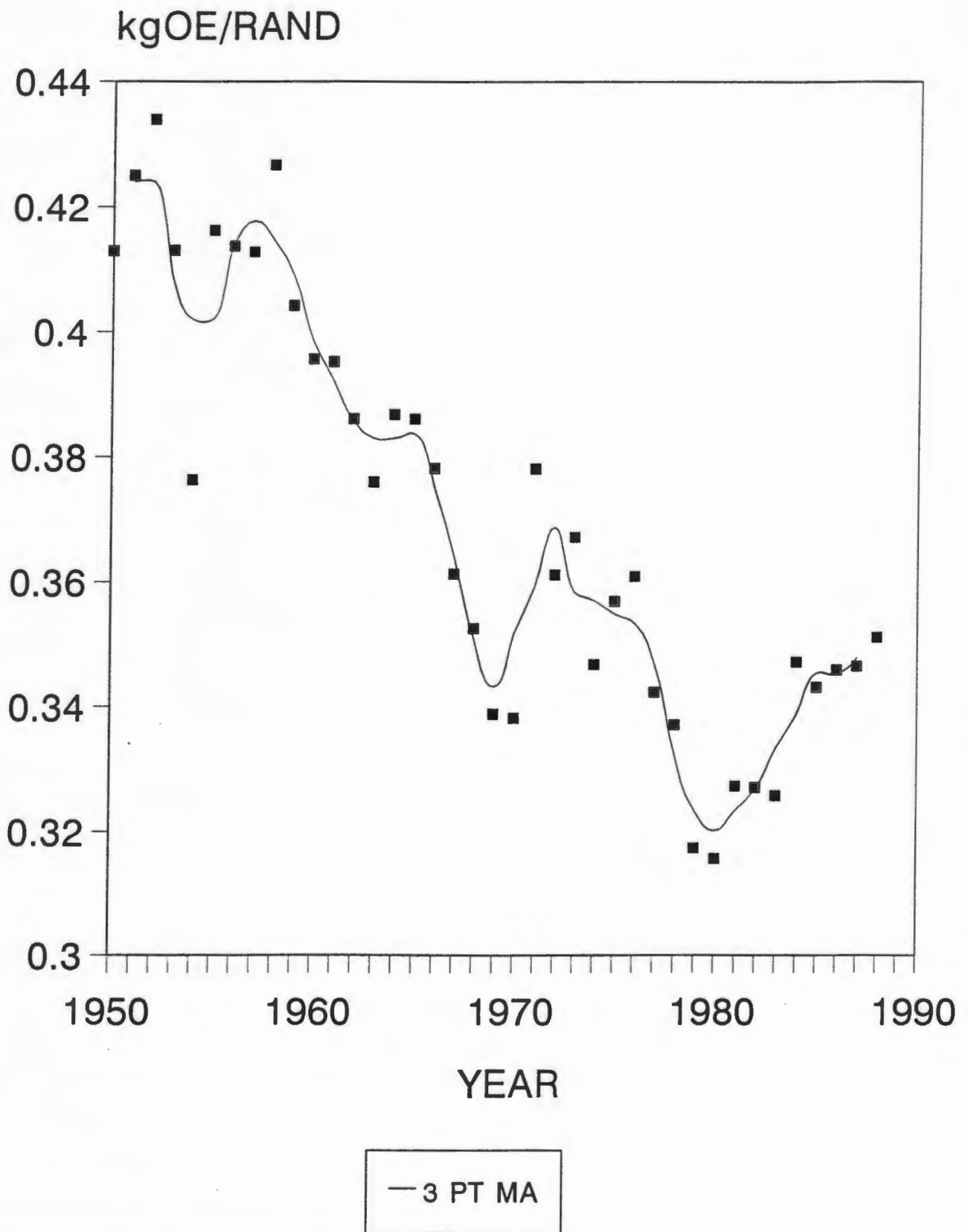


FIGURE 16 TOTAL FINAL CONSUMPTION OF ENERGY INTENSITY

kgOE PER UNIT REAL GDP (1985)

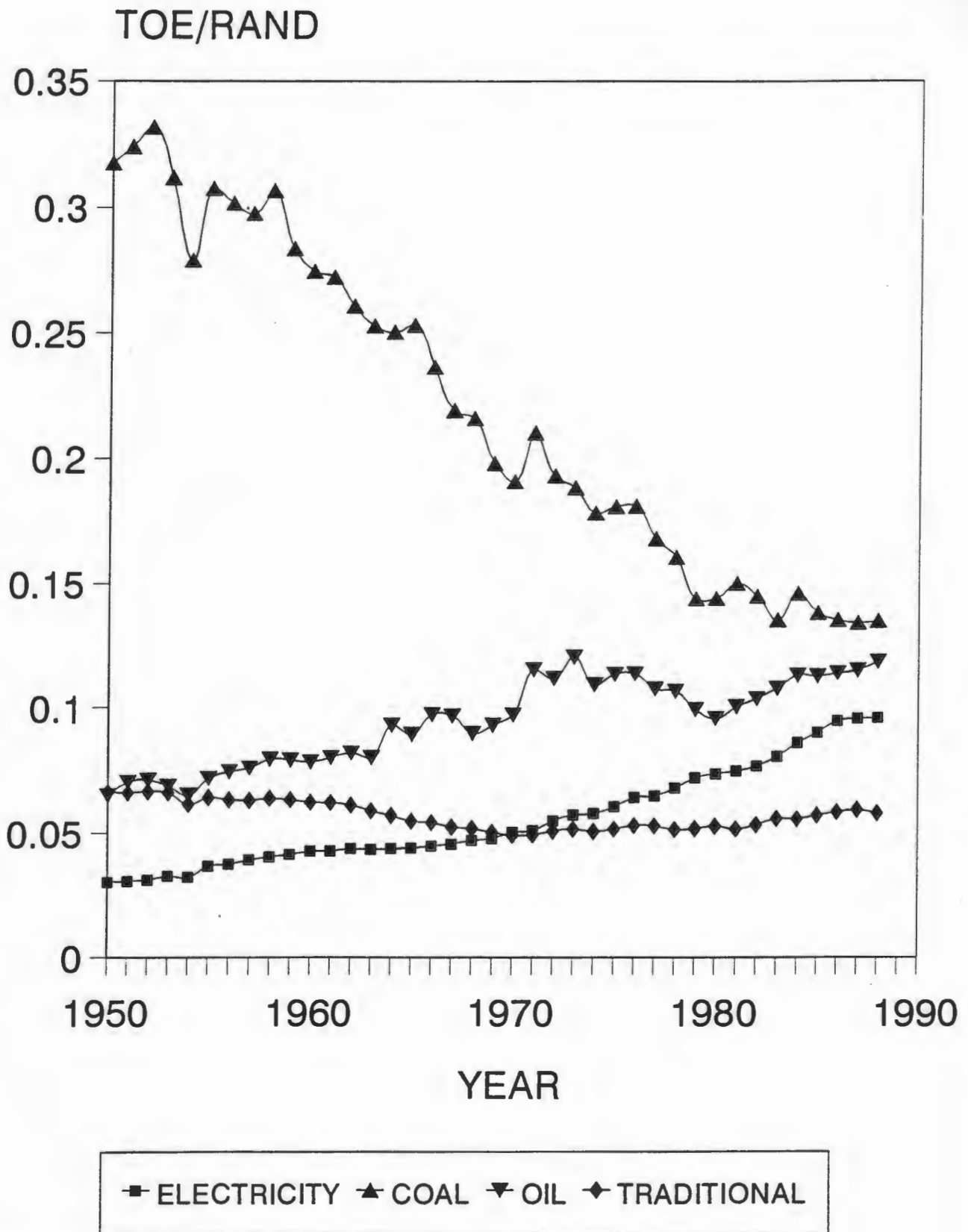
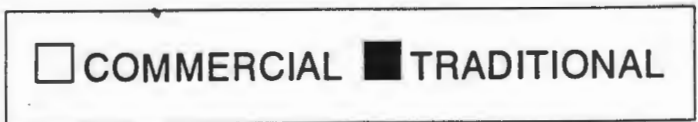
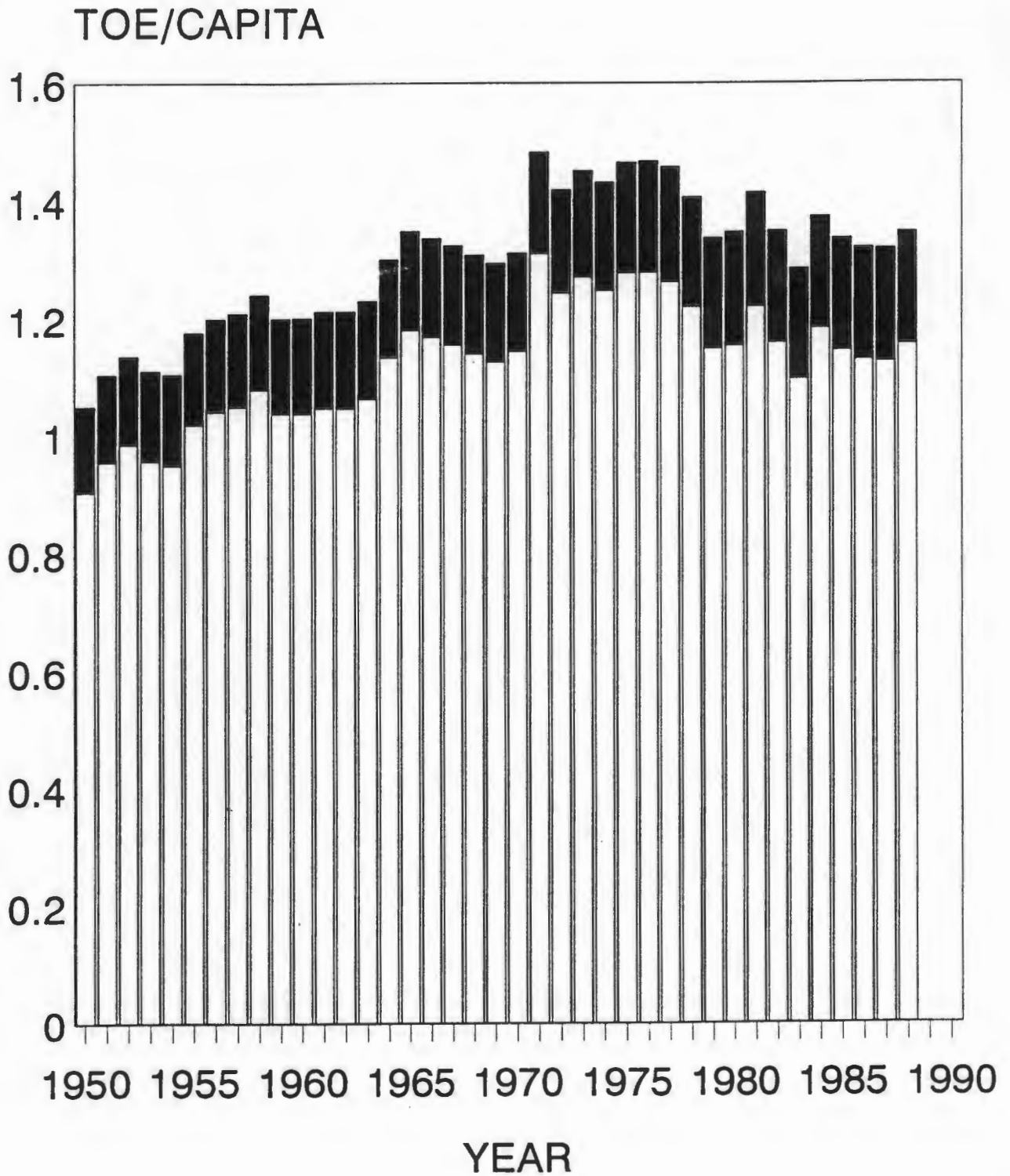


FIGURE 17 TFC OF ENERGY PER CAPITA
TOE PER CAPITA



TFC - TOTAL FINAL CONSUMPTION
TOE - TONS OIL EQUIVALENT

FIGURE 18 SASOL: COAL CONSUMPTION, OIL PRODUCTION, TRANSFORMATION EFFICIENCY.

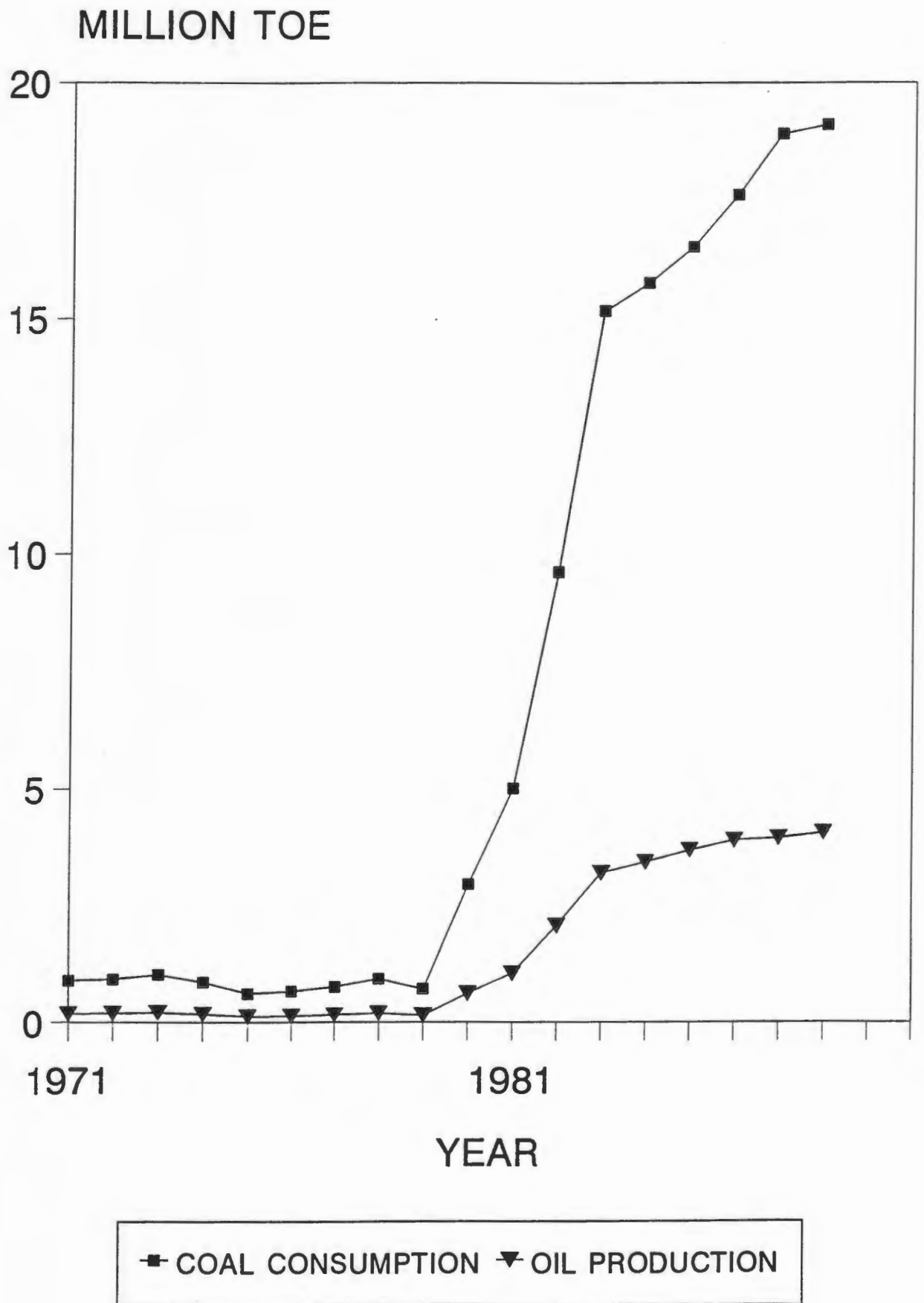


FIGURE 19 OIL TOTAL FINAL CONSUMPTION

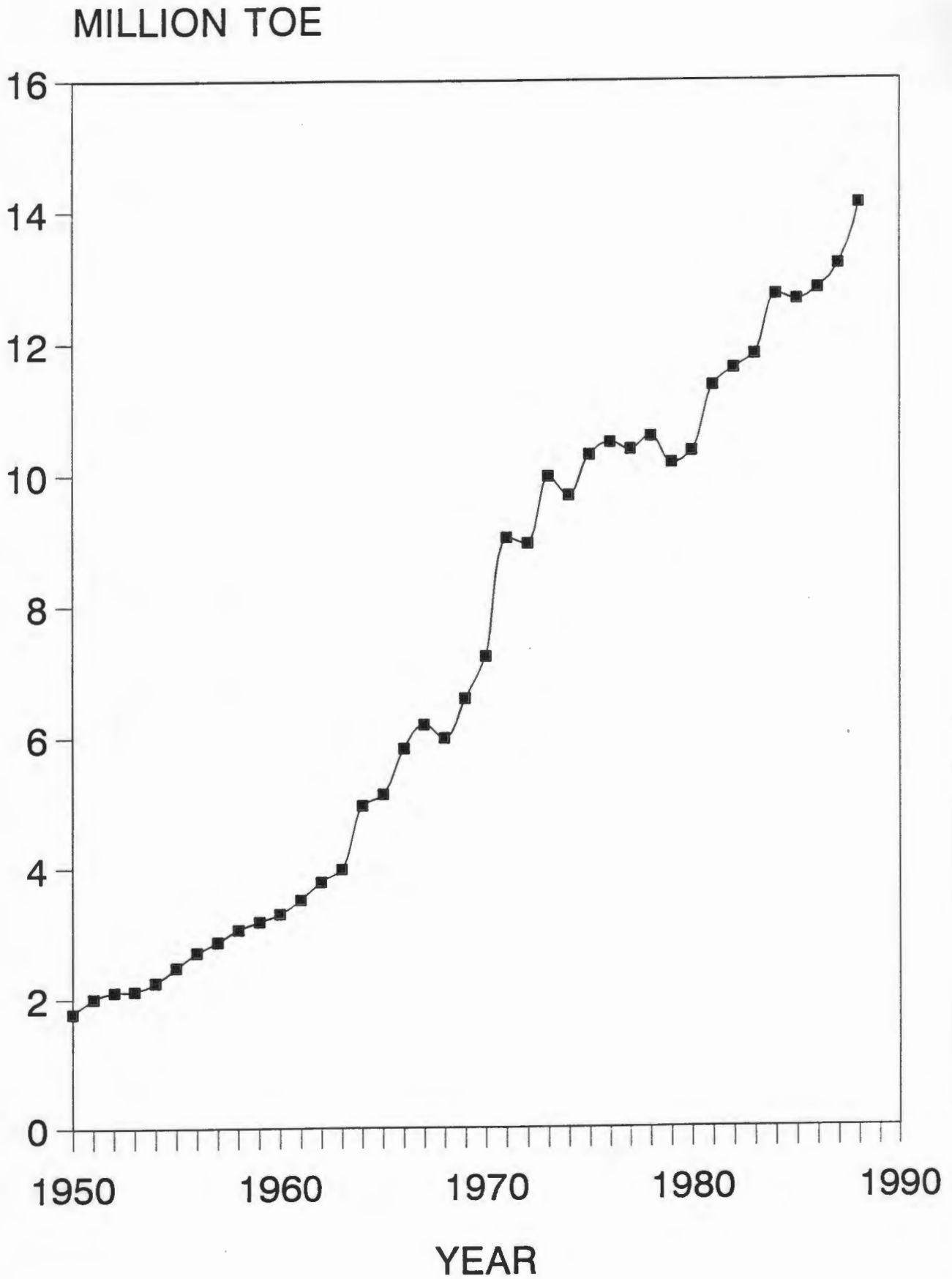


FIGURE 20 OIL PRODUCT CONSUMPTION BY TYPE

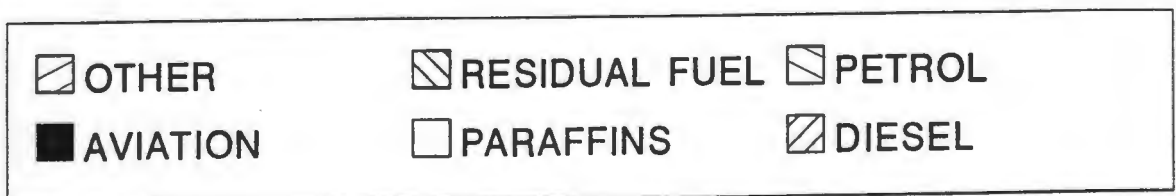
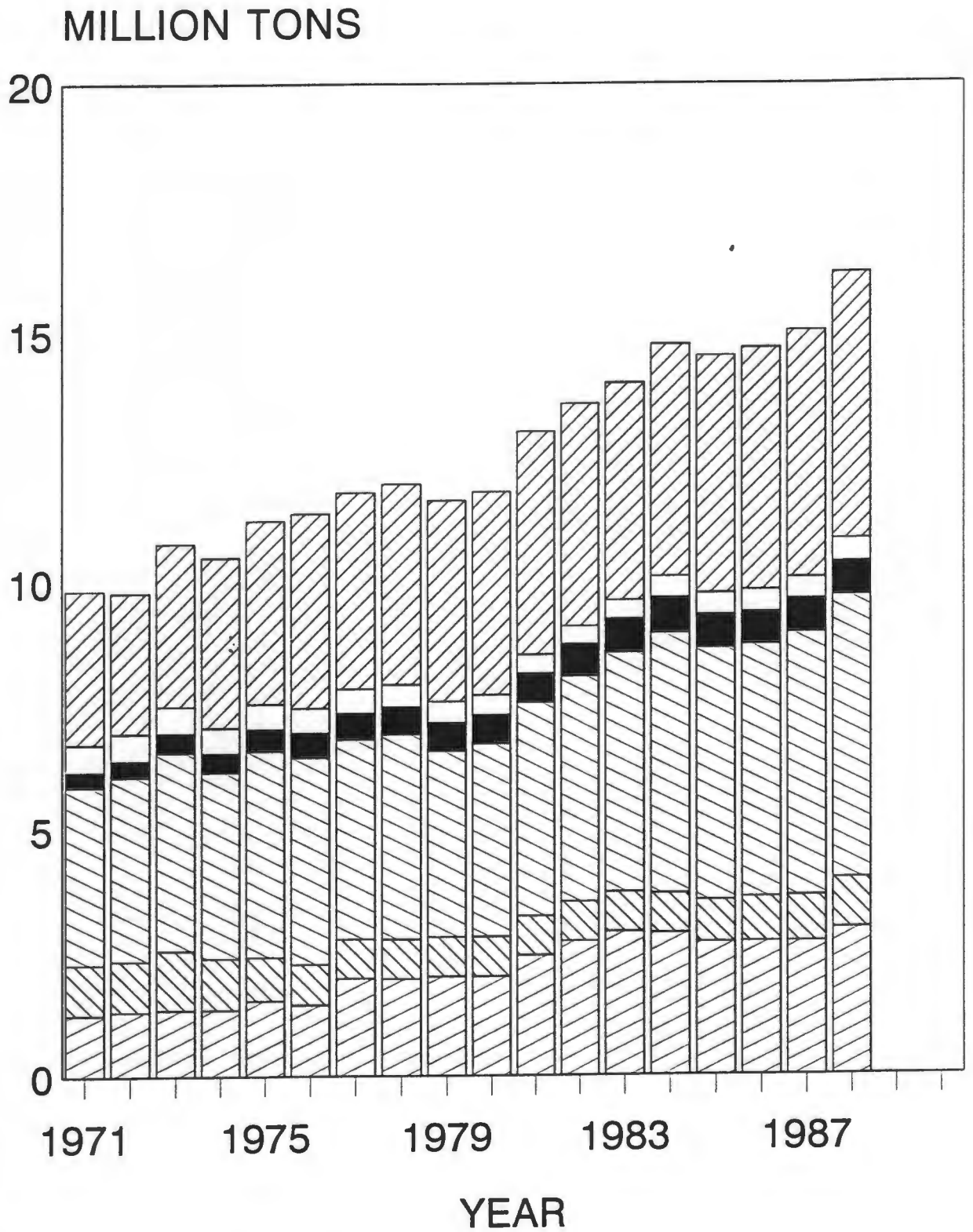


FIGURE 21 TFC OF OIL: SECTORIAL BREAKDOWN
(AS A PERCENTAGE OF TOTAL)

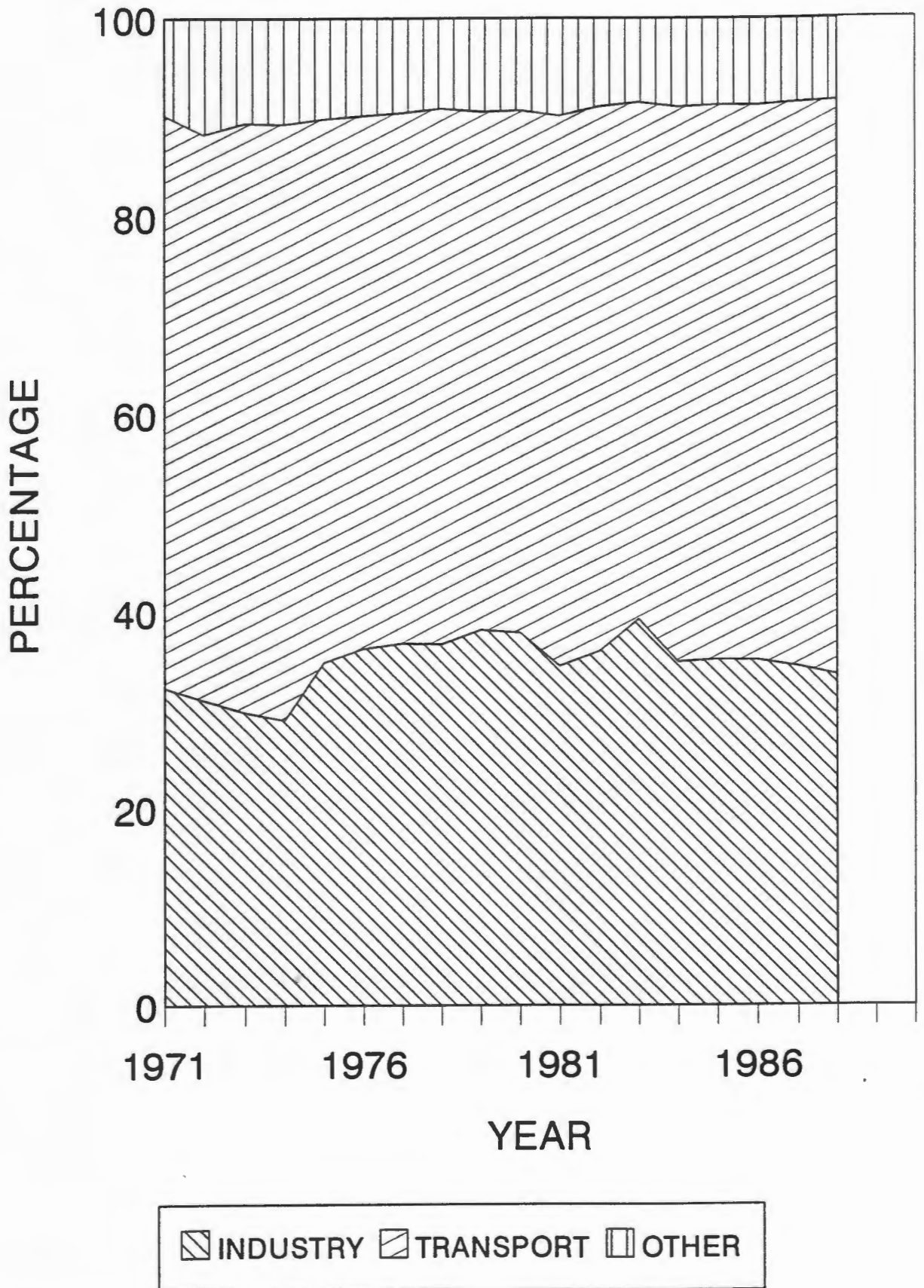


FIGURE 22 RATIO OF DIESEL TO PETROL

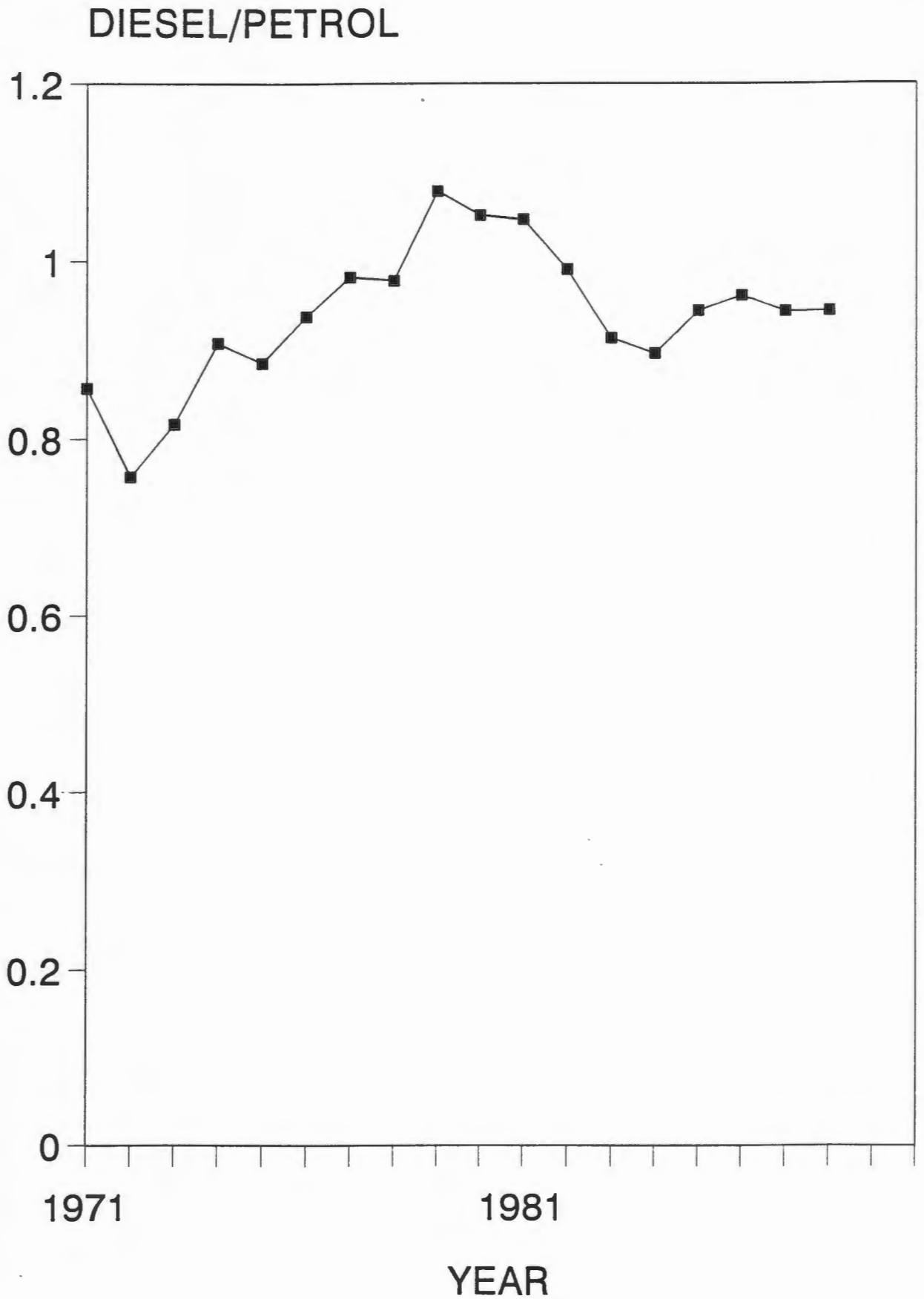
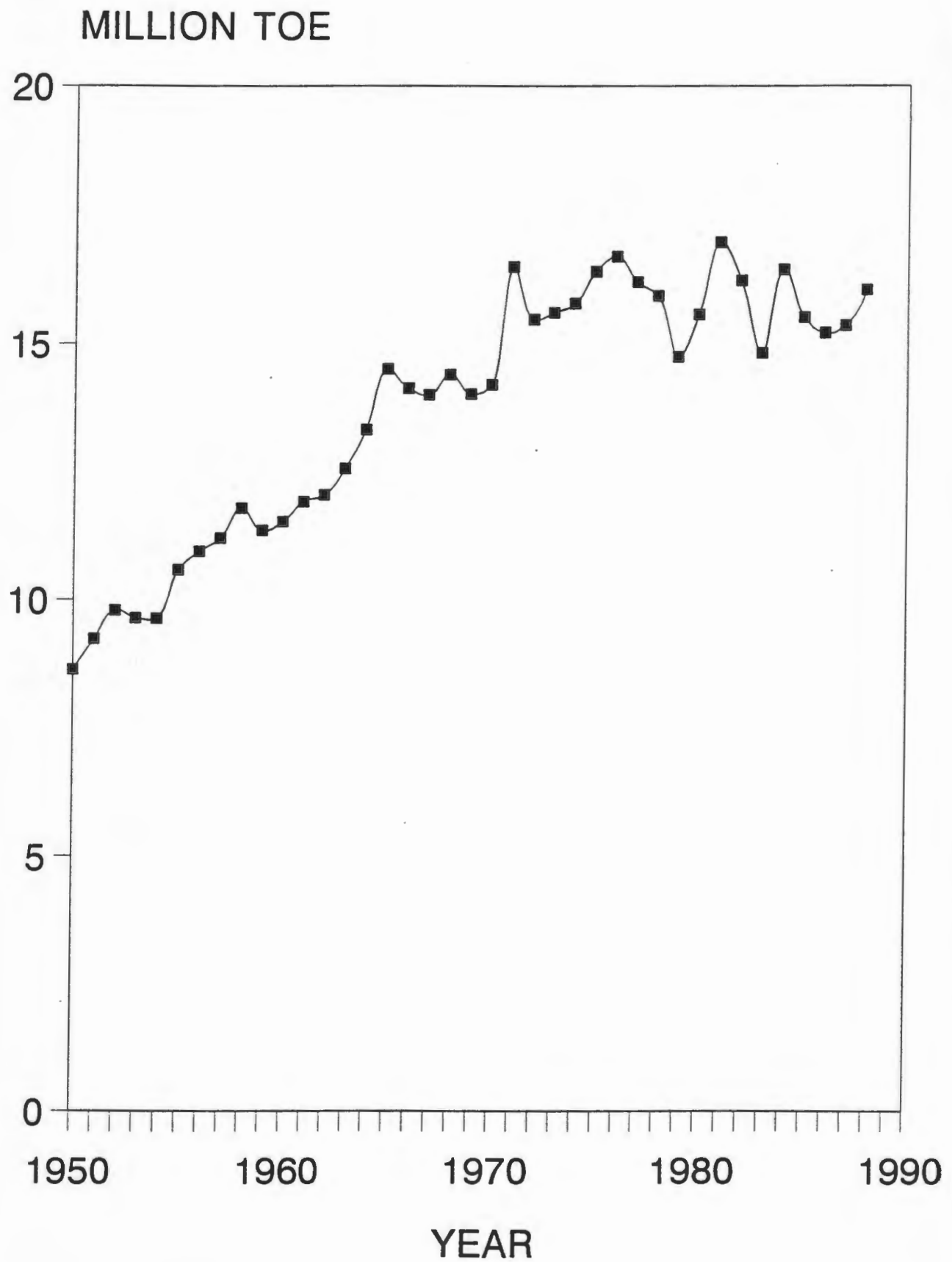
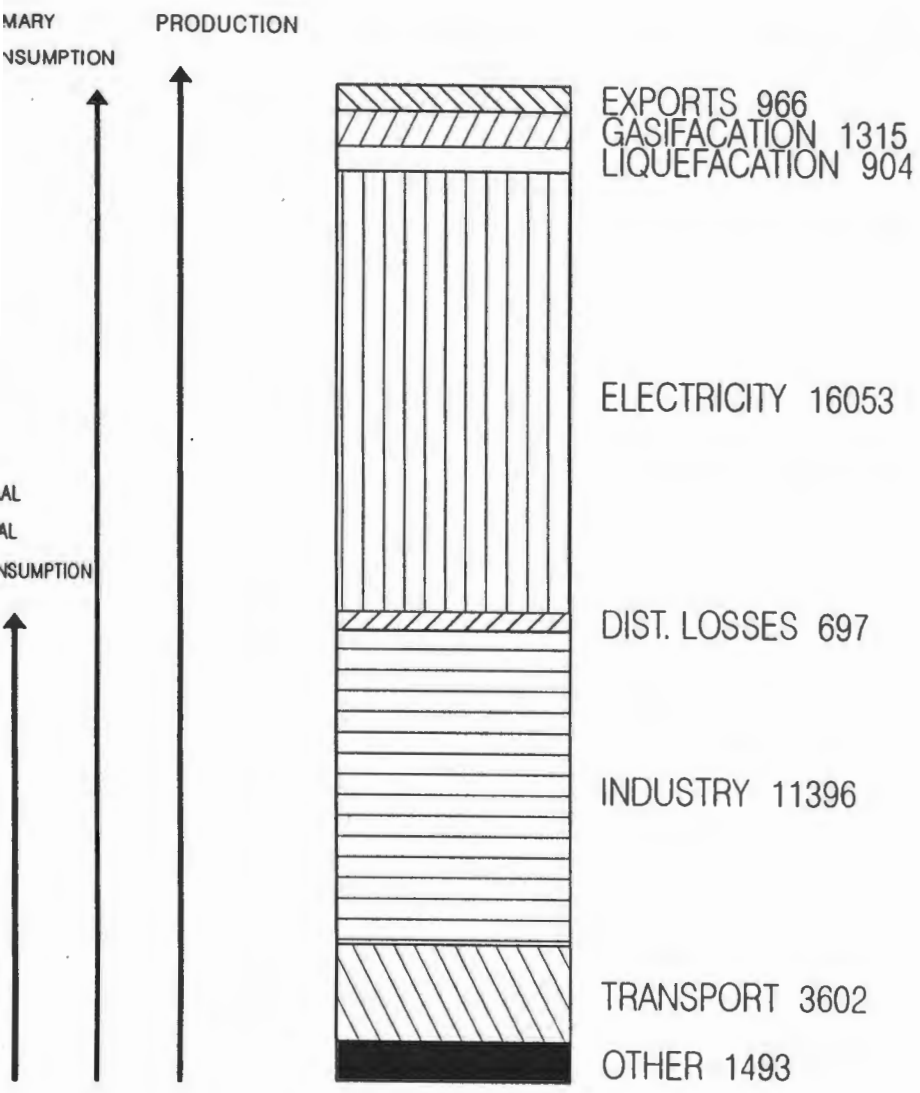


FIGURE 23 TOTAL FINAL CONSUMPTION OF COAL



TOE - TONS OIL EQUIVALENT
SA2/COAL1

COAL : ENERGY BALANCE 1971
OO'S OF TOE



COAL : ENERGY BALANCE 1988
OOO'S OF TOE

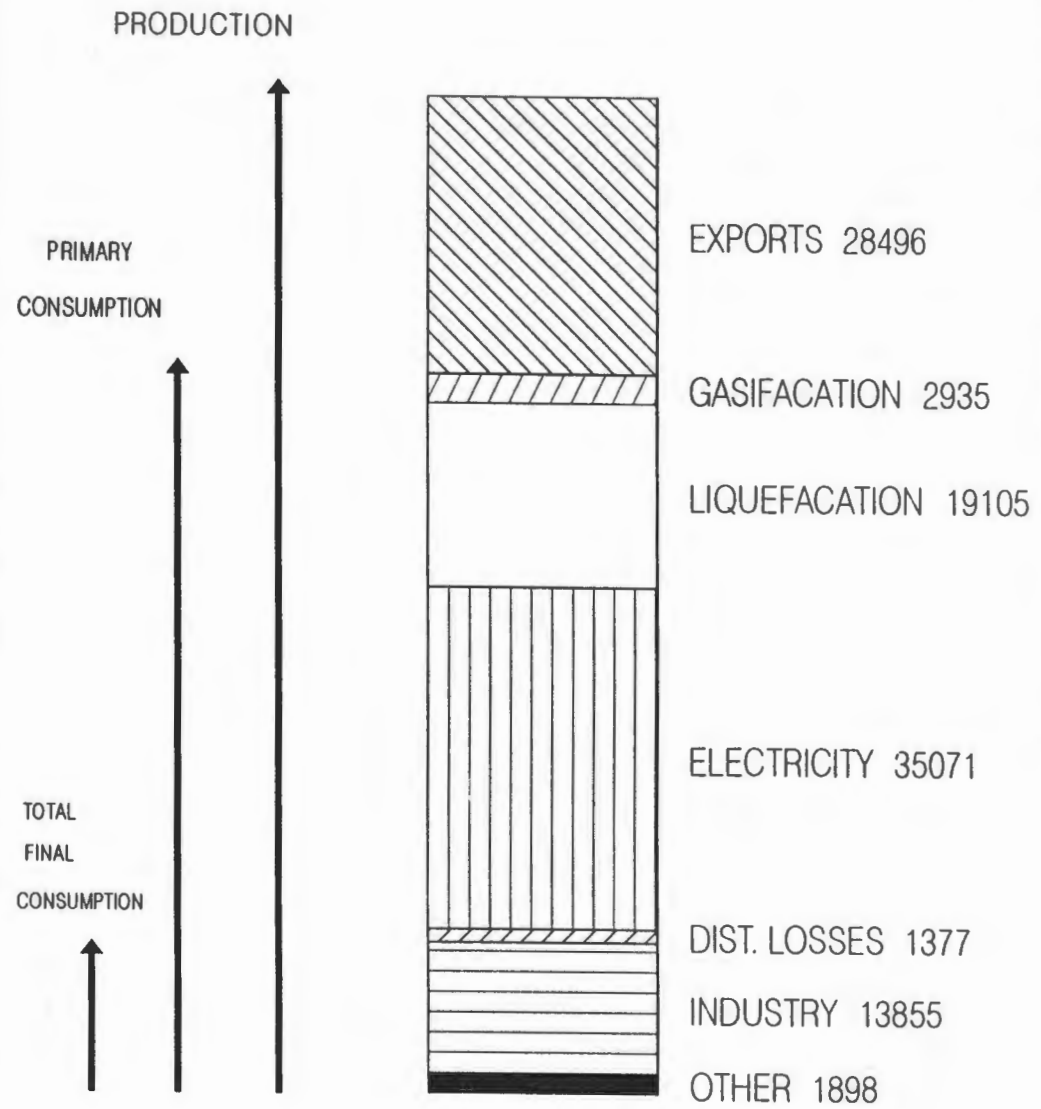


FIGURE 24 COAL ENERGY BALANCE

FIGURE 25. COAL PRODUCTION AND EXPORTS

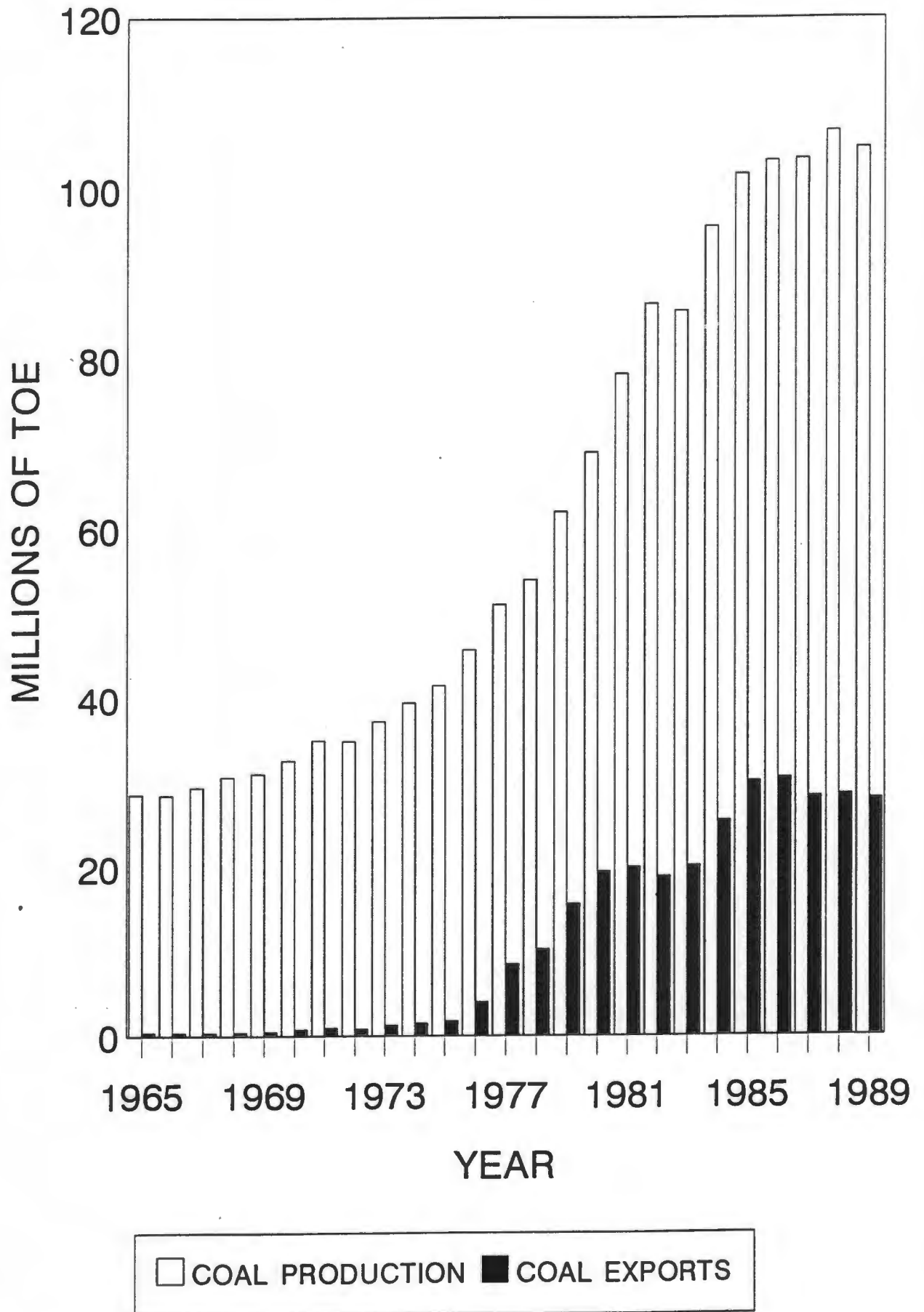
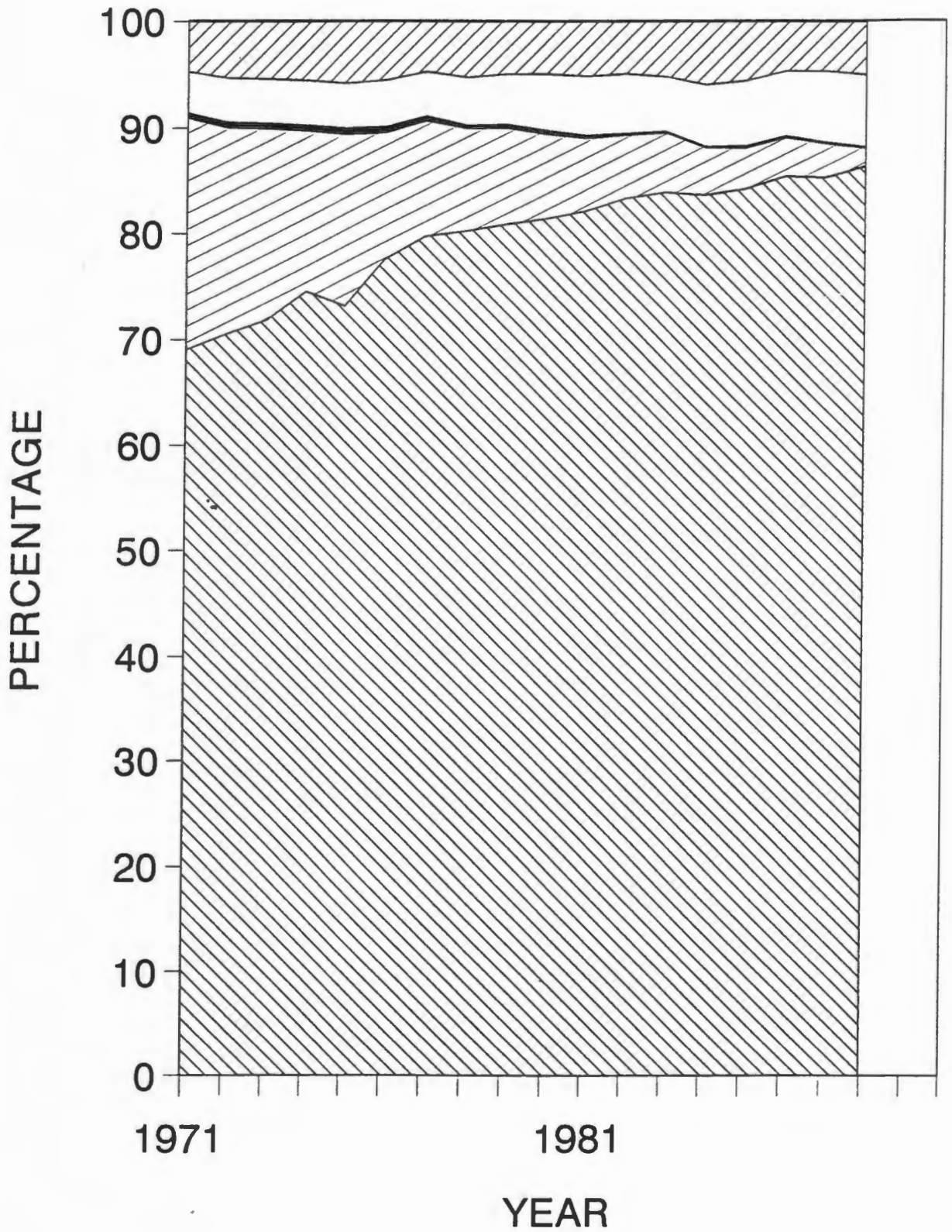


FIGURE 26 TOTAL FINAL CONSUMPTION OF COAL :
SECTORIAL BREAKDOWN (AS A PERCENTAGE OF TOTAL)



INDUSTRY TRANSPORT AGRICULTURE RESIDENTIAL OTHER

FIGURE 27. ELECTRICITY CONSUMPTION

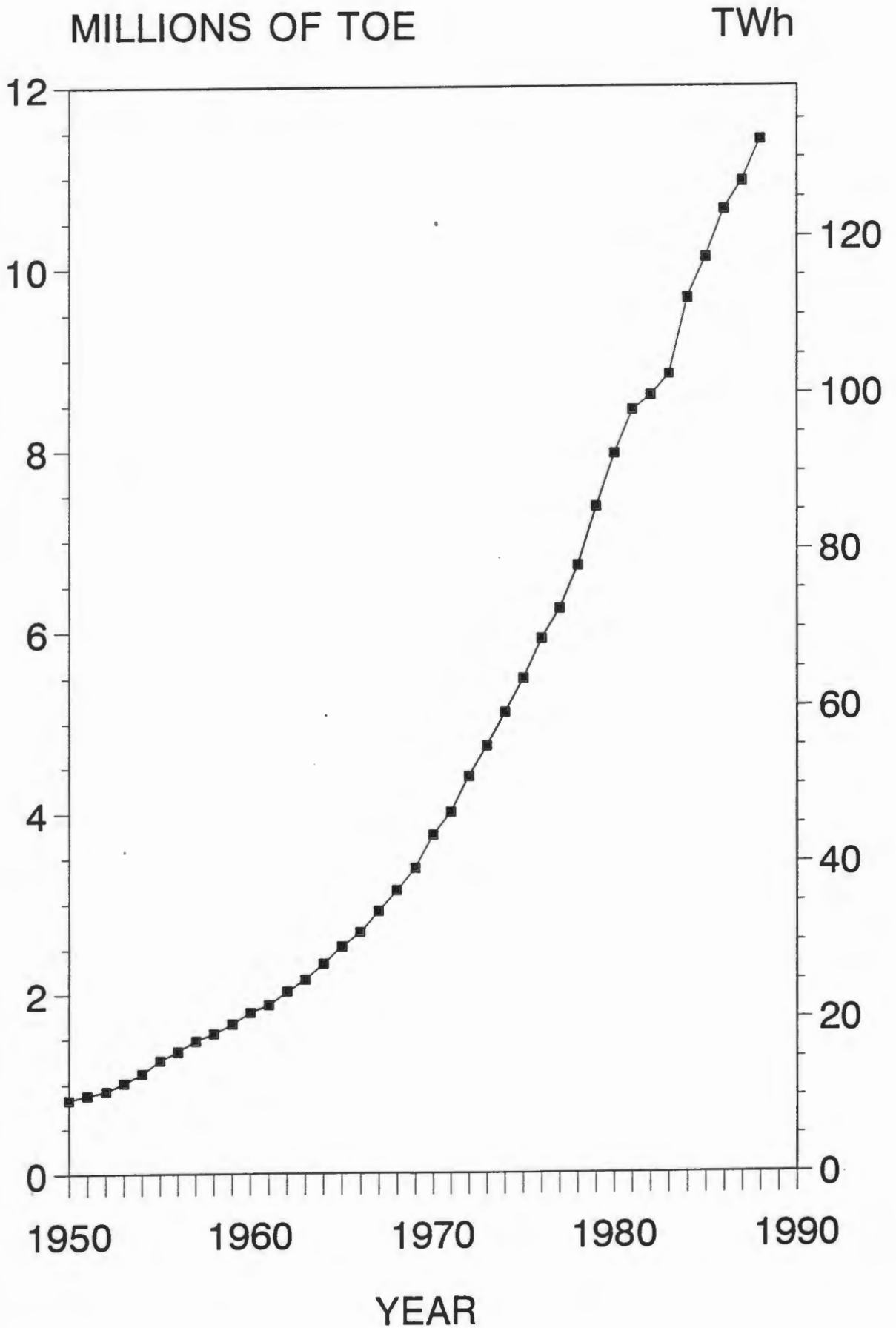
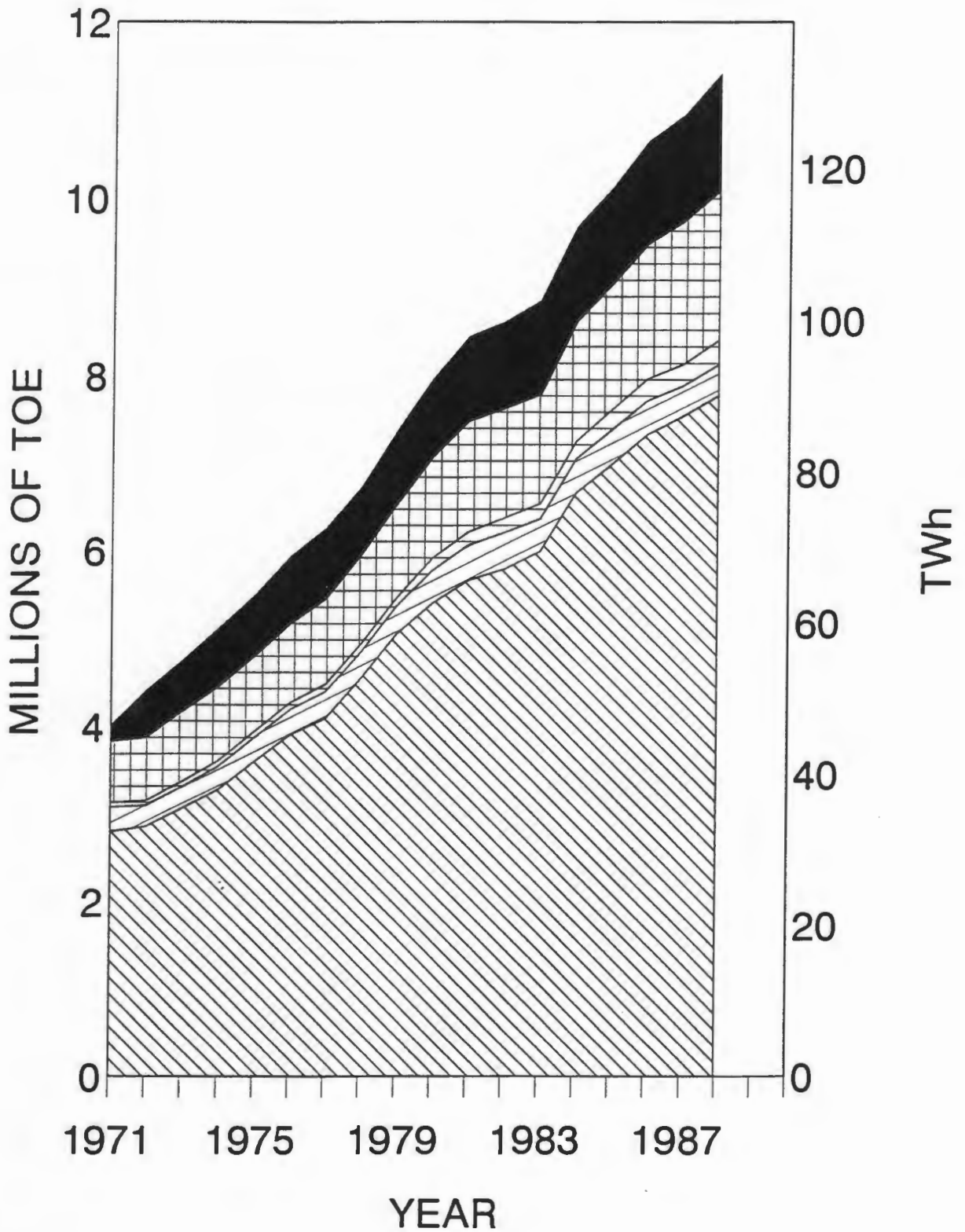


FIGURE 28. SECTORIAL CONSUMPTION OF ELECTRICITY



INDUSTRY TRANSPORT AGRICULTURE RESIDENTIAL OTHER

FIGURE 29 GROWTH OF INSTALLED CAPACITY AND MAXIMUM DEMAND

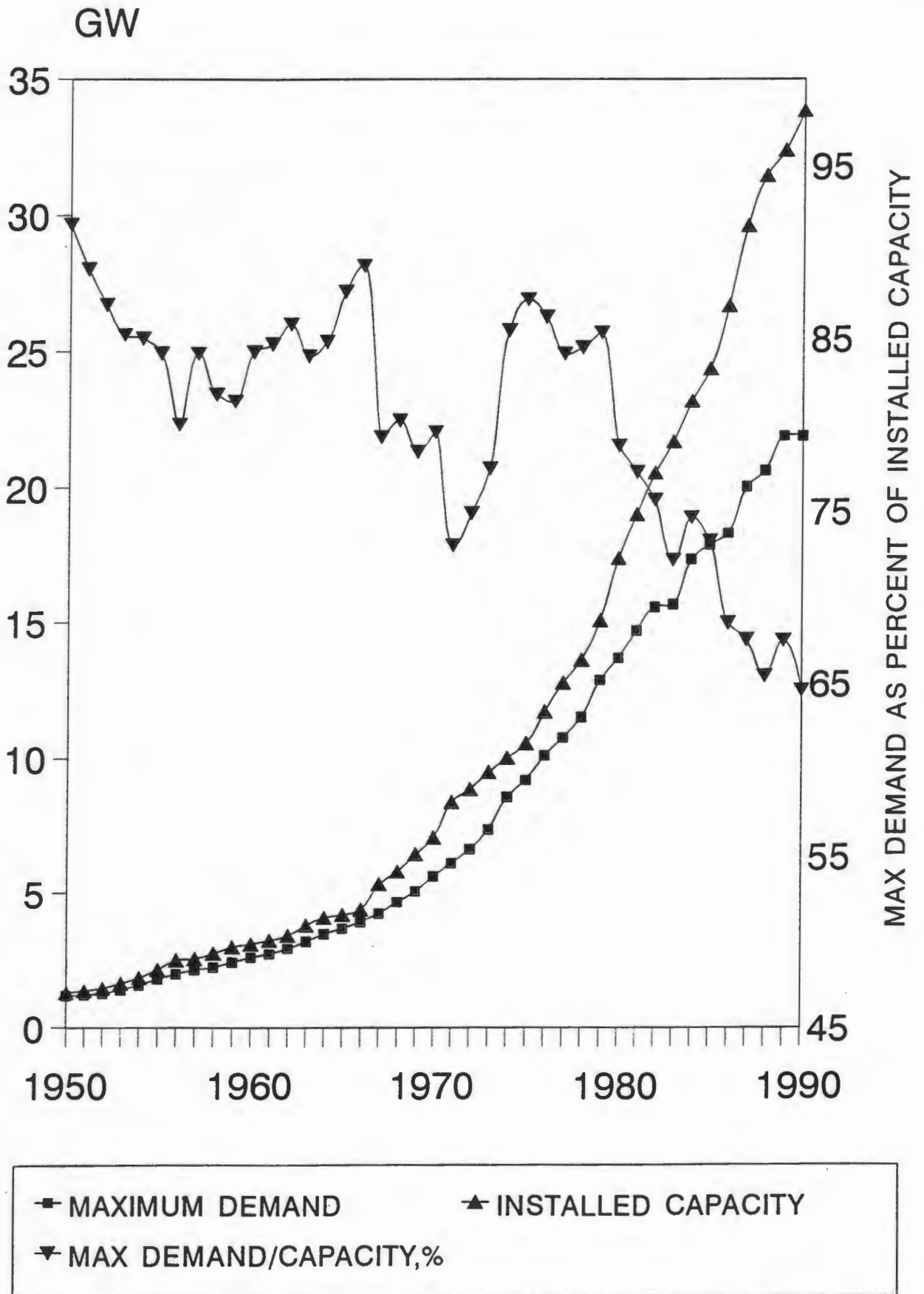


FIGURE 30 ELECTRICITY SENT OUT FROM ESKOM POWER STATIONS, BY TYPE

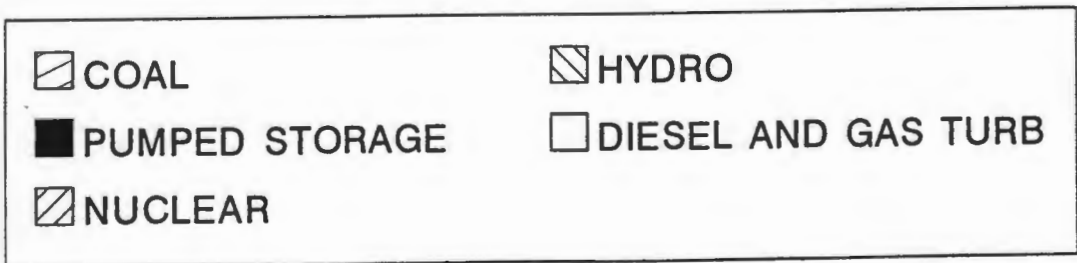
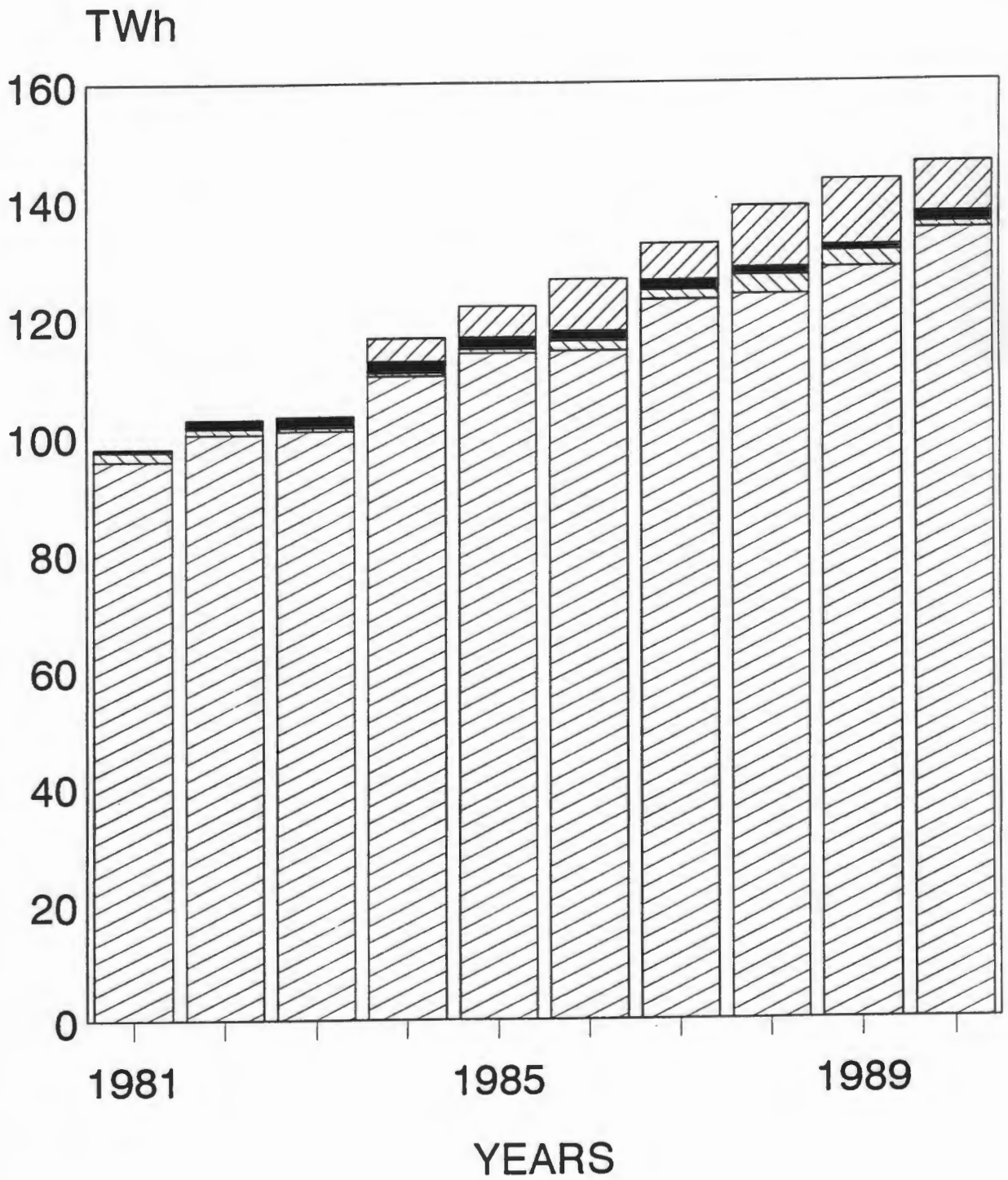
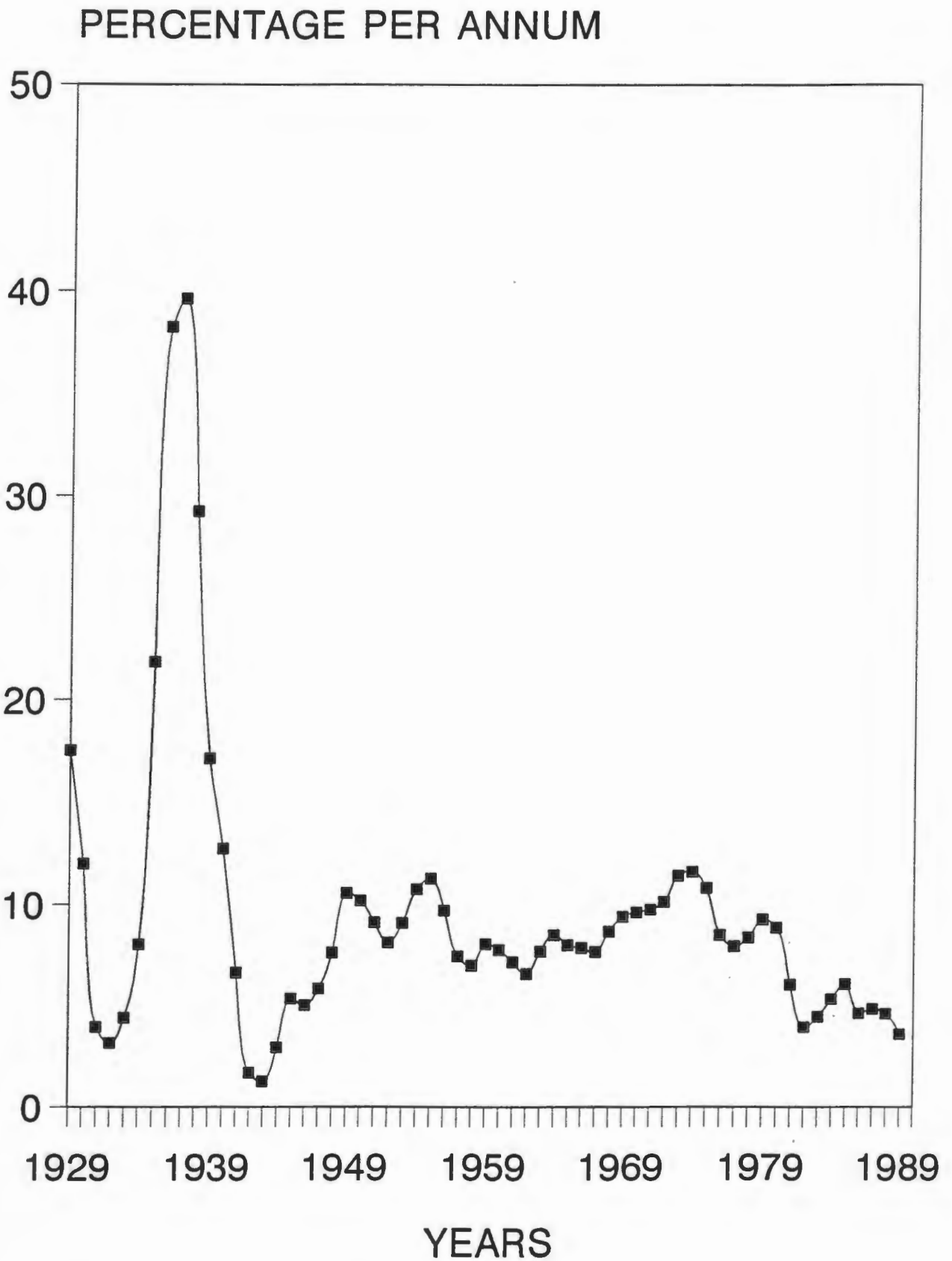


FIGURE 31 GROWTH IN ESKOM ELECTRICITY SALES
(3 - POINT MOVING AVERAGE)



MAP

REPORT NO. GEN 158

ENERGY PROFILE: SOUTH AFRICA

FINAL REPORT

M I GIELINK
R K DUTKIEWICZ

SEPTEMBER 1993



ENERGY RESEARCH INSTITUTE