ENERGY IN EAST AND SOUTHERN AFRICA:

WITH SPECIAL REFERENCE TO SOUTH AFRICA

by

M. I. GIELINK

Submitted to the University of Cape Town
in fulfillment of the degree of
Master of Science in Engineering

"The use of energy by mankind has been a key factor in the supply of food, in physical comfort and in the development of organized society" [i]

i EDEN. E, POSNER. M, BENDING. R, CROUCH. E, STANISLAW. J. "Energy Economics Growth, Resources and Policies".

DECLARATION

I, Michael Ian Gielink, submit this thesis in fulfillment of the requirements of the degree of Master of Science in Engineering. I claim that this is my original work and that it has not been submitted in this or in a similar form for a degree at any other University.

Signed by candidate

M. I. Gielink BSc.(ENG.) Mechanical

4th day of May 1992.

ABSTRACT

In this thesis the energy sector of the East and Southern Africa Region (as defined by the World Energy Council) is investigated. Special attention is given to South Africa and the potential future role she could play in the region.

The region is characterized by large population growth rates, insufficient economic growth, political and civil instability, massive urbanization, high illiteracy rates, a low level of development, a lack of finance and foreign exchange, and inadequate institutional structures, all of which effect the energy sector making the provision of a sustainable and adequate supply of energy difficult.

On the other hand, South Africa, the economic giant of the region, has a sophisticated and well established energy infrastructure and has the potential to play a large role in the energy sector of the region.

A large portion of the region's energy demand is supplied by traditional energy sources and is consumed by the domestic sector. In many countries of the region, energy demand exceeds sustainable supply, resulting in energy scarcities and increased deforestation. These issues need to be addressed as a priority. Reforestation based on agro- forestry, was identified as the option most likely to succeed in this regard.

Although commercial energy resources are abundant within the region, they are largely unexploited as a result of the lack of suitably large markets, vast distances, a lack of finance and regional instability. The promotion of the utilization of these resources, which would ease supply constraints, is reliant on regional cooperation and the trade in energy.

Forecasts of future energy consumption in the region indicate that unless present constraints on the energy sector are alleviated, the adequate supply of energy, and in particular traditional energy, will be jeopardized. It is proposed that any long-term cost-effective solution for the provision of an adequate and sustainable supply of energy requires regional political stability and cooperation, institutional reform, the integration of traditional and commercial energy structures, and should address the issues of deforestation and population growth.

ACKNOWLEDGEMENTS

The Author thanks the following for their invaluable support and assistance:

Professor R.K Dutkiewicz for his supervision and guidance,

Mr 't Sas Rolfes for his assistance with the economic and environmental aspects,

K. J. Morrison for undertaking the daunting task of proof reading and for her constructive criticism,

the secretarial and administrative staff of the Energy Research Institute, and

ESKOM and SANCWEC for supporting me in this endeavor.

TABLE OF CONTENTS

	ABSTRACT	i
	ACKNOWLEDGEMENTS	ii
	LIST OF TABLES	vii
	LIST OF FIGURES	viii
	NOMENCLATURE	x
	GLOSSARY	xii
1.	INTRODUCTION	1
1.1	Background	1
1.2.	Objectives	2
1.3	Methodology	3
1.4	Thesis Outline	3
1.5	Limitations	4
2.	GLOBAL OVERVIEW	6
2.1	Introduction	6
2.2	Energy Usage Patterns, Resources and Resource Utilization	11
2.2.1	Coal	12
2.2.2	Oil	13
2.2.3	Gas	13
2.2.4	Nuclear	15
2.2.5	Fuelwood	15
2.3	Energy Indicators	16
2.5	Conclusion	19
3.	ENERGY IN - EAST and SOUTHERN AFRICA	21
3.1	INTRODUCTION	21
3.2	DEMOGRAPHY	25
3.2.1	Introduction	25
3.2.2	Population Distribution	27
3.2.2.1	Population Densities	27
3.2.2.2	Urbanization	27
3.2.3	Social and Cultural Indicators	29
3.2.3.1	Social Indicators	29
3.2.3.2	Health	29

3.2.4	Education	31
3.2.5	Culture and Nationalism	33
3.2.6	Discussion	34
3.3	INSTITUTIONAL ASPECTS	35
3.3.1	Introduction	35
3.3.2	Political considerations	35
3.3.3	Dualistic Economies	38
3.3.4	Existing Energy Institutions	39
3.3.5	Institutional Shortcomings	39
3.4.	ECONOMICS AND ENERGY	43
3.4.1	Introduction	43
3.4.2	Economic Growth	44
3.5.1	Introduction	49
3.5.2	Traditional Energy	49
3.5.3	Commercial Energy	52
3.5.4	Energy Indicators	54
3.5.5	Electrification	58
3.6	ENERGY RESOURCES AND SUPPLY ISSUES	63
3.6.1	Energy Resources	63
3.6.2	Energy Supply and Markets	67
3.6.2.1	Introduction	67
3.6.2.2	Electricity	68
3.6.2.3	Oil	70
3.6.2.4	Coal	73
3.6.2.5	Gas	73
3.6.2.6	Fuelwood	74
3.6.2.7	Nuclear	77
3.6.2.8.	The Potential for Regional Energy Interchange	77
3.6.3	Energy Technology and Efficiency	81
3.6.3.1	Energy Technology	81
3.6.3.2	Technology Transfer	83
3.6.4	Energy Security	84
3.7	ENVIRONMENTAL ASPECTS	87
3.7.1	Introduction	87
3.7.2	Atmospheric Pollution and Global Warming	89
3.7.3	Other environmental hazards	91
3.7.4	Public and political significance	93
3.7.5	Summary	94

3.8 FINANCIAL RESOURCES 96
3.8.1 Introduction 96
3.8.2 Financial resources 97
3.8.3 Coordination of financing 98
3.9 CONCLUSION: Strategies for Solutions 99

4. ENERGY - SOUTH AFRICA 104
4.1 Introduction 104
4.1.1 Political Background 104
4.1.2 Demography 105
4.2 Economy 108
4.2.1 Discussion 112
4.3. Energy; General 113
4.3.1 Introduction 113
4.3.2 Energy Institutions 114
4.4. Energy Resources 116
4.4.1 Fuelwood 116
4.4.2 Petroleum and Gas 116
4.4.3 Coal 117
4.4.4 Hydro-electricity 117
4.4.5 Uranium 118
4.4.6 Biomass 118
4.4.7 Solar and Wind 119
4.4.8 Geothermal 121
4.5. Energy Supply and Demand 121
4.5.1 General 121
4.5.2 Fuelwood 127
4.5.3 Petroleum products 128
4.5.4 Coal 130
4.5.5 Electricity 132
4.5.6 Pricing and Marketing 135
4.5.6.1 Oil and oil products 135
4.5.6.2 Coal 136
4.5.6.3 Electricity 136
4.5.6.4 Other energy 137
4.5.7 Comment 137
4.6 DISCUSSION 137

5.	Energy Demand Forecasts: 1990-2020	140
5.1	Introduction	140
5.2	Overall Methodology	143
5.3	Results of Demand Analysis	145
5.3.1	RSA	145
5.3.1.1	Commercial Energy	145
5.3.1.2	Traditional Energy	149
5.3.1.3	Total Energy	149
5.3.2	ESA Excluding South Africa (RSA)	151
5.3.2.1	Introduction	151
5.3.2.2	Commercial Energy	151
5.3.2.3	Traditional Energy	152
5.3.4	Total Region - ESA (Including RSA)	153
5.4	Discussion	158
5.5.	Conclusion	158
6.	THE FUTURE - Implications for the Region	159
6.1	Introduction.	159
6.2	The Future - the potential for regional energy interchange.	160
6.2.1	Coal	160
6.2.2	Gas	160
6.2.3	Oil	161
6.2.4	Electricity	161
6.2.5	Traditional Energy	161
6.3	Conclusion	161
7.	THE POTENTIAL FUTURE ROLE OF SOUTH AFRICA IN THE REGION	162
7.2	Energy Interchange	163
7.3	Energy Technology	164
7.4	Maintenance and Operating	165
7.5	Exploration and mining	166
7.6	Summary	166
8.	CONCLUSION	167
9.	REFERENCES	169

APPENDICES

LIST OF TABLES

TABLE 2.1:	TOTAL PRIMARY ENERGY SUPPLY - 1988	11
TABLE 2.2:	TOTAL FINAL CONSUMPTION OF ENERGY - 1988	12
TABLE 2.3:	ENERGY RESOURCES - PROVEN RECOVERABLE	12
TABLE 3.1	POPULATION GROWTH RATES AND GDP PER CAPITA	26
TABLE 3.2	URBAN POPULATION STATISTICS	28
TABLE 3.3	SOCIAL INDICATORS	30
TABLE 3.4:	HEALTH PROFILE	31
TABLE 3.4	ILLITERACY RATE IN THE OVER 15 AGE GROUP	32
TABLE 3.5	TERTIARY EDUCATION STATISTICS	32
TABLE 3.6:	TOTAL FINAL CONSUMPTION DATA FOR THE REGION	50
TABLE 3.7	TRADITIONAL ENERGY AS PERCENTAGE OF TOTAL ENERGY	51
TABLE 3.8:	TOTAL FINAL CONSUMPTION COMPONENTS AS A PERCENTAGE	52
TABLE 3.9:	ACCESS TO ELECTRICITY	62
TABLE 3.10 a:	ENERGY RESOURCES OF THE REGION	64
TABLE 3.10 b:	ENERGY RESOURCES OF THE REGION	65
TABLE 3.11:	ELECTRICITY POWER SYSTEM PERFORMANCE - 1987	69
TABLE 3.12:	NET ATTRIBUTED ADDITIONS TO THE GREENHOUSE HEATING EFFECT BY CARBON DIOXIDE	88
TABLE 4.1	POPULATION GROWTH RATES	106
TABLE 4.2	GDP OF SELECTED COUNTRIES IN 1988	109
TABLE 4.3	AVERAGE FLOWS OF MAIN RIVERS IN THE SUBCONTINENT	118
TABLE 4.4	AVERAGE YEARLY INSOLATION	119
TABLE 4.5	MEAN ANNUAL WIND SPEED	120
TABLE 4.6:	TOTAL FINAL CONSUMPTION OF COMMERCIAL ENERGY FOR SELECTED COUNTRIES	122
TABLE 5.1:	COMMERCIAL ENERGY - TOTAL FINAL CONSUMPTION	148
TABLE 5.2:	TOTAL FINAL CONSUMPTION OF ENERGY	150
TABLE 5.3:	COMMERCIAL ENERGY - TOTAL FINAL CONSUMPTION	152
TABLE 5.4:	TOTAL FINAL CONSUMPTION OF ENERGY	153
TABLE 5.5:	TOTAL FINAL CONSUMPTION OF ENERGY	154

LIST OF FIGURES

FIGURE 2.1:	FUEL DEMAND PATTERN IN THE USA	7
FIGURE 2.2:	TFC OF ENERGY FOR SELECTED REGIONS	8
FIGURE 2.3:	TOTAL PRIMARY ENERGY SUPPLY	9
FIGURE 2.4:	TFC (COMMERCIAL)PER CAPITA VS GDP PER CAPITA	17
FIGURE 2.5:	TFC (TOTAL) PER CAPITA VS GDP PER CAPITA	17
FIGURE 2.6:	TFC (COMMERCIAL) INTENSITY VS GDP PER CAPITA	18
FIGURE 2.7:	TFC (TOTAL) INTENSITY VS GDP PER CAPITA	18
FIGURE 3. :	POPULATION OF THE ESA	25
FIGURE 3.1:	REAL GDP PER CAPITA IN LOCAL CURRENCY TERMS	46
FIGURE 3.2:	AVERAGE GDP PER CAPITA FOR THE REGION	47
FIGURE 3.3:	SECTORIAL USAGE OF ENERGY	53
FIGURE 3.4:	FINAL CONSUMPTION OF ENERGY PER CAPITA FOR SELECTED COUNTRIES	55
FIGURE 3.5 A:	COMMERCIAL ENERGY PER CAPITA FOR THE REGION	56
FIGURE 3.5 B:	TOTAL ENERGY PER CAPITA FOR THE REGION	56
FIGURE 3.6:	TOTAL FINAL ENERGY INTENSITY VS GDP PER CAPITA	57
FIGURE 3.7:	INTENSITY OF FINAL ENERGY CONSUMPTION	59
FIGURE 3.8 A:	COMMERCIAL FINAL ENERGY INTENSITY FOR THE REGION	60
FIGURE 3.8 B:	TOTAL FINAL ENERGY INTENSITY FOR THE REGION	60
FIGURE 3.9:	ENERGY PER CAPITA VS GDP PER CAPITA - 1988	61
FIGURE 4.1:	GROSS DOMESTIC PRODUCT	110
FIGURE 4.2:	GDP GROWTH RATE	110
FIGURE 4.3:	GDP PER CAPITA	110
FIGURE 4.4:	GDP IN US$	110
FIGURE 4.5:	GDP PER CAPITA US$	111
FIGURE 4.6:	GDP COMPONENTS	111
FIGURE 4.7:	TFC OF COMMERCIAL ENERGY	122
FIGURE 4.8:	TFC OF COMMERCIAL ENERGY COMPONENTS	122
FIGURE 4.9:	TFC OF COMMERCIAL ENERGY - SECTORIAL	123
FIGURE 4.10:	ENERGY PER CAPITA VS GDP PER CAPITA	123
FIGURE 4.11:	TFC AND GDP GROWTH RATES	124
FIGURE 4.12:	INDUSTRIAL SECTOR GROWTH RATES	124
FIGURE 4.13:	AGRICULTURAL SECTOR GROWTH RATES	125
FIGURE 4.14:	MINING SECTOR GROWTH RATES	125
FIGURE 4.15:	COMMERCIAL ENERGY INTENSITY	125
FIGURE 4.16:	TFC OF ENERGY INTENSITY	125
FIGURE 4.17:	TFC OF ENERGY PER CAPITA	126

FIGURE 4.18:	SASOL	129
FIGURE 4.19:	OIL TFC	129
FIGURE 4.20:	OIL PRODUCT CONSUMPTION	129
FIGURE 4.21:	TFC OIL - SECTORIAL BREAKDOWN	129
FIGURE 4.22:	RATIO OF DIESEL TO PETROL	131
FIGURE 4.23:	TFC OF COAL	131
FIGURE 4.24:	COAL ENERGY BALANCE	131
FIGURE 4.25:	COAL PRODUCTION AND EXPORTS	131
FIGURE 4.26:	TFC OF COAL - SECTORIAL	132
FIGURE 4.27:	ELECTRICITY CONSUMPTION	132
FIGURE 4.28:	SECTORIAL CONSUMPTION OF ELECTRICITY	134
FIGURE 4.29:	GROWTH OF INSTALLED CAPACITY	134
FIGURE 4.30:	ELECTRICITY SENT OUT	134
FIGURE 4.31:	GROWTH IN ESKOM ELECTRICITY SALES	134
FIGURE 5.1:	RELATIONSHIP BETWEEN TYPICAL ENERGY INDICATORS	141
FIGURE 5.2:	TYPICAL ENERGY CONSUMPTION PATTERN VS DEVELOPMENT	142
FIGURE 5.3:	REAL GDP GROWTH SCENARIOS	144
FIGURE 5.4:	GDP PER CAPITA: HISTORIC AND SCENARIOS	144
FIGURE 5.5:	ENERGY ELASTICITY - REAL 1985 RAND BASIS	146
FIGURE 5.6:	INITIAL ENERGY ELASTICITY PREDICTIONS 1989 - 2020	146
FIGURE 5.7:	FINAL ENERGY ELASTICITY AND INTENSITY FORECAST	148
FIGURE 5.8:	TRADITIONAL ENERGY : ENERGY - POPULATION ELASTICITY	150
FIGURE 5.9:	TRADITIONAL ENERGY AS A PERCENTAGE OF TOTAL ENERGY	150
FIGURE 5.10:	ESA TFC OF COMMERCIAL ENERGY AND ELECTRICITY AS A PERCENTAGE OF TFC	155
FIGURE 5.11	COMMERCIAL ENERGY PER CAPITA	156
FIGURE 5.12	TOTAL ENERGY PER CAPITA	156
FIGURE 5.13	COMMERCIAL ENERGY PER 1985 US$	157
FIGURE 5.14	TOTAL ENERGY PER 1985 US$	157

NOMENCLATURE

EDF	-	Electricite de France
ESA	-	The East and Southern Africa Region as defined by the IMF, World Bank, and the World Energy Council. A list of countries is given in Appendix A.
ESKOM	-	South African Electricity Utility.
Forex	-	Foreign Exchange
GDP	-	Gross Domestic Product
GNP	-	Gross National Product
IEA	-	International Energy Agency
kgOE	-	Kilograms of oil equivalent
LDC	-	Least Developed Country
MTOE	-	Million TOE
OAU	-	Organization of African Unity
PTA	-	Preferential Trade Area
PWV	-	Pretoria-Witwatersrand-Vereeniging Area
RSA	-	Republic of South Africa
SADCC	-	South African Development Coordination Conference
TFC	-	Total Final Consumption.
TOE	-	Tons of oil equivalent (1 TOE = 42 x 10^9 Joules)
TTOE	-	Thousand TOE
UK	-	United Kingdom

UNDP	-	United Nations Development Programme
WIC	-	Western Industrialized Countries
ZESA	-	Zimbabwe Electricity Supply Authority
ZESCO	-	Zambia Electricity Supply Corporation

GLOSSARY

Commercial Energy	-	Energy which is the subject of a commercial transaction and can thus be quantified more easily.
Conservation	-	Careful use of resources to allow for their use in future.
Deforestation	-	The permanent destruction of indigenous forests and woodlands.
Development	-	Modification of resources to obtain their benefits and improve human well-being.
Fuelwood	-	Wood burnt to obtain energy as opposed to wood used for construction or furniture etc. (includes charcoal).
Resources	-	Anything which can be used to maintain or improve human well-being.
Traditional Energy/ (Non-commercial Energy)	-	Energy forms which are not the subject of a commercial exchange and which are difficult to account for in energy balances. For the purpose of this study all wood and charcoal are defined as traditional.
Urbanization	-	The process by which the number of people living in cities increases compared with the number of people living in rural areas.

1. INTRODUCTION

1.1 Background

An adequate and sustainable supply of energy is vital, in order to maintain and improve quality of life. Not only does energy 'power' the economy, but it also provides for the basic needs of the population such as cooking, heating and lighting. For most of the period of human existence man's energy requirements were limited to the intake of food, and he was at the mercy of his environment. The exploitation of each new technology aimed at improving man's chance of survival, and giving him greater control of his environment, increased his needs for energy, amongst other things[4].

In developed countries the provision of energy to the main consuming industries, as well as the residential and other sectors, is carried out in an integrated manner and almost exclusively by commercial energy forms. In the countries studied in this thesis the provision of energy to the various sectors is not carried out in an integrated manner, and traditional energy, which is mainly used by the residential sector, is the major supplier of energy. The supply of traditional energy is not integrated into the overall energy sector planning. In many areas supply of traditional energy is insufficient and is resulting in a forced change of lifestyle for many people.

Economic growth, and the commensurate improvement of quality of life and increase in the standard of living, is reliant on the efficient supply of the various energy forms, in a sustainable manner. An under-supply of energy will strangle the economy and rule out economic growth. An over-supply of energy will not in its self create economic growth. On the contrary, it will tie up valuable capital which could have been used more effectively and thus also puts a strangle hold on the economy[5]. In the ideal situation just enough energy is supplied as is demanded by the economy at any one time. In the real situation long lead times and unforeseen circumstances (amongst other logistical restraints) have to be taken into account. This results in the need for some over-capacity in the supply infrastructure. The actual over-capacity depends on these lead times as well as economies of scale, risk of supply bottlenecks and the importance placed on the need for security of supply.

In the region studied in this thesis many countries experience major supply problems due to the lack of:

(1) suitable institutional infrastructure,
(2) integrated energy sector planning,
(3) suitably qualified personnel,
(4) finance,
(5) foreign exchange,
(6) spares,
(7) resource depletion (wood), and
(8) adequate and efficient transport infrastructure.

This is in turn having a detrimental impact on the economies and well, being of the population of many countries. This is in stark contrast to the plentiful commercial energy resources with which the region is endowed. Solutions to the energy problems need to be addressed on a regional as well as a national scale, and are reliant on efficient exploitation and utilization of indigenous resources and regional trade in energy.

In order to identify strategies for solving the regions energy issues, as well as identifying South Africa's policy options with respect to its future role in the region, the past and present energy situation in the region has to be studied, and specific issues identified. Predictions of future energy demands have to be made, implications for the region studied, and strategies identified.

1.2. Objectives

The objectives of this thesis are:

(1) compilation of a set of energy statistics and indicators for countries of the region,
(2) assessment of the energy sector of the region and a number of key countries,
(3) identification of problems, issues and options in the energy sector
(4) prediction of future energy demand,
(5) identification of options for meeting future demand, and the implications for South Africa, and
(6) outline South Africa's future role in the region.

1.3 Methodology

The energy sector of the East and Southern Africa Region (ESA)[i] is studied in this thesis. In order to gain insight into the energy sector and put the region into the World perspective, a brief study of the global energy scene was undertaken. Statistics and information on the energy and economic sectors of the countries of the region were then compiled. These statistics were then manipulated and key indicators produced. From this information energy profiles of the major countries of the region were compiled. These profiles were used to identify key issues, problems and options for the various countries. A regional energy profile was then compiled using the individual country profiles as a basis. This regional profile, together with a profile of South Africa, was then used as a starting point for predicting energy demand in the future. The year 2020 was chosen as an end point. The options for satisfying this demand and strategies for solutions were then studied and the implications for South Africa identified. These findings were then used as a basis for studying South Africa's future role in the region.

1.4 Thesis Outline

Chapter 1 provides an introduction and background to the thesis and outlines the main objectives.

Chapter 2 presents a brief description of the energy sector in global terms in order to place the East and Southern Africa region (ESA) in a global perspective. A short history of global energy trends is given, the present situation is summarized, future trends are discussed, selected energy indicators are given and conclusions drawn.

Chapter 3 gives a profile of the energy sector of the **East and Southern Africa Region (ESA)**. The institutional infrastructure, demography and economy of ESA are discussed in order to give a background to the region and indicate how these impact on the energy sector. Energy supply and demand, markets, resources, technology, security and environmental issues, amongst others, are studied. Key problems, issues,and options are identified and strategies for solutions put forward. The data and information contained in the Energy Profiles of thirteen of the major countries of the region was used as a basis for this chapter. These Country Energy Profiles were compiled as part of the research undertaken for this thesis.

---

i A complete list of countries is given in Appendix A.

Chapter 4 gives a profile of the energy sector of **South Africa (RSA).** The institutional infrastructure, demography and economy of RSA are discussed in order to give a background to the country and indicate how these impact on the energy sector. Energy supply and demand, markets, and resources, amongst others, are studied.

Chapter 5 forecasts the future total final consumption of energy in the region and in South Africa to the year 2020. Data collected for, and trends identified in, Chapters 3 and 4 are used as a basis for this forecast.

Chapter 6 discusses the implications the results of the analysis undertaken in Chapter 5 has for the region.

Chapter 7 discusses South Africa's probable future role in the energy sector of the region in light of the political reform taking place in South Africa, and the state of the regions energy sector as highlighted in Chapter 3. Attention is given to measures needed, in order to prevent polarization, and to enable equitable development of the regions energy sector.

Findings are highlighted and conclusions drawn in Chapter 8.

Supporting information and data for Chapters 3, 4 and 5 are contained in the various Appendices.

1.5 Limitations

A complete set of statistics and data on energy consumption and economic indicators is not available for a number of countries and their accuracy is questionable in many cases. In order to obtain a reasonable set of statistics for the region, excluding South Africa, a sample set of countries with reasonable statistics was chosen to represent the region. Data for these countries was compiled for the period 1971 - 1988 and where data was missing interpolation was used to gain an estimate. Economic data was expressed in 1985 US$[i] in order to make calculation of total GDP possible.

The data for these individual countries was then combined and scaled up using suitable factors to obtain an estimation for the statistics of the 23 countries making up

---

i 1985 US$ - local currency converted to US$ at prevailing exchange rate and then deflated using US$ deflator.

the ESA region, excluding South Africa. These estimates, together with data for South Africa, are contained in Appendices H and I.

Use has been made of a number of sources for the statistical information presented in this thesis, 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. GLOBAL OVERVIEW

This chapter gives a brief description of the energy sector in global terms in order to place the East and Southern Africa region (ESA) in a global perspective. A short history of global energy trends is given, the present situation is summarized, future trends are discussed, selected energy indicators are given and conclusions drawn.

2.1 Introduction

> "Each and every society's capability of development, or indeed its ability to survive, depends on continuing access to energy in the appropriate forms and quantities, and at acceptable levels of cost"[(1)]

Prior to the industrial revolution, which began in the second half of the eighteenth century, energy was primarily used for cooking, heating, lighting and for cottage industries[(4)]. Energy in the form of animal, wind, and water power was also used for transport and in the agricultural and mining sectors. The beginning of the industrial revolution saw energy consumption increasing rapidly due to the energy intensive nature of the flourishing industrial sector. Thus, the relative share of energy consumed by the household sector decreased as a result of industrialization. Typically, the fraction of energy used in the household sector is lower in the more developed countries[i]. The development process is also associated with a decrease in the share of traditional energy in the end use of energy. Figure 2.1 shows the share of fuelwood in the USA over the period 1860 - 1980.

It has been estimated that during the period 1788 to 1860 global energy usage doubled, and by 1988 global energy use was forty times that of 1788 [(1)]. Although global energy use has shown a long term 2% per annum growth rate since 1860, energy usage increased to around 5% during the period 1945 to 1973, after which it returned to the long term trend of 2%[(1,7)].

---

i It can be expected that as industrialized countries move into the post industrialization stage this fraction could increase slightly as the growth in, and energy intensity of, industrial production decreases.

This increase in energy usage was as a result of a number of factors including the following:

A number of nations were in[i], or were entering into[ii], the very energy intensive stage of development.

The USSR and Eastern European countries embarked on the deliberate expansion of heavy, energy intensive, industry.

Rapid urbanization, especially in the third world, and the increasing use of electrically powered equipment in the households of rich western countries.

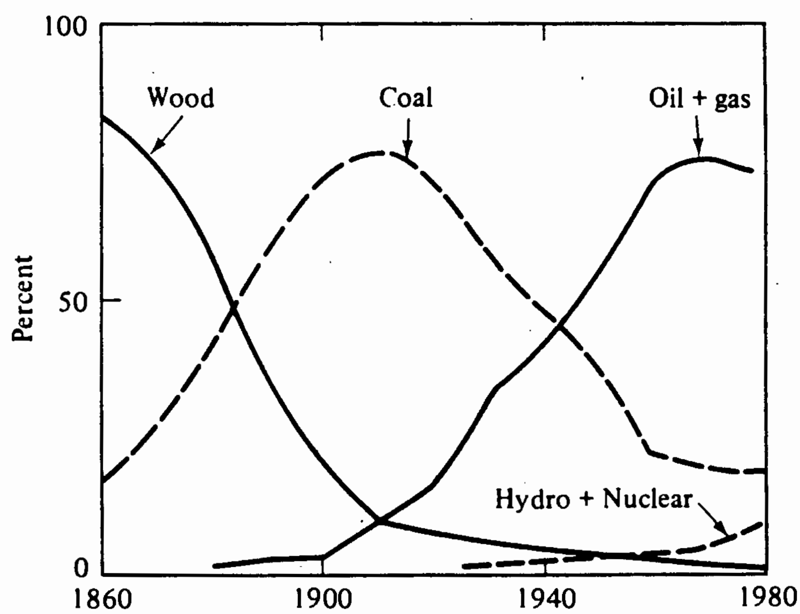
The switch from public to private transport and the mass use of cars[1,4].

The continuing decline of the real price of energy during this period, especially between 1958 and 1970, gave rise to the perception of 'cheap energy', which formed the basis for the 'revolution of rising expectations' by the populations of rich western countries. This led to a large increase in energy use during this period[2].

The concerns of resource depletion and supply constraints were not yet an overriding concern.

Environmental and pollution issues and concerns related to the exploitation of energy had not yet gained momentum, nor had an impact on energy usage patterns.

FIGURE 2.1: Fuel Demand Pattern in the USA.

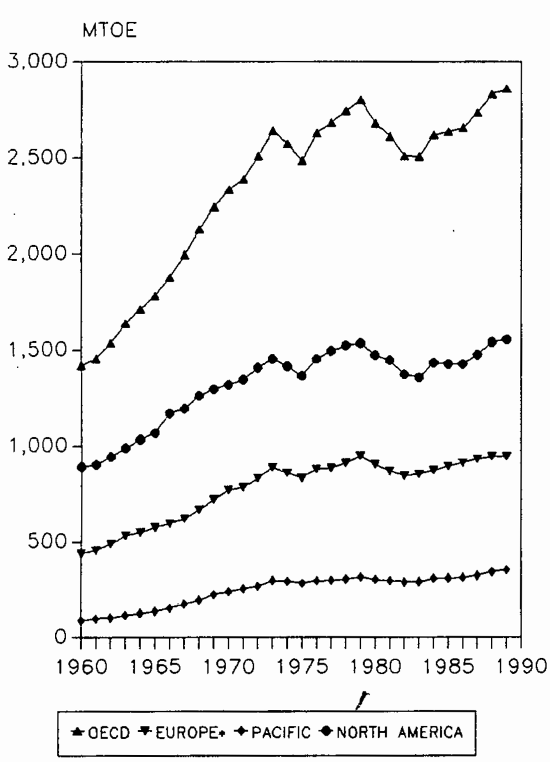


i namely the rich Western nations

ii namely a large number of third world countries.

The subsequent decrease in global energy usage to 2% was mainly as a result of the first and second oil price shocks of 1973-74 and 1979-80, and the subsequent structural changes in the energy system. Economic development also played a role. Figure 2.2 shows the effects of the above on the total final consumption of energy of selected regions. In the late 1960's and early 70's the USA (which was then responsible for some 30%[3] of global energy use), moved into the period of post industrial economic development which is characterized by a lower energy intensity. This was as a result of the service sector growing more rapidly than the manufacturing sector. This in itself exerted a downward influence on global energy usage rates which was aided by other nations entering the less energy intensive post industrial development stage. However the greatest influence on energy usage rates was due to the termination of the downward trend in real energy prices and the enormous increase in oil price with the oil price shock of 1973-4. This brought to an end the perception that energy was cheap (and getting cheaper), which had resulted in the careless, inefficient, use of energy, in an energy intensive economy in which energy was seen as a near costless input[1].

FIGURE 2.2[8,9]:
Total Final Consumption of Energy For Selected Regions - 1960 to 1989



THESIS/GLOBAL2
* EXCLUDES EASTERN EUROPE

This extraordinarily large rise in oil and other energy prices led to structural changes in the energy system which have resulted in a large decrease in the energy intensity of economic activity. This has mainly taken place in Western industrialized countries (WIC), as they are at the stage of development which makes the implementation of efficiency and conservation policies and measures easier than in less developed countries[i].

The inability of developing countries to achieve energy savings, on a scale equal to those of WIC, is in part due to the overwhelming influence of developmental priorities

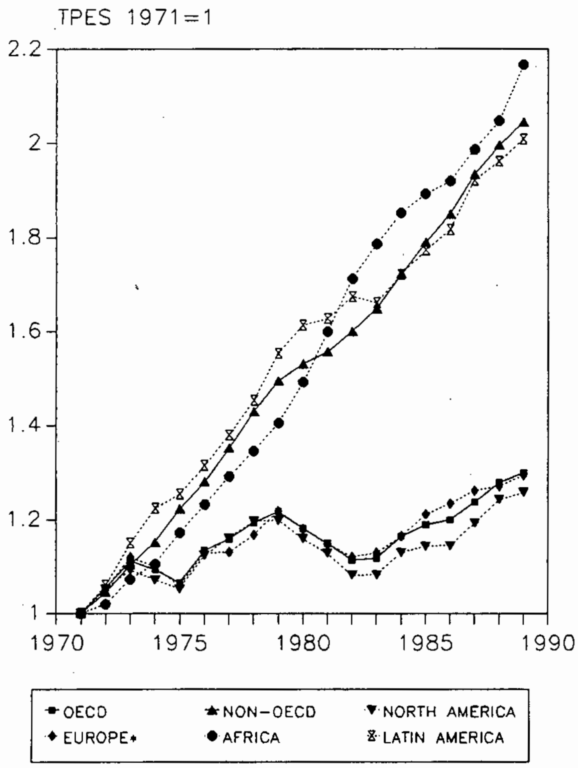
---

i It has been estimated that energy conservation measures adopted in developed countries in the first five years following the 1973 "oil crises", enabled savings amounting to 6 to 12 per cent of their total energy demand[4].

and the energy intensive nature of the industrialization process through which they are going. The lack of finance, resources and skilled manpower has also thwarted attempts at energy conservation and the implementation of energy efficiency measures.

FIGURE 2.3[8,10]**:**

TOTAL PRIMARY ENERGY SUPPLY
RELATIVE TO 1971
(COMMERCIAL + TRADITIONAL ENERGY)



THESIS/GLOBAL3
* EXCLUDING EASTERN EUROPE

Measures aimed at addressing the careless and wasteful use of energy were well established in WIC by the time of the second "oil price shock". These conservation measures have since been intensified, partially due to the growing concern surrounding environmental and resource depletion issues. Figure 2.3 shows the effect the differing stages of development between OECD and non-OECD countries, together with the oil price shocks, has had on the total supply of primary energy. It should be noted that developing countries, and especially countries of the East and Southern Africa region (ESA), were far less prepared for these two oil crisis than WIC[i]. This had a detrimental effect on the economies of ESA countries, from which many are still recovering.

Of significance to the energy community is the fact that the energy predictions made in the 1970's and early 80's did not come about[6]. Instead:

(1) energy demand growth rates were less than expected,
(2) oil prices were at first much higher, and then much lower than expected,
(3) there was a marked change in energy carrier consumption patterns,
(4) oil consumption has been much higher than expected,
(5) growth in the use of coal and nuclear has been much less than anticipated,
(6) renewable energy had less impact than was hoped for,
(7) there was a surprising boom in the consumption of natural gas (production has increased by 100% since 1970).

---

i This was mainly due to a lack of adequate infrastructure, specifically the lack of strategic storage facilities, the lack of adequate procurement options and strategies, the large reliance on imported

These are the results of the underlying global trends of the last decade. Institutional factors such as the organization of oil markets, inter-government interaction, and the liberalization of gas and electricity supply had a great effect on consumption patterns. There have also been changes in the attitude of society towards the energy community, which have manifested themselves in the environmental and "green" movements. This has had a significant effect on the politics and economics of the energy industry. Environmental issues are expected to play an increasingly significant role in the energy sector in the future. Major players in future energy strategies will probably be the introduction of carbon taxes and environmental audits[6].

The liberalization of the electricity and gas supply was started in the USA, closely followed by the UK, and is spreading to Europe and beyond. Liberalization has resulted in privatization, changes in regulations, and vertical disintegration within the industries. The vertical disintegration has resulted in the production, generation and distribution functions being separated into individual businesses, thus helping to establish market relationships. It has also resulted in more efficient utilization of existing infrastructure and resources. Due to this liberalization, as well as growing environmental concerns, new entrants into the electricity generation sector have emerged, the most significant being the increasing use of natural gas. Privatization has also led to the establishment of regulatory bodies to police the energy industries, and to safeguard the public. These regulatory bodies are unexpectedly strong, and have been able to bring about increased pressures, mostly driven by environmental issues, on these privatized industries.

An increasing number of commercialized energy utilities are emerging with a bias against capital investment, due to the inability to guarantee returns and the risks involved. Instead they are purchasing additional supplies from other utilities within their own countries, or from foreign utilities, as well as employing alternative technology to maximize efficiency. This has resulted in a greater emphasis on demand side management. These commercial utilities are finding the cost of providing new supply so expensive, that it is often cheaper to manage the demand side more efficiently so as to extend the existing supply and reduce the need for capital expenditure on new supply. The electricity utilities are doing this by remotely controlling domestic appliances, especially at peak times, implementing sophisticated

(continued)

oil, the lack of adaptability to alternative energy supply forms, the small size of the market and the lack of finance to take advantage of the best procurement options.

pricing schemes and spot pricing mechanisms, subsidizing the purchase of more efficient equipment by customers and importing supply from utilities with spare capacity.

2.2 Energy Usage Patterns, Resources and Resource Utilization

Total primary energy supply data for the World, and Africa are shown in Table 2.1. Total final consumption (TFC) of energy data for the World, Africa, ESA and OECD countries, are shown in Table 2.2. The use of energy by the ESA is low in global terms. Global TFC of energy was 5829,7 MTOE, while that of Africa was 227,4 MTOE and that of ESA was 132,6 MTOE.

TABLE 2.1: TOTAL PRIMARY ENERGY SUPPLY - 1988[8,10] (Million TOE)

CARRIER	AFRICA	WORLD
COAL	81,7	2205,8
OTHER SOLID	0,0	122,9
OIL	88,5	3036,8
GAS	24,1	1588
HYDRO	5,3	194,2
NUCLEAR	2,7	491,9
TRADITIONAL	104,6	423,0
TOTAL	306,9	8062,6

In the ESA, the relative usage of natural gas is lower, and that of traditional energy is higher, than the global average and that of OECD countries. The reliance on nuclear energy in the ESA is restricted to South Africa. Table 2.3 shows World energy resources, on a proven recoverable basis as at the end of 1987, and compares them to those of the ESA and Africa.

TABLE 2.2: TOTAL FINAL CONSUMPTION OF ENERGY - 1988[8,10,12]
(Million Toe)

CARRIER	ESA	AFRICA	WORLD	OECD
COAL	18,5	20,4	929,9	192,3
OTHER SOLID	0,0	0,0	114,2	111,6
OIL	23,2	72,7	2433,9	1497,0
GAS	0,4	8,1	962,0	554,7
ELECTRICITY	14,0	21,5	785,8	492,5
HEAT	0,0	0,0	180,9	12,1
TRADITIONAL	76,5	104,6	423,0	0,0
TOTAL	132,6	227,4	5829,7	2860,1

TABLE 2.3[7,11,12]: ENERGY RESOURCES - PROVEN RECOVERABLE (END OF 1987)

RESOURCE		ESA	AFRICA	WORLD
COAL	BILLION TONS			
BITUMINOUS		60,40	62,6	1075,5
SUB-BITUMINOUS and lignite		0,08	0,26	391,7
OIL	BILLION TONS	0,21	7,6	121,1
GAS	10 M	421,4	7248	109327
HYDRO	TWh/YEAR	1042,9	1311,3	12460
URANIUM*	THOUSAND TONS	544,9	605,4	2355,9

* Recoverable at less than 130 US$ per kilogram

2.2.1 Coal

Coal remains the world's most widely available energy resource. The economics of the coal industry have been transformed by the environmental debate, with demand and prices lower than expected. Annual hard coal production amounted to some 3,3 billion tons, and lignite 1,2 million tons. Thus, sufficient reserves, proven recoverable, are available for several hundred years even with increased production. With the development of coal gasification technology offsetting the environmental concerns, and the depletion of oil and gas reserves, it is expected that coal will again attain its mid-sixties position as the World's primary energy source in consumption terms[6,7]. This would result in an increase in the price of coal.

Currently 90 % of coal is consumed in the source country. Countries with coal resources are expected to rely increasingly on coal, and thus this trend is expected to continue.

2.2.2 OIL

The consumption of oil was effected significantly by the two oil price shocks. Environmental concerns have subsequently maintained pressure on the consumption of oil. There has been a reduction in the global oil intensity since 1973. The most dramatic reduction occurred between 1973 and 1980 when the global oil intensity dropped from 0,30 to 0,19 tons/US$(1980)[7]. In the production of electricity and in the industrial sector oil has been displaced by nuclear, coal and natural gas. In the household and tertiary sectors oil has been replaced by gas, electricity, and coal. This trend is continuing. Thus although it is predicted that global energy consumption will continue increasing at a rate of 2% per annum, it is predicted that oil consumption will increase at only 1% per annum[7].

Annual production of oil in 1987 was 2,8 billion tons, whilst resources, proven recoverable, amount to some 121,0 billion tons. Thus present reserves are limited, and at present rates of production, will only be sufficient for 40 - 50 years. However it is expected that oil will still play a significant role in the supply of energy for some time to come.

2.2.3 GAS

There has been a large increase in the consumption of gas since the early 1970's. Production has increased by 100% since 1970, and it expected to increase by 2,2 to 2,4% per year until the end of the century[7]. The growth in the use of gas is anticipated to be strongest in Africa, the Middle East and Asia, where present usage is low and reserves are abundant and growing with increased exploration.

The following factors, amongst others, have been the main driving force behind the large growth in the use of natural gas[6,7]:

the abundance of reserves and the growing number of "gas rich countries".

natural gas is a high quality fuel and this, together with the liberalization of the supply industry has made it an attractive fuel.

capital costs are lower than for other fuel types.

natural gas has a lower environmental impact than coal and oil, and is more acceptable to the public and to politicians than nuclear;

its emissions of SOx, NOx and CO_2 are less than those from coal and oil.

transport infrastructure and storage facilities are inconspicuous

the image of a cleaner fuel has enabled utilities to gain optimum plant siting permission much more effortlessly.

the cost of transport infrastructure can be shared by a number of sectors of the market.

the emergence of "gas grids" in Europe, which are shared by many sectors of the economy, have made gas an attractive option.

reserve reassessments undertaken over the last decade which have indicated reserves larger than previously estimated have guaranteed security and stability of supply and have won the confidence of the end users.

Annual production of gas in 1987 was 1923 billion m^3 and resources, proven recoverable, amount to some 109,3 billion m^3. Thus, present reserves are somewhat limited and at present rates of production will only be sufficient for 50 - 60 years. However, total recoverable gas resources are expected to rise as many areas have still not adequately been explored for gas reserves. None-the-less, due to the large number of projects utilizing gas under construction, or planned, there is a possibility of a gas price "crunch" in the late 1990's[6]. Conversely, utilities have confidence that coal gasification will have been perfected by then and they will be able to switch to this source of fuel at an acceptable cost, if necessary.

2.2.4 Nuclear

Annual production of uranium in 1987 was 36 311 tons, and resources, proven recoverable at 130 US$ per kg, amount to some 2 355 945 tons.

At present only France and Japan are actively following a nuclear programme. Opposition, mainly from the public, to nuclear power has been increasing, and most other countries have a "nuclear freeze", although a number of plants are presently being constructed in fulfillment of previous contracts . The nuclear industry's image was severely tarnished by the Chernobyl accident, and the fact that reliability of nuclear installations has not been as high as was hoped, due to unexpected problems. Nuclear technology is seen by many as not having matured yet. Parties promoting the nuclear industry are using the greenhouse effect as an argument for nuclear electricity generation.

Many people and utilities, including Electricite de France (EDF), and some Government Ministries, believe that nuclear power will be revived. However the nuclear industry still does not have an acceptable package. Present thinking in nuclear circles indicate that;

(1) nuclear energy is too complex and sophisticated for many utilities,
(2) nuclear designs need to be standardized,
(3) nuclear designs need to be simplified,
(4) more effective management of radiation hazards is necessary (especially in the areas of safe and effective, long term, waste disposal),
(5) the improvement of both Western and non-Western standards, and
(6) the problems and issues associated with decommissioning need to be addressed satisfactorily.

There is a growing belief that due to the plentiful uranium resources, technical resources should be used to improve conventional nuclear designs, rather than to develop breeder and fusion reactors, and that reprocessing of fuel should be delayed until it is the only option left.

2.2.5 Fuelwood

Fuelwood used directly, or in the form of charcoal, is probably the world's most widely used fuel. It is universally used in the domestic sector throughout the rural areas of the developing nations. The degree of dependence by nations on fuelwood is broadly related to the level of economic development.

In a number of areas in the developing World, fuelwood supplies are becoming increasingly scarce. People are having to spend an increasing amount of time collecting supplies. There have been many programmes to encourage rural people to grow trees to meet their energy needs, but the impact of these efforts has been minimal.

It is generally accepted that the expansion of agriculture is the main reason for the loss of forests. However the increasing use of wood for energy is adding to the problem. It would therefore seem that any solution to the problem of fuelwood shortages will need to incorporate the needs of agriculture in an integrated manner.

2.3 Energy Indicators

Figures 2.4 and 2.5 show energy consumption per capita,for selected countries, in terms of final consumption, for commercial energy and total[i] energy respectively. In general, per capita consumption is a function of development (GDP/capita). Commercial energy consumption per capita ranges from 0,07 TOE per capita (Ethiopia) to 7 TOE per capita. Total energy per capita ranges from 0,1 TOE per capita (Bangladesh) to 8 TOE per capita.

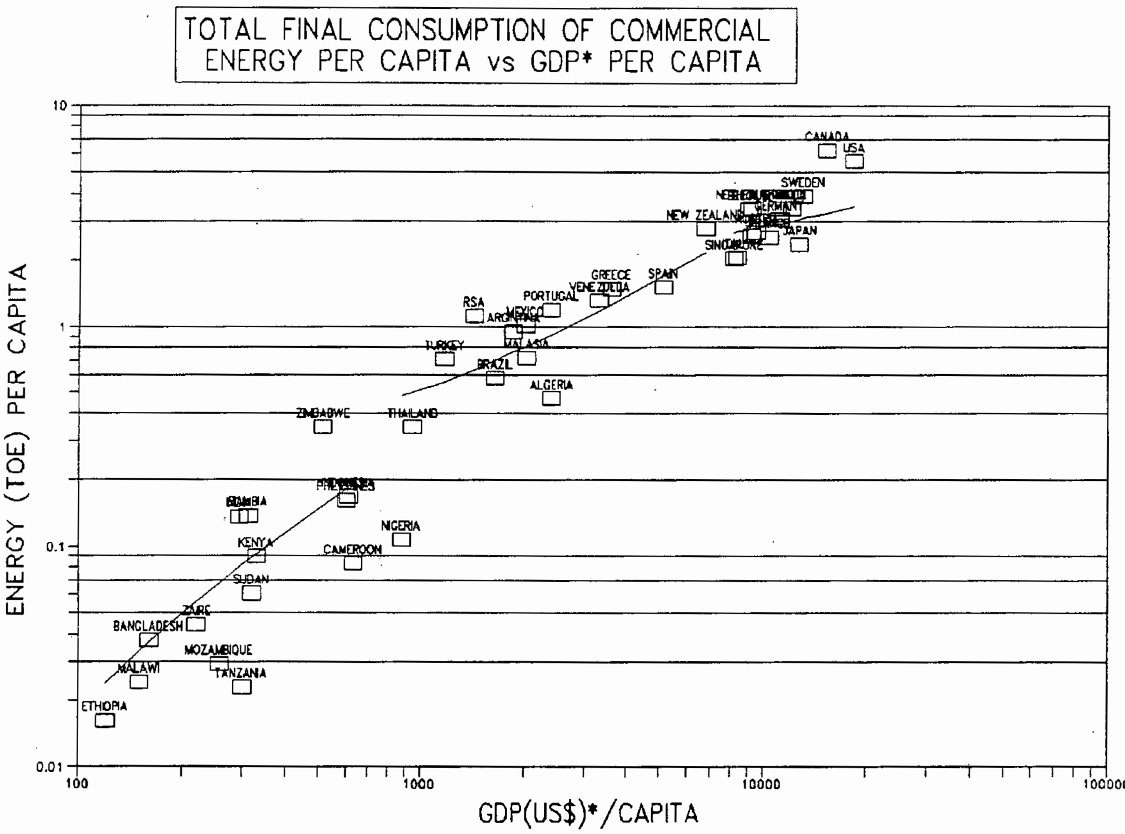
In terms of commercial energy, it can be seen (from Figure 2.4) that the initial stages of development are associated with a rapid increase in energy consumption per capita . The rate of increase in commercial energy consumption with development decreases as economies mature, and there is a further decrease in the rate as countries enter the post industrial stage of development.

In terms of total energy, the rate of increase of energy consumption with development is complicated by the substitution of commercial energy for traditional energy, as a result of the development process, and the resultant large increase in end use efficiency. The initial and intermediate stages of development are associated with the substitution of commercial energy for traditional energy, and the trends are thus masked by the difference in end use efficiency.

---

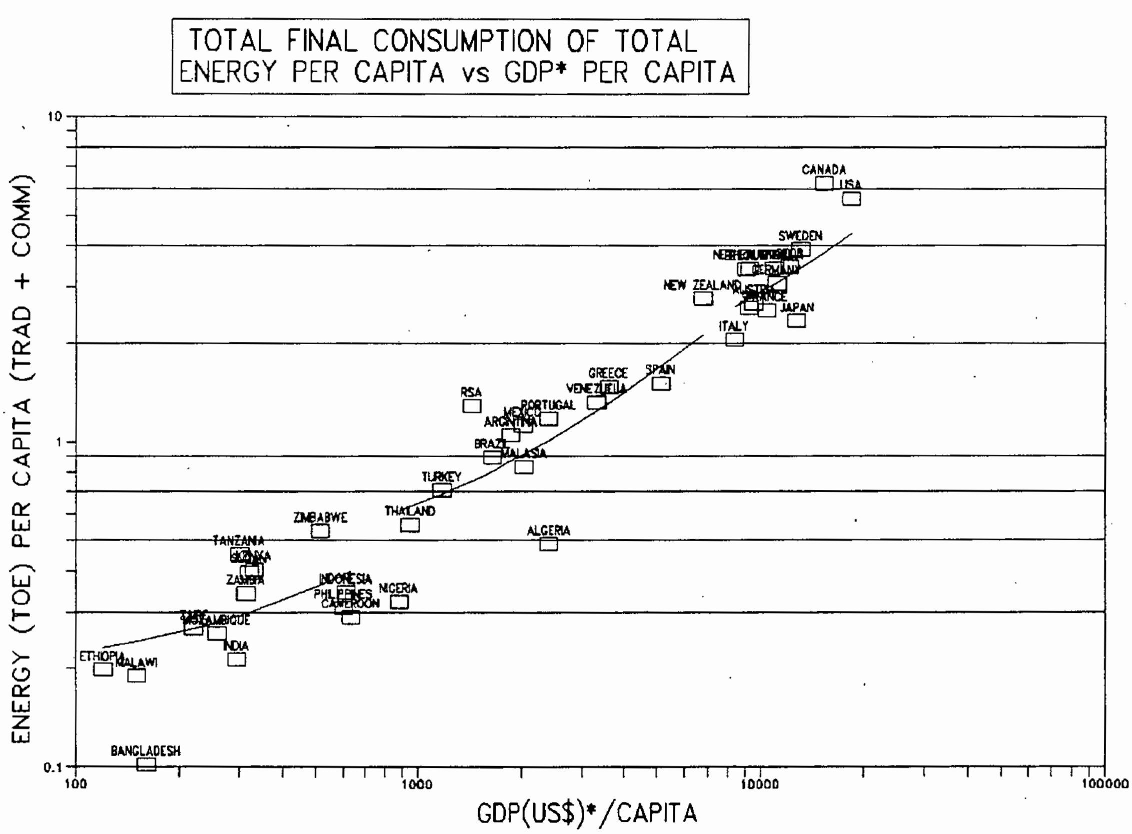
i Commercial and traditional energy.

FIGURE2.4[8,10,12,13]:



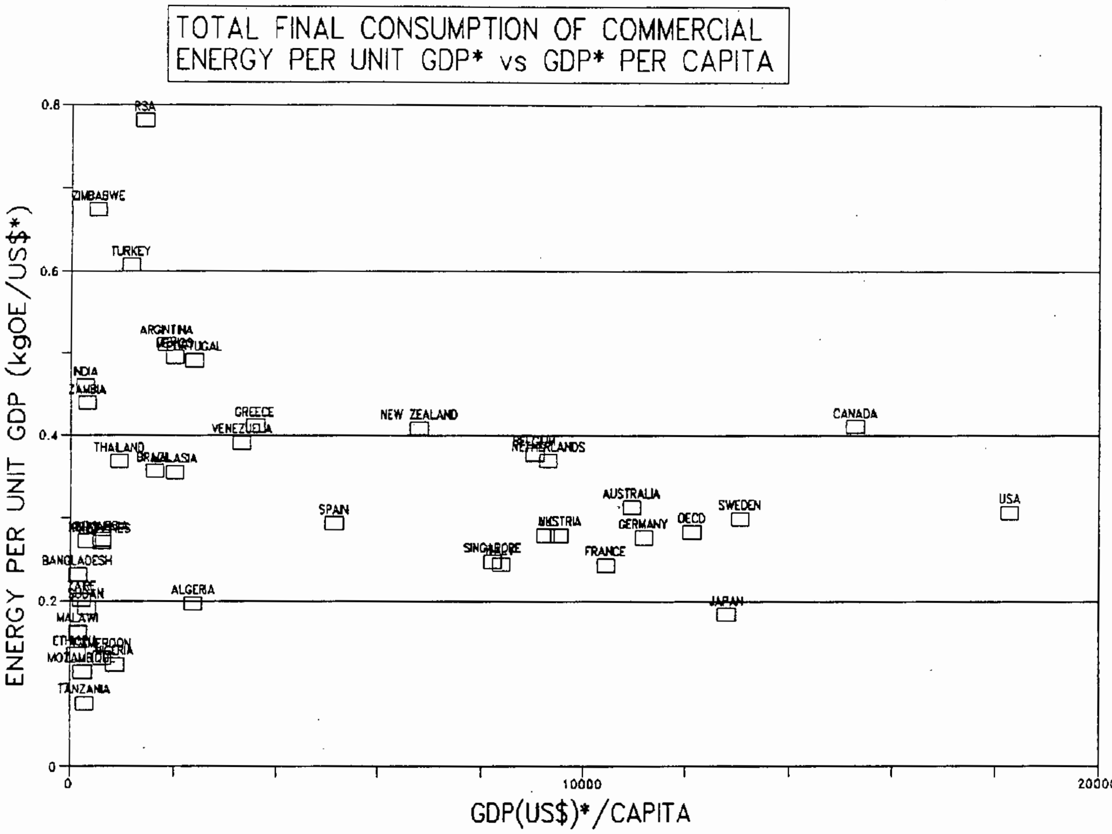
* REAL LOCAL CURRENCY CONVERTED USING 1985 US$ EXCHANGE RATES

FIGURE 2.5[8,10,12,13]:



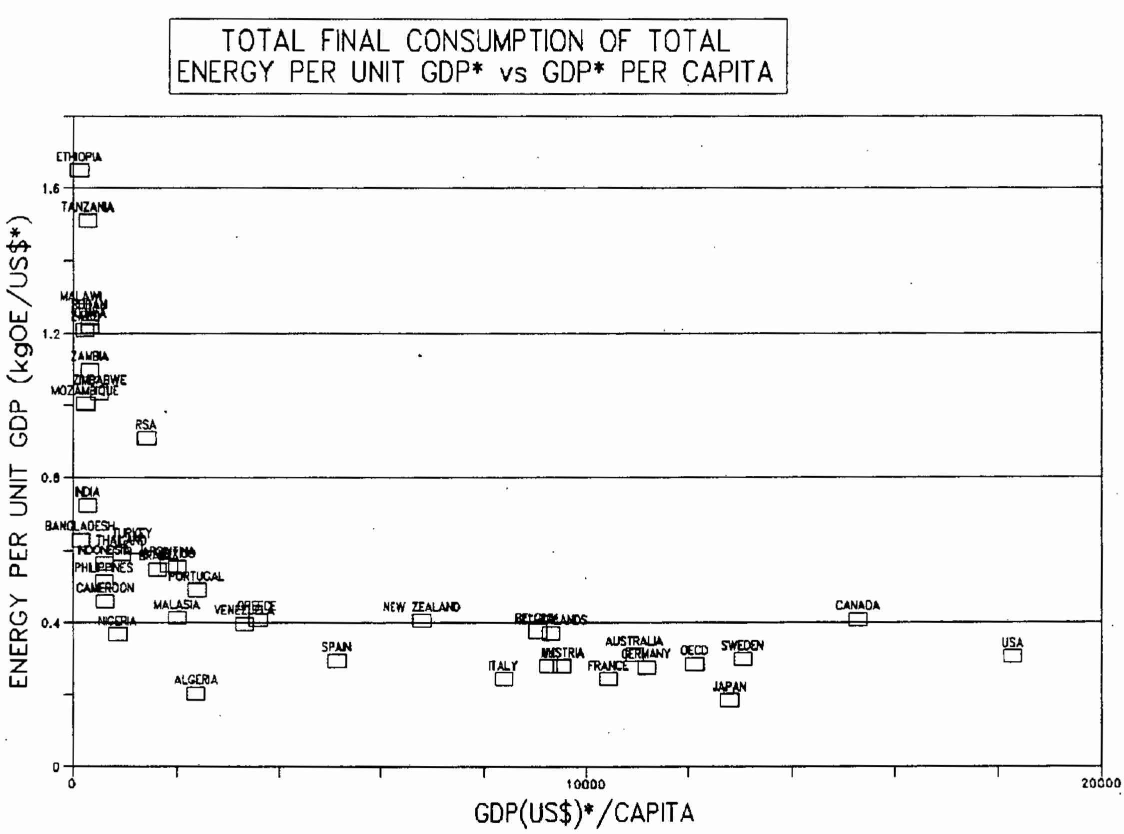
* REAL LOCAL CURRENCY CONVERTED USING 1985 US$ EXCHANGE RATES

FIGURE 2.6(8,10,12,13)**:**



* REAL LOCAL CURRENCY CONVERTED USING 1985 US$ EXCHANGE RATES

FIGURE 2.7(8,10,12,13)**:**



* REAL LOCAL CURRENCY CONVERTED USING 1985 US$ EXCHANGE RATES

Figures 2.6 and 2.7 show energy intensity on a final consumption basis versus development (GDP/capita) for commercial and total[i] energy. Commercial energy intensities range from 0,2 kgOE per US$(1985)[ii] (Tanzania) to 0,8 kgOE per US$(1985) (South Africa). Figure 2.6 indicates that initial development is associated with low commercial energy intensities, which increase during the early industrialization process, and later decrease, due to increased efficiency and the low energy intensity nature of post industrial societies. In contrast, Figure 2.7 indicates that total energy intensity decreases rapidly with industrialization and increased development. This reflects the large increase in efficiency in the end use of energy, due to the substitution of commercial energy which is associated with the development process. This phenomenon is also partially due to the fact that a portion of the traditional energy component is used in the informal sector which is not accounted for in classical GDP statistics. It would be expected that if the difference in end use efficiencies between traditional and commercial energy types was accounted for, as well as the inadequacies of GDP measurement, Figure 2.7 would show a similar trend to that of Figure 2.6.

2.5 Conclusion

Natural gas, energy efficiency and demand side management will emerge as the key players in the energy sector , although oil will still play a significant role. Renewable and nuclear energy can be ruled out as major players in the short to middle term. With the perfection of coal gasification technology, and the depletion of gas and oil reserves, coal is expected to regain its position as the world's primary energy resource in the long term.

Institutional factors drawn from the international political sphere are going to play a major role in future energy policies and strategies. An example is the formation of the EEC in 1992 which could result in a major change in the electricity industry, due to the envisaged implementation of "blanket" regulations governing the industry.

In the past the environmental debate has been driven by emotive factors, resulting in some foolish, and unrealistic solutions being put forward and implemented. Solutions to the environmental issues are increasingly being driven by market incentives instead of government legislation. Transport is emerging as the chief environmental issue, and it is generally accepted that the utilization of motor vehicles needs to be curtailed.

---

i Commercial and traditional energy.

ii Real local currency converted at 1985 US$ exchange rates.

Major players in future environmental related energy strategies will most probably be the introduction of carbon taxes and environmental audits. The introduction of environmental audits, whereby imports into WIC will only be allowed from those countries who practice acceptable environmental controls, could result in a two-tier Third World: those countries which are able to meet acceptable environmental standards and those that cannot.

A knock-on effect of the increasing environmental regulations in the WIC is that many environmental decisions are being taken out of the hands of the Third World as international companies are increasingly only producing "environmental" products/components. This could have a dramatic effect on the Third World motor car and petroleum industries.

Due to the underdeveloped nature and the low level of industrialization of much of ESA, economic and social development will be accompanied by;

(1) an increase in the consumption of energy per capita,
(2) a rise in commercial energy intensity,
(3) the substitution of commercial energy for traditional energy, and
(4) an increase in end use efficiency and a related decrease in total energy intensity[i].

Consumption patterns and environmental concerns, energy sector trends, issues, problems and structure in ESA, differ in many respects from those of the WIC. However it is necessary to keep the international picture in mind when studying the energy sector of the region as it often impacts on the regional scene, and there are lessons to be learnt.

---

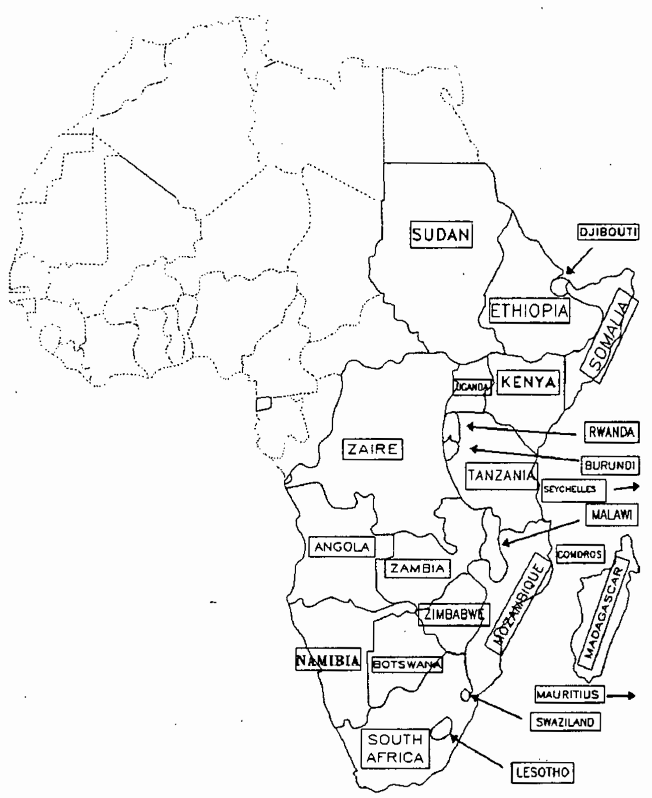
i This will not be true if population growth (with which traditional energy consumption is closely related) is greater than the rate of substitution by commercial energy (which is related to the rate of increase in GDP per capita or more crudely to development).

3. Energy in - EAST and SOUTHERN AFRICA

This chapter gives a profile of the energy sector of the **East and Southern Africa Region (ESA)**. The institutional infrastructure, demography and economy of ESA are discussed in order to give a background to the region and indicate how these impact on the energy sector. Energy supply and demand, markets, resources, technology, security and environmental issues, amongst others, are studied. Key problems, issues,and options are identified and strategies for solutions put forward. The data and information contained in the Energy Profiles[(5)] of thirteen of the major countries of the region was used as a basis for this chapter[i].

3.1 INTRODUCTION

The Eastern and Southern African Region (ESA) encompasses 24 countries and is bounded to the north by Zaire, Sudan and Ethiopia[ii]. It also includes Madagascar, Seychelles, the Comoros and Mauritius. The topography of the region is quite diverse, with tropical forests in the equatorial region, and more arid savannas and desert areas further to the north and south. Water resources are abundant in the central equatorial areas, but scarce elsewhere. Other resources such as energy and minerals are abundant throughout the area, but varied in type and location. A large portion of the region is plagued by recurrent cycles of drought, and shortages of food are common in many countries.



The region is characterized by large cultural and linguistic differences. Population growth rates are high, averaging 3,2%, which has resulted in the region having a young population.

---

i These Country Energy Profiles were compiled as part of the research undertaken for this thesis.

ii A list of countries and general statistics are contained in Appendix A.

Although the present levels of urbanization in the region are low, urban population growth rates are very high, far exceeding the average population growth rates. This results in the proliferation of peri-urban squatter settlements with the concomitant socio-economic problems, and creates extraordinary demands for housing, services and jobs which are far beyond the capacity of most cities to fulfill.

Life expectancy is low while infant mortality rates and live birth rates are high. The crude death rate in the region is significantly higher than rates in more developed countries.

Illiteracy rates in the region are very high, especially amongst females. Of particular concern to the energy sector, as well as the industrial sector, is the lack of suitably qualified and competent technical and scientific personnel at all levels.

Political systems in the region have been profoundly affected by European Colonization. Colonization of the region led to the creation of artificial boundaries dictated by the division between the colonizing powers rather than any logical division on traditional, cultural or geographical grounds.

During the colonial period the countries of the region were regarded as sources of minerals and labour, and little was done to develop them as self-governing entities with local entrepreneurial and administrative skills. Many of the countries, on achieving independence, chose a socialistic system rather than return to the traditional institutions of the past. The welding of Marxist ideology to African political systems has led to a strong central control by government and to an interventionist system which has hampered the development of a sound regional economy. Decisions are often made more for ideological reasons rather than for technical or economical reasons. Price controls, taxes, and subsidies are common means of achieving political goals, leading to distortions in production and distribution. This has had an impact on the ability of the energy sector to perform adequately and efficiently.

The mass exodus of colonial powers in the post-war years, with the granting of independence to these countries, left them with few technical and administrative skills, illogical boundaries and alliances, and great expectations from the sharing of wealth.

In line with the events in Eastern Europe, the countries of the region are re-assessing their political and economic systems. Those with the worst political problems appear to be reaching some form of rapprochement between the dissenting parties although recent events in Zaire are disheartening.

Over the last two decades the economy of the region has deteriorated significantly. The per-capita economic growth rate has been negative, the balance of payments has been deteriorating, serious foreign exchange shortages exist, and unfavourable terms of trade are intensifying. A significant feature of the economy of the region is its dualistic nature, with an evident formal sector representing organized agriculture, mining, manufacturing, and commerce, together with a large informal sector which consists mainly of subsistence economies, in which the government plays almost no role. The link between these two sectors is limited and in many cases this poor link results in serious institutional problems.

In the area of economic development, the region would greatly benefit from increased cooperation and trade across national boundaries. However the political problems within individual countries and between certain countries, such as between South Africa and its neighbours, have mitigated against such cooperation. Significant benefits should accrue from the present political changes taking place.

Commercial energy consumption in the region is dominated by South Africa. Due to the low level of development and the poor economic condition of the region, there is a great reliance on traditional forms of energy, mainly in the domestic sector, but also in the commercial sector in certain countries. The domestic sector is the single largest consumer of energy in most countries, South Africa being the notable exception.

Deforestation is occurring in many areas, mainly as a result of clearing for agricultural production, although the collection of fuelwood also plays a role especially in the areas surrounding population centers. The result is that serious in-roads are being made into forestry resources, which in many cases are no longer self sustaining. In a number of countries demand for fuelwood has outstripped supply, jeopardizing energy availability to the population of many areas.

The region is endowed with large reserves of commercial energy resources including coal, hydro and geothermal potential, gas, oil, peat, solar, wind and uranium. These vast energy reserves are large enough to supply the needs of the region for a considerable time, although, they are mostly unexploited which is a reflection of the poor economic development of the region. For instance the hydro-potential of the Zaire and Zambezi Rivers is large, with the Zaire River alone being able to supply all the electricity needs of countries in the region. If present oil production from Angola, 93% of which is exported outside the region, was traded within the region it would satisfy approximately 82% of the region's oil requirements, and stimulate regional economic growth at the same time. It is thus increasingly being realized that the resources of the region as a whole should be incorporated into energy planning in an integrated manner.

The promotion of the exploitation of energy resources, for the benefit of the region as a whole, is reliant on regional cooperation and energy interchange . A change from confrontational to cooperational politics could enable the regional interchange of energy, and the utilization of local resources to be used for the benefit of the whole region. This would;

(1) enable more efficient use to be made of the region's resources,
(2) increase the use of idle capacity in certain countries,
(3) reduce the outflow of scarce foreign exchange from the region as a result of the associated decrease in the dependence on imported commercial energy,
(4) improve the security of energy supply to the region as a whole,
(5) and most importantly , stimulate economic growth. This can only become a reality once political stability is achieved in the region.

The energy community transcends political and ideological barriers, and through its regional initiatives it can play a leading role in paving the way for regional cooperation between governments. However, without institutional reform and the establishment of integrated sectorial policy and planning, at national as well as regional level, encompassing both the commercial as well as traditional energy sources, deforestation will continue unabated, and a solution to the provision of adequate and reliable energy will be impossible.

3.2 DEMOGRAPHY

This section describes the demography of the region, indicating variations within the region, as well as variations between the region and Western Industrialized Countries. Characteristics and trends which have an impact on the energy sector are identified.

3.2.1 Introduction

The total population of the Southern and Eastern Sub-Saharan African Region (ESA), according to World Bank[13] data, was estimated to be approximately 285,8 million in 1988. The populations of countries within the region have been growing rapidly with population growth rates significantly higher than those in developed countries. In many of these countries Real GDP growth rate in local currency has not been able to keep up with the population growth rate, resulting in a decreasing trend in GDP per capita. This has been exacerbated in many cases by a decrease in local currency value against the US$. Table 3.1 shows population growth rates for various countries in the region as well as GDP(US$)/Capita. It should be noted that these figures represent the official rates which are often pegged artificially low. This over valuation of local currency is reflected in significantly higher parallel black market rates in many countries. A human development index (as defined in reference 5), which gives a more realistic statistical measure of human development than gross domestic product, is included.

FIGURE 3.: Population of the East and Southern Africa Region (ESA).

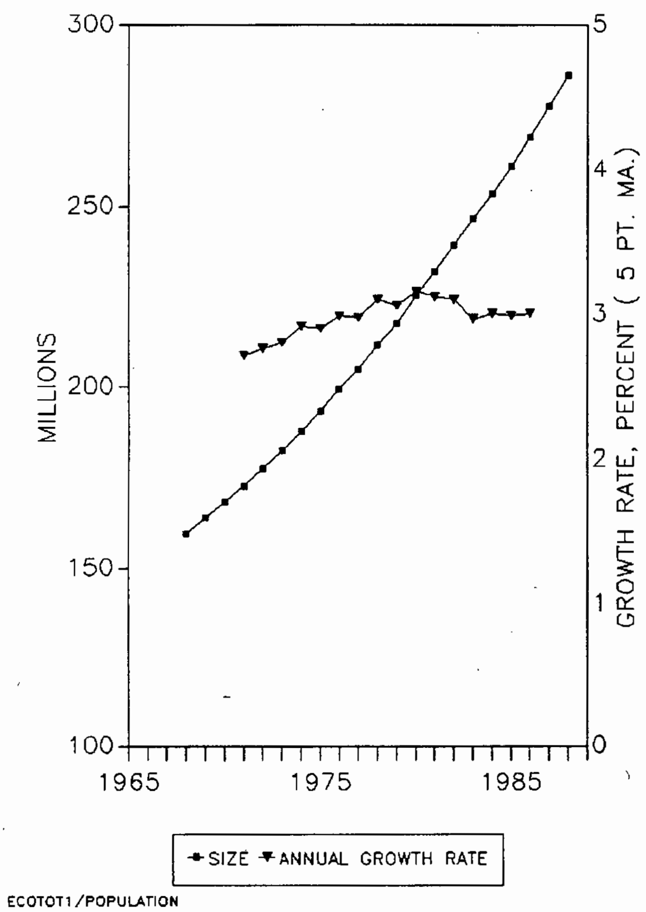


Figure 3. shows the total population of the region and the average annual growth rate over the period 1968-1988. The high population growth rates can, to some extent, be

attributed to the widespread introduction of medicine and the associated immunization programmes introduced into Sub-Saharan Africa by the various colonialists and philanthropic organizations, coupled with the lack of education, low literacy rates and low income of the majority of the population of the region. The high population growth rates (and low life expectancy) has resulted in a young population in the region. On average over 45% of the population of countries in the region are under 15 years old and some 65% are under 25 years old[14,15]. Notable exception include South Africa (35% and 56%) and Mauritius (30% and 52%). In Europe and America populations are relatively older and on average 19% are under 15 years of age and 35% are under 25[14].

TABLE 3.1 Population Growth Rates and GDP per Capita[12,13,14,16,17].

COUNTRY	POPULATION	GROWTH RATE	GDP(US$)/CAPITA (Current)		Human Development Index
	PERIOD	%PER ANNUM	1982	1988	1990
ANGOLA	1980-1987	2,5	541	546*	0,150 (147)**
BOTSWANA	1990	3,4	805	1 542	0,525 (95)
ETHIOPIA	1979-1988	2,6	112	120	0,166 (141)
KENYA	1979-1988	4,1	352	374	0,399 (113)
LESOTHO	1980-1989	2,6	242	255	0,432 (107)
MADAGASCAR	1980-1987	3,1	310	160	0,371 (116)
MALAWI	1977-1987	3,5	185	145	0,179 (138)
MAURITIUS	1980-1987	1,2	1080	1860	0,831 (47)
MOZAMBIQUE	1980-1987	2,6	190	85	0,155 (146)
SOMALIA	1979-1988	2,9	548	285	0,188 (149)
SOUTH AFRICA	1980-1986	2,3	2 412	2 441	0,766 (57)
SUDAN	1979-1988	3,1	400	493	0,164 (143)
SWAZILAND	1990	3,4	855	827	0,462 (104)
TANZANIA	1979-1988	3,5	312	130	0,266 (127)
UGANDA	1979-1988	3,1	110	263	0,204 (134)
ZAIRE	1979-1988	3,1	322	192	0,299 (124)
ZAMBIA	1980-1987	3,7	640	530	0,351 (118)
ZIMBABWE	1982-1988	2,7	905	683	0,413 (111)
CANADA					
FRANCE	1980-1987	0,5	10 180	16 983	0,971 (10)
GERMANY	1980-1987	-0,1			0,959 (14)
GREECE					
JAPAN	1979-1988	0,6	9 175	23 309	0,993 (1)
SPAIN					
SWEDEN	1979-1988	0,2	12 110	21 700	0,982 (4)
U K	1979-1988	0,14	8 662	14 500	0,967 (11)
U S A	1979-1988	0,98	13 367	19 700	0,976 (7)

* ... 1985

** ... Rank out of 160 Countries given in brackets.

3.2.2 Population Distribution

3.2.2.1 Population Densities

Population densities vary considerably in the region. Both the tropical rain forests and the desert areas have very low population densities. The wide variation in population density in other areas can be attributed to historical circumstances, geographical differences , productivity of the land, and mineral deposits. Average country population densities on the continent range from 2 per km^2 (Botswana) to 70 per km^2 (Uganda) , while on the islands in the region densities are much higher. Mauritius has a population density of 510 per km^2 and the Comoros 212 per km^2. Population densities within the countries vary greatly as would be expected, with the highest densities in the urban areas and rural densities being dictated mainly by geographical differences. The high densities in the rapidly growing "squatter" settlements is a cause for concern, and makes the provision of an adequate commercial energy supply infrastructure a daunting task, while the low densities in the rural areas results in financial and logistical difficulties with respect to electrification.

3.2.2.2 Urbanization

The present level of urbanization in the region is relatively low, typically ranging between 10% and 30% of the total population, with a few notable exceptions such as South Africa (60% in 1990), Zaire (40% in 1990), Zambia (50% in 1990) and Mauritius (41% in 1990)[14,16]. Table 3.2 shows urban population as a percentage of total population and urban population growth rates for selected Sub-Saharan African countries, and compares them to selected industrialized countries.

These urban percentage figures are much lower than those of the industrialized countries, where urbanization typically ranges from 70 to almost 100%. The urbanization process in these industrialized countries was relatively slow, allowing governments time to plan and provide for the needs of an increasing population. In the ESA region, urban population growth rates are very high, far exceeding the average population growth rates. This can be attributed mainly to population pressure on the land, the associated degradation of the soil and the poor economic prospects in the rural areas, which together influence people to migrate to the cities where they perceive prospects to be better. Governments have been unable to plan and provide for the needs of this rapidly increasing urban population. This results in the proliferation of peri-urban squatter settlements with the concomitant socio-economic problems, creating extraordinary demands on the energy sector for the provision of an adequate supply infrastructure. There is also an increasingly large need for housing, services and jobs which are far beyond the capacity of most cities to fulfill

TABLE 3.2 Urban Population Statistics[16]

COUNTRY	URBAN POPULATION AS PERCENTAGE OF TOTAL		URBAN POPULATION GROWTH RATE 1960-1990 (% PER YEAR)
	1960	1990	
ANGOLA	10	28	5,9
BOTSWANA	2	28	13,5
BURUNDI	2	6	5,5
DJIBOUTI	50	81	7,3
ETHIOPIA	6	13	4,8
KENYA	7	24	7,7
LESOTHO	3	20	8,6
MADAGASCAR	11	24	5,6
MALAWI	4	12	6,5
MOZAMBIQUE	4	27	9,5
NAMIBIA	15	28	4,8
SOUTH AFRICA	47	60	3,2
RWANDA	2	8	7,4
SOMALIA	17	36	5,8
SUDAN	10	22	5,4
SWAZILAND	4	33	10,5
TANZANIA	5	33	10,3
UGANDA	5	10	6,1
ZAIRE	22	40	4,8
ZAMBIA	17	50	7,1
ZIMBABWE	13	28	5,9
CANADA	69	77	1,7
FRANCE	62	74	1,3
GERMANY	76	85	0,6
GREECE	43	62	1,9
JAPAN	63	77	1,6
SPAIN			
SWEDEN	73	84	0,9
UK	86	89	0,4
USA	70	75	1,3

Urbanization in South Africa has been complicated by "apartheid" legislation which enforced segregation with respect to colour. For generations, the urbanization of black people was made difficult by requiring them to live in areas far from the main cities. With the lifting of racial restrictions on where people may live and work, many unemployed people in the homelands migrated to the major South African cities in search of work. The shortage of accommodation in cities has forced them to live in shack towns or squatter camps. This has resulted in a rapid increase in the number of urban people who need electricity, land, water, health care, and education facilities.

The lack of employment opportunities in the formal sectors has resulted in a fast growing informal sector. The lack of job opportunities at home and the better prospects and living conditions abroad has influenced many of the better educated to emigrate, thus undermining the economy's ability to develop and provide employment to the populace. This has undermined the technical, management and administrative skills, resource base of the energy sector.

3.2.3 Social and Cultural Indicators

3.2.3.1 Social Indicators

Compared to the First World, life expectancy is low while infant mortality rates and live birth rates are high. The Crude death rate in the region are significantly higher than those of more developed countries. Table 3.3 shows the infant mortality rate, live birth rate, crude death rate and life expectancy for selected countries of the region and compares these to some first world countries.

3.2.3.2 Health

Table 3.4 gives a number of health indicators for selected countries of the region and compares them to developed countries.

Access to health services is relatively low while the ratio of population per doctor and per nurse is high. Public health expenditure is generally very low. It has been estimated[16] that in excess of half the Sub-Saharan population does not have access to public health services, while traditional medicine and spiritual healing still play an important role. About two thirds of the population do not have access to safe drinking water and tropical diseases are prevalent. Approximately 18 million people in the Sub-Saharan region suffer from sleeping sickness and malaria kills hundreds of thousands of children each year[16]. The spread of the Aids virus is a serious problem in the region and could have far reaching effects. It has the potential to wipe out a large proportion of the 18-35 year old age group[18], who represent over 60% of the economically active population[14], with disastrous effects on the economy of the region. At the Fifth International Conference on Aids in Africa held in Kinshasa, Zaire, it was announced that 5 million people on the African continent were infected with Aids representing 62% of the total World figure. The countries most affected are Burundi, Kenya, Rwanda, Uganda, and Zaire[18].

TABLE 3.3 Social Indicators[14,16]

COUNTRY	INFANT MORTALITY RATE*	LIVE BIRTH RATE#	CRUDE DEATH RATE+	LIFE EXPECTANCY AT BIRTH MALE	FEMALE
ANGOLA	137,0	-	20,2	42,9	46,1
BOTSWANA	67,0	47,3	11,7	52,3	59,7
ETHIOPIA	154,3	43,7	14,5	39,4	42,6
KENYA	70,0	53,9	11,9	56,5	60,5
MALAWI	150,5	53,0	20,0	38,1	41,1
MOZAMBIQUE	141,5	45,0	18,5	44,9	48,1
SOUTH AFRICA**	72,5	31,7	9,8	57,5	63,5
UGANDA	102,7	50,1	15,4	49,4	52,7
ZAMBIA	79,8	51,2	13,7	50,4	52,5
FRANCE	7,6	14,1	9,5	71,3	79,5
JAPAN	5,2	11,4	6,2	75,2	80,9
U K	9,1	13,3	11,6	71,6	77,5
USA	10,3	15,5	8,7	71,2	78,2

* number of deaths of infants under 1 year of age per 1000 births (1986 data).

\# number of live births per 1000 population (1986 data).

\+ number of deaths per 1000 population excluding infants under 1 year of age

** excluding homelands

TABLE 3.4 ILLITERACY RATE IN THE OVER 15 AGE GROUP[16,19]

COUNTRY	YEAR (%)	MALE (%)	FEMALE (%)	TOTAL (%)
ANGOLA	1990	44,4	71,5	58,3
BOTSWANA	1985	18,0	40,0	30,0
BURUNDI	1985	47,0	68,0	58,0
COMOROS	1985	44,0	60,0	52,0
DJIBOUTI	1985	82,0	87,0	86,0
KENYA	1990	20,2	41,5	31,0
MADAGASCAR	1985	14,0	32,0	23,0
MALAWI	1985	48,0	69,0	58,0
MAURITIUS	1985	11,0	23,0	17,0
MOZAMBIQUE	1985	61,0	84,0	72,0
NAMIBIA	1985	-	-	27,0
SEYCHELLES	1985	-	-	40,0
SOMALIA	1990	63,9	86,0	75,9
SOUTH AFRICA	1985	-	-	15,0
SUDAN	1990	57,3	88,3	72,9
SWAZILAND	1985	30,0	34,0	32,0
TANZANIA	1985	-	-	48,0
UGANDA	1990	37,8	65,1	51,7
ZAIRE	1985	21,0	47,0	34,0
ZAMBIA	1990	19,2	34,7	27,2
ZIMBABWE	1990	26,3	39,7	33,1
BRAZIL	1985			11,5
CANADA	1985			1,0
FRANCE	1985			1,0
GERMANY	1985			1,0
GREECE	1985			7,0
JAPAN	1985			1,0
SPAIN	1985			5,0
UK	1985			1,0
USA	1985			1,0

TABLE 3.5 Tertiary Education Statistics[16]

COUNTRY	SCIENTISTS AND TECHNICIANS PER 1000 PEOPLE (1986-88)	TERTIARY GRADUATES AS AS A % OF CORRESPONDING AGE GROUP
BOTSWANA	1,2	0,6
DJIBOUTI	0,1	-
KENYA	2,5	0,2
MADAGASCAR	-	0,4
MALAWI	-	0,1
MAURITIUS	24,3	0,7
RWANDA	0,2	0,1
SUDAN	0,1	0,4
UGANDA	-	0,1
ZAIRE	-	0,2
ZAMBIA	4,4	0,2
ZIMBABWE	-	0,5
CANADA	257	14,0
FRANCE	83	12,1
GREECE		
JAPAN	317	11,5
SPAIN	130	5,1
SWEDEN	262	10,7
USA	55	15,5
UK	-	10,4

Of particular concern to the energy sector, as well as the industrial sector, is the lack of suitably qualified and competent technical and scientific personal at all levels. This is reflected in Table 3.5 which shows the number of Scientists and Technicians per 1000 people and the tertiary graduate ratio in ESA, countries and compares them to industrialized and other developing countries.

Education will be a vital component in any solution to the regional problems, especially with respect to the curbing of population growth rate, development of the economy and provision of jobs. In this respect the creation of a technical skills resource base is essential.

3.2.5 Culture and Nationalism

The region is characterized by large cultural and linguistic differences. The natural tribal and linguistic boundaries were destroyed by European colonialism. All over Africa boundaries were laid down, with scant regard for logic as turn of the century colonizers engaged in a carve-up of the continent, which African Nationalists blame for many of their problems. This has caused much tension in many of the effected countries as various tribes, cultures and language groups were divided by the new boundaries and forced to live under the rule of, and alongside, foreign peoples. However the main thrust of popular dissatisfaction was aimed at the "white" colonial rulers. This resulted in nationalism amongst the indigenous population and a struggle for self determination. In the post war years colonial powers granted independence to countries of the region. However, the "colonial" borders remained intact and the "cultural" tensions resurfaced. The net effect was political structural instability.

Liberation movements have emerged which are battling to re-establish more equitable borders. The result has been the ongoing civil wars in, the Horn of Africa (namely Ethiopia and Somalia), Mozambique and Angola, amongst others. These conflicts have had a profound effect on the economies and population of the countries, as well as on the stability of the region. This has resulted in a lack of food and mass starvation in these areas, as much of the population is unable to participate in the informal or formal sectors of the economy, thus making production and distribution of food, and other goods, difficult. A long term cost effective energy strategy for the region, based on an interchange of resources, can only be adopted once differences have been resolved and stability returned to the region.

3.2.6 Discussion

The large population growth, the related lack of sufficient economic growth, relatively low urbanization levels, high illiteracy rate and instability in the region are reflected in the energy usage patterns. The use of traditional fuels is high, and household consumption takes a large share of total energy use. Cooking with fuelwood generally dominates the energy flows and consumption almost parallels population growth[20]. This, together with the growing populations' increase in demand for food, has resulted in deforestation, desertification and siltation in many areas where sustainable supply can no longer be achieved. The rapid urbanization in the region could potentially shift the energy consumption patterns increasingly towards commercial energy. However, the squatter type nature of much of the peri-urban housing and lack of funding makes electrification difficult, and these settlements still rely on wood and charcoal to a large extent for their energy needs.

A large proportion of the region's difficulties, as far as energy provision and socio-economic development are concerned, can be directly or indirectly attributed to the rapid population growth in general, as well as the rapid growth in the peri-urban population. As long as population growth is accompanied by economic stagnation and unrest, the expansion of the low income class will continue, and an almost constant increase in demand for fuelwood will prevail, being directly related to population growth. A significant reduction in population growth and/or rapid economic growth, causing an increase in real income per capita, would result in fuelwood demand at first increasing and then declining due to inter-fuel substitution[20].

The underlying need is for the provision of appropriate education, economic growth and development. In this respect, the energy sector needs to ensure that adequate planning and policy formulation are undertaken so that the necessary institutional arrangements are made and infrastructure provided. This will ensure that adequate and appropriate energy supplies are made available, in the most efficient and cost effective manner possible.

3.3 INSTITUTIONAL ASPECTS

This section examines the characteristics of political, administrative and energy institutions of ESA, and indicates how they effect energy policy and planning on both regional and national levels. A more detailed description of the energy institutions of 13 selected countries of the region is given in Appendix B.

3.3.1 Introduction

It is generally recognized that the existence of adequate political and administrative institutional structures is the key to solving energy issues. The nature of these structures will determine, among other things, the balance between conflicting and inter-related activities and objectives, the design and implementation of effective policies and incentives, and the solution of trans-boundary and global problems.

The role of institutional structure is especially important in Africa, and it is certainly true that institutional change is the key to the solution of this continent's energy issues. Institutional reform is required in order to facilitate regional cooperation on energy issues.

3.3.2 Political considerations

Past and existing institutional structures in Africa have been determined to a large extent by prevailing political trends, with ideology and conflict playing a major role. To understand the relationship between structures and these trends, it is necessary to provide a brief historical perspective.

Colonization had a profound impact on institutional structure in Africa[21,22]. Traditional structures were decentralized, with minimal regulation and control over economic activity. These structures were tribal in nature, and tribal boundaries provided a basis for political boundaries. The process of colonization led to the suppression of traditional institutions which were replaced with structures created by colonial governments.

Colonization led to the creation of new political boundaries, which bore little, if any, relation to existing tribal boundaries. This resulted in the eventual creation of nations consisting of numbers of different, and sometimes rival, tribes. Certain tribes were also split between nations. The net effect was to create structural political instability in many African countries.

Structural instability was partially offset by both colonial suppression and the rise of African Nationalism. The latter process involved the unification of different tribes to create a new national front within a colony. Many of these nationalist movements successfully ousted colonial governments, thereafter creating their own. After independence a number of countries experienced recurring structural instability because of inherent differences between tribal factions. In many African countries this factor continues to be of critical importance.

Colonial institutional structures were essentially mercantilistic, with central government playing a key role in the economy. This resulted in large scale exploitation of resources and people in the colonies, which led to revolution in many cases. Frequently, revolutionaries were assisted by Socialist countries, with the result that many African Nationalist movements adopted Marxist-Leninism as a doctrine. After gaining control of national governments, these movements sought to implement central economic planning systems. In many cases, few changes needed to be made to existing colonial structures, because of their inherently centralistic nature.

Certain countries did not adopt overtly Socialist policies, but retained links with Western countries after independence. Such countries, however, still inherited the mercantilistic structures of the former colonies. The result was that all independent African nations continued to be governed with strong central control; institutions such as single party states and dictatorships being commonplace. This remains a significant factor throughout Africa.

A factor that is of key importance in the Eastern and Southern African region (ESA), is the role of South Africa. This country has played a crucial role in influencing regional politics in the past and continues to do so. Two features of South Africa are of significance: the size of its economy (creates 54% of the ESA GDP) and its adherence to the politically controversial system of Apartheid. The latter factor has placed certain major constraints on regional activity.

Governments of independent African countries were generally vehemently opposed to South Africa's policies. Most of them imposed economic sanctions on this country, although unofficial trade did take place. In addition, African countries expended considerable resources in their attempts to dissociate themselves from the South African economy and to encourage a process of political change in the country. The estimated costs of these isolationist policies are vast, especially to the neighbouring states of Southern Africa.

At the time of writing, significant changes are taking place in the region as South Africa dismantles the system of Apartheid. By the mid 1990's this country is expected to have regained complete international acceptability. There are great expectations that South Africa will play a leading economic role in the region. This is because of the size of this country's economy relative to that of the rest of the region. South Africa has a good infrastructural base and could provide a strong link between the region and the rest of the world.

There are, however, some potential problems related to change in South Africa. The Apartheid system has left a legacy of violence and political instability in the country which may take some time to diffuse. The Nationalist government intervened heavily in the economy, with many key sectors being either nationalized or strictly regulated. There is a strong possibility that a future government will continue to practice these economic policies, or even intervene further, a factor that will negatively impact upon the country's growth potential.

While the short term scenario in the ESA region is somewhat uncertain, there are certain processes taking place which suggest the direction of longer term developments. These processes must be viewed in the context of global developments.

Most African countries currently have strongly centralized regimes, with institutions such as single-party states and dictatorship being commonplace. The adherence to central planning and other Marxist economic principles has had limited success in promoting sustained and adequate economic development. Furthermore, much development has been financed with foreign debt, much of which cannot be repaid.

The experience of donor countries whose investments have not borne fruit, has led to a widespread review of debt policy. In addition, the recent developments in Eastern Europe have diverted much capital away from Africa. The result has been that African governments have been forced to review domestic economic policy, both due to internal pressures and externally due to the demands of foreign donor agencies. Institutions such as the World Bank are currently encouraging political and economic change through loans linked to conditional structural adjustments. There has also been a growing call for multi-party democracy (pluralism), and economic reform by the population of countries under illegitimate rule[(23)]. This has resulted in political protests, sabotages, revolts and rebellions, the current political events in Zaire and Rwanda being the latest. The smooth transition of Zambia to a multi-party democracy is an encouraging development. The democratization process could accelerate economic reform and facilitate the restructuring of institutions, and foster cooperation between countries of the region.

Institutions within Africa have also attempted to bring about structural change. The Organization of African Unity (OAU) is attempting to move Africa towards a common market by the end of the century. Within the ESA, two institutions have been formed with the intention of promoting similar objectives, namely the Southern African Development Coordinating Conference (SADCC) and the Preferential Trade Area (PTA). The activities of (SADCC) have been greatly affected by the issue of South Africa, with attention being focused on economic independence from that country, rather than regional cooperation.

With South Africa's changing role in the region, and probable admission to membership of SADCC in the near future, the priorities of these institutions are likely to change, and the possibility of regional trade liberalization and cooperation in the future is much greater. However, there are still considerable structural constraints that need to be overcome, as well as fears on the part of other countries that South Africa may dominate the region.

3.3.3 Dualistic Economies

Most countries in the region are classified as Developing Countries. In these countries, formal institutions are often inadequate, and are replaced in many instances by informal institutions. This results in a dualistic economy, with a formal sector and an informal sector reflecting the stage of social and economic development. This characteristic is of great significance to the region, as it has a considerable impact on policy decisions.

The problems of the dualistic economy manifests itself in a number of ways. First, it is difficult to accurately measure certain economic trends because of the lack of informal sector reporting. Secondly, it is difficult to regulate activity in the informal sector, and this reduces the effectiveness of macro policy. Thirdly, there is often inadequate synergy between the formal and informal sectors, which could have detrimental consequences if there are conflicting objectives. Finally, institutional structures tend to have a formal sector bias, and are therefore often inappropriate for dealing with issues that originate in the informal sector.

One of the greatest hurdles in bringing about sustainable development in the energy sector in Africa, is the dualistic nature of the energy economy. This must be overcome by the introduction of institutional structures that are capable of coping with this dualism by adopting integrated approaches.

3.3.4 Existing Energy Institutions

Most energy institutions in the region are state-controlled, highly centralized and politically regulated[22,24]. Regulatory mechanisms include statutory monopoly powers, distribution controls, price controls, subsidies and taxes. Institutions frequently deal with energy issues in three major areas: electricity, fossil fuels and biomass fuels. The way in which these different sources are dealt with differs between countries, but in general, integrated planning between the energy sub-sectors is absent.

Within the region, SADCC plays a role in policy formulation, and has encouraged cooperation between certain countries on energy issues. SADCC has entrusted this energy coordination role to Angola. Other regional institutions include the Preferential Trade Area for Eastern and Southern African States (PTA) and the Economic Community of Great Lakes Countries. It is important to note that South Africa does not belong to any of these, although its membership of SADCC is assured once complete reform has taken place in that country.

An emerging regional energy force is the South African electricity supplier, ESKOM. ESKOM produces about 80% of the region's electricity, and with the opening of trade links between South Africa and its neighbours, is proposing that a regional grid be established. It is likely that ESKOM will play a leading role in the electricity sector in the region in the future since it has the necessary technical resource base and is adept with respect to the African environment.

3.3.5 Institutional Shortcomings

From the above discussion it is clear that there are various institutional shortcomings, both as far as political structures within the ESA are concerned, as well as within the energy sector. The political environment is particularly important and cannot be ignored, because without institutional change at this level, changes within the energy sector are much less likely to take place.

At present, most nations in the ESA have fairly rigid political boundaries. These boundaries were created under colonial regimes, and have had a number of negative repercussions. Apart from creating structural political instability within countries, arbitrary boundaries have also cut across potentially lucrative trade links. Intra-regional trade is severely limited, transport links restricted, and energy exchange potential lost.

To promote cooperation within the region, institutional change is essential. National governments will need to abandon protectionist policies, and regional institutions need to be strengthened. SADCC and the PTA could play key roles in this process, and should receive more support, internally and externally, although their role needs to be reassessed. The past preoccupation of these organizations with the South African issue will undermine their effectiveness in this regard once South Africa is democratized, and this needs to be addressed.

Although ESKOM could play a key role in promoting regional cooperation, there may be some initial resistance to this from other countries, because of its links with the South African government. The fact that ESKOM is still indirectly influenced by South African government policy is a potential institutional weakness that needs to be considered. The same principles apply to other large organizations in the energy sector with the potential to play a regional role.

The dualistic nature of the energy economy creates a major institutional weakness. Few governments have sought to play more than a nominal role , if any, in the supply of traditional energy on which the majority of rural and urban population depend to an overwhelming extent[25]. There is a serious need to integrate energy sector activities, but this is difficult to achieve for several reasons. Firstly, centralized structures are not equipped to deal with the informal sector. Secondly, most informal sector activity is related to biomass fuels, and the responsibility for this is often delegated to ministries other than those primarily responsible for energy matters. In addition, agencies are often understaffed and lacking in expertise. The supplementation of these agencies with foreign aid also results in the use of inappropriate technologies to tackle informal sector issues.

Throughout the region, energy policy is largely politically-driven rather than market-driven. As a result, institutions tend to have insufficient autonomy, and are often directly controlled by central government. There is often a lack of accountability, and little market orientation. Price controls, subsidies and taxes are common, and result in distortions in production and distribution patterns. This situation is likely to prevail for some time. Advocates of a free market systems would consider this to be a serious institutional shortcoming, while proponents of central planning for developing countries would consider it essential for government to guide this crucial element of the development process. It does appear, however, that there is scope for reduction and rationalization of state involvement in the energy sector[22].

Accepting the fact that national governments wish to influence the development process, it is still questionable whether state ownership of utilities is more effective than appropriate regulation of private sector activity. It is also worth considering whether elaborate pricing controls, taxes and subsidies are necessary, and whether the introduction of market pricing would not promote economic prosperity by encouraging efficient resource use.

The greatest shortcoming of centrally controlled institutions has been highlighted by the Eastern European experience, ie. the loss of accountability and creation of opportunities for rent-seeking by public officials. These weaknesses seriously impair efficiency and stifle broad-based economic growth. To achieve sustainable development, it is essential that economic growth should be spread over the entire population as much as possible, and that public participation be encouraged. The concentration of political and economic power in the hands of a small elite is probably the greatest deterrent to sustainable development.

The internal structure of energy functions is problematic in a number of countries. Functions are often split between several agencies, resulting in communication and coordination problems. This is especially the case as far as coordination between the commercial and traditional energy sectors is concerned[26], as well as in the case of energy project financing with foreign capital. The institutional structures, in many cases, lack adequate organization, making the collection of reliable data on the status of resources and the consumption of energy by locality and sector very difficult[26]. These factors have precluded the possibility of integrated planning at national level to check the continual deforestation and to guarantee the sustainability of energy supply[25].

The role of central banks and finance ministries is also a crucial issue that frequently impacts the energy sector. In most countries in the ESA, these institutions control access to all financing, and regulate the flow of foreign exchange. By restricting access to money markets, central banking policy often severely impairs the ability of energy producers to raise much needed development capital, and to carry out the repairs and maintenance necessary to keep plants running reliably and efficiently.

The ability of energy producers to cover recurrent operating costs is also impaired in certain countries where government policy has been to provide energy as a free good. An example of this is the provision of electricity in Angola at a cost so low that it is uneconomic to collect arrears. The imposition of ideologically motivated tariff controls could be regarded as an exceptionally serious institutional shortcoming.

3.4. ECONOMICS AND ENERGY

This section examines the characteristics of economies of ESA, and indicates how these effect the energy sector. A more detailed description of the economies of selected countries of the region is given in Appendix C. Economic data for these countries is contained in Appendix D. Appendix H contains estimates of economic data for the region, including and excluding South Africa.

3.4.1 Introduction

All countries in the region (with the possible exception of South Africa) could be described as developing or least developed countries (LDC's) and economic growth is a key objective to development. Aspirations for economic growth are high, but in reality there are considerable obstacles to achieving this. Throughout the region, population growth is rapid, rendering substantial economic growth necessary simply to retain the current per capita living standard. In some countries, real GDP growth rates are negative, and on a per capita basis, virtually all countries are declining, resulting in the standard of living dropping throughout the region. Most countries are experiencing a continued decline in access to essential goods and services such as food, water, **energy**, housing, health care, education, and transport[27].

In many countries, formal institutions are often inadequate, and are replaced in many instances by informal institutions. This results in a dualistic economy, with a formal sector and an informal sector. This characteristic is of great significance to the region, as it has a considerable impact on policy decisions. The formal sectors are characterized by significant government intervention. Features often include state ownership and/or regulation of strategic sectors of the economy, foreign exchange controls, trade restrictions, licensing and heavy taxation. These features encourage informal economic activity. In addition, bureaucracies are often incapable of administering the state machinery efficiently in all areas, thereby having no choice but to allow some informal sector activity.

Formal sector activity is most likely to occur in industrialized urban areas and regions with rural development such as commercial agriculture and tourism. In traditional rural areas and urban areas with no industry, informal economic activity is more likely to take place. Formal activity is linked with commercial growth, and informal activity with subsistence. This distinction is very important, because it relates closely to energy supply and use patterns.

This dualistic nature extends to the energy economy. Industrial and large scale commercial developments generally acquire their energy from the formal sector, as do developed residential areas in major urban centers. Conversely the large and rapidly expanding peri-urban areas are heavily reliant on fuelwood which is predicted to increase in the future[18]. In rural areas, energy is obtained informally, with fuelwood harvesting being the main source.

Throughout the region the lack of effective institutional structures is stifling economic growth and development[28]. Substantial market reforms are necessary in order to bring about greater economic efficiency and equity. The future of both the regional economy and energy sectors will depend, to a large extent, on the ability of governments to effect the necessary policy changes. Future economic growth will have an impact on energy demand, and the ability to supply the required energy will have an impact on the sustainability of economic growth.

A number of countries are undertaking so called economic structural readjustment programmes due to pressure brought to bear by organizations such as the IMF and the World bank. However, progress has been slow and it's to soon to determine how successful they will be.

3.4.2 Economic Growth

In recent years, Gross Domestic Product has been criticized as a measure of national human welfare[29]. This is because of its failure to take into account social and environmental costs. Although certain developed countries are starting to experiment with new methods of measurement which do take such factors into account, countries in the region only provide traditional data.

Throughout the region, total national income figures appear to be increasing in nominal local currency terms. There is also growth in all economic sectors. In South Africa, there appears to be more rapid growth in the commercial and industrial sectors, and less in the agricultural and mining sectors. In most other countries, there are no clear shifts in sectorial growth trends. In some countries, such as Tanzania, there is a shift towards the agricultural sector. However, it can be expected that the relative importance of commerce and industry will increase with development, which will result in an increase in commercial energy intensity and commercial energy consumption.

In real local currency terms, total GDP growth rates in the region are poor and in some cases they are negative. In several countries there is no clear trend, with fluctuating income levels in local currency terms. In almost all cases, with the exception of Botswana, real GDP growth has not been able to keep pace with the growth in population. Real GDP per capita has in general been declining, especially since the early 80's, as shown in Figures 3.1 which compares real GDP per Capita trends for selected countries. National income data for the region tends to be somewhat unreliable[30]. This is because of logistical difficulties in measurement, lack of adequate informal sector data, and the instability of foreign exchange rates. Rates are frequently manipulated by central bank intervention, and thus disguise certain trends. For example, it is common for governments to artificially elevate exchange rates through strict control of foreign exchange.

Using the US currency as a general indicator for the region has the advantage of assessing the region's performance in international terms. Also, using per capita figures, presents a clearer indication of standards than total figures. When using this measurement, national income per capita is seen to be falling in almost all countries in the region. This can be attributed to the rapid increase in population throughout the region without a corresponding economic growth, which was exacerbated by the oil price shock of 1979. Therefore, in real terms, and by international standards, the economic performance of the region is poor. The above trend is reflected in Figure 3.2 which shows the average GDP per capita for the total region expressed in real 1985 US$ for the period 1968 to 1988. Figure 3.2 is based on data contained in Appendix H. (Regional data is presented including and excluding South Africa as this country's large economy distorts the regional statistics). The average GDP per capita in the region has been decreasing in real terms since the late 70's. In 1988 the average current GDP per capita for the region, excluding South Africa, was **277 US$** per capita and including South Africa, **515 US$** per capita.

If national income figures were adjusted to account for environmental degradation, performance would most likely appear even worse. This is because of the, unaccounted for, reduction in natural capital that is taking place in parts of the region. Of particular concern is deforestation, topsoil loss, and water degradation and depletion. The loss of these natural resources is eroding the agricultural economic base of the region, thus reducing the potential for sustainable development.

FIGURE 3.1: REAL GDP PER CAPITA IN LOCAL CURRENCY TERMS[12]

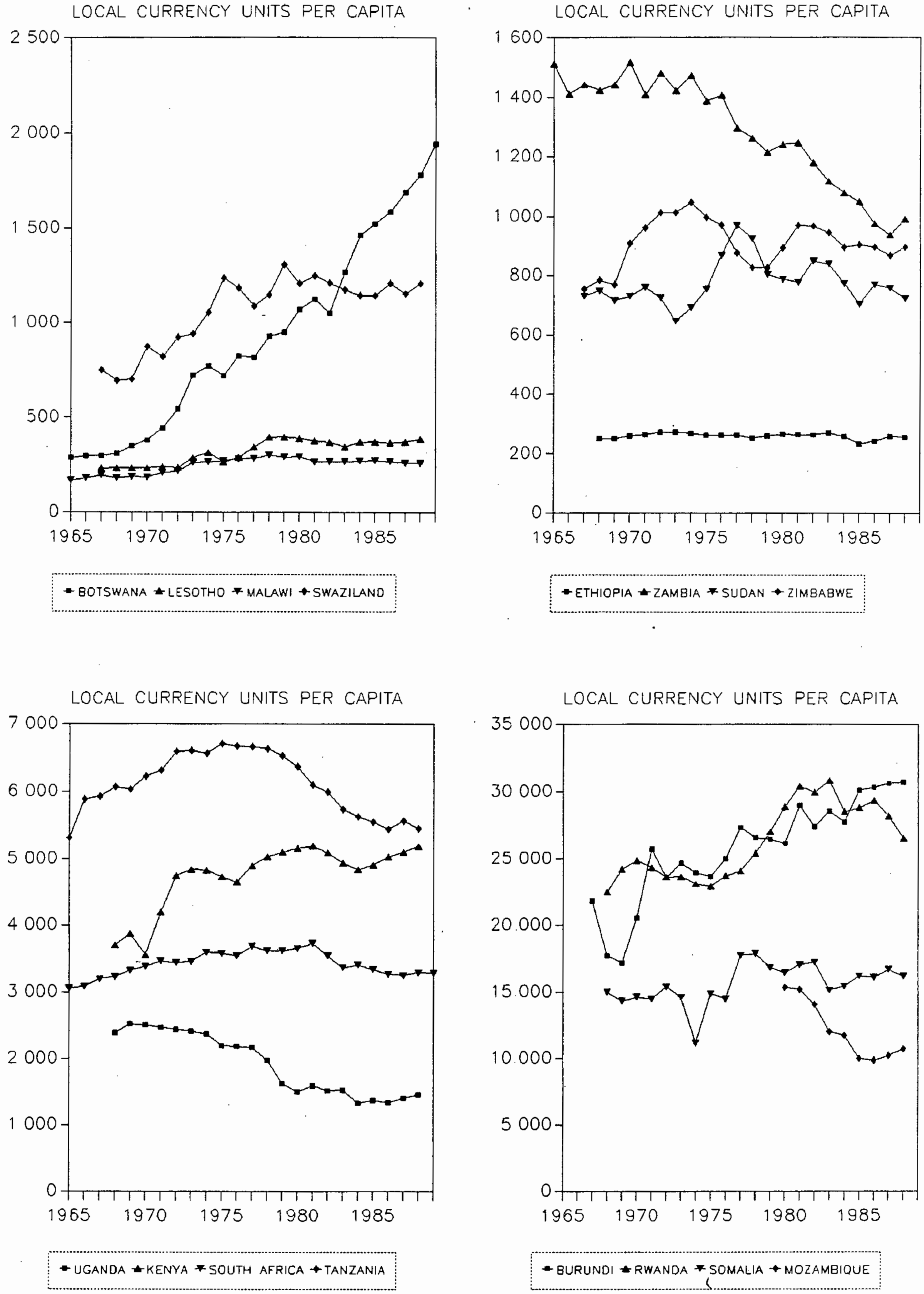
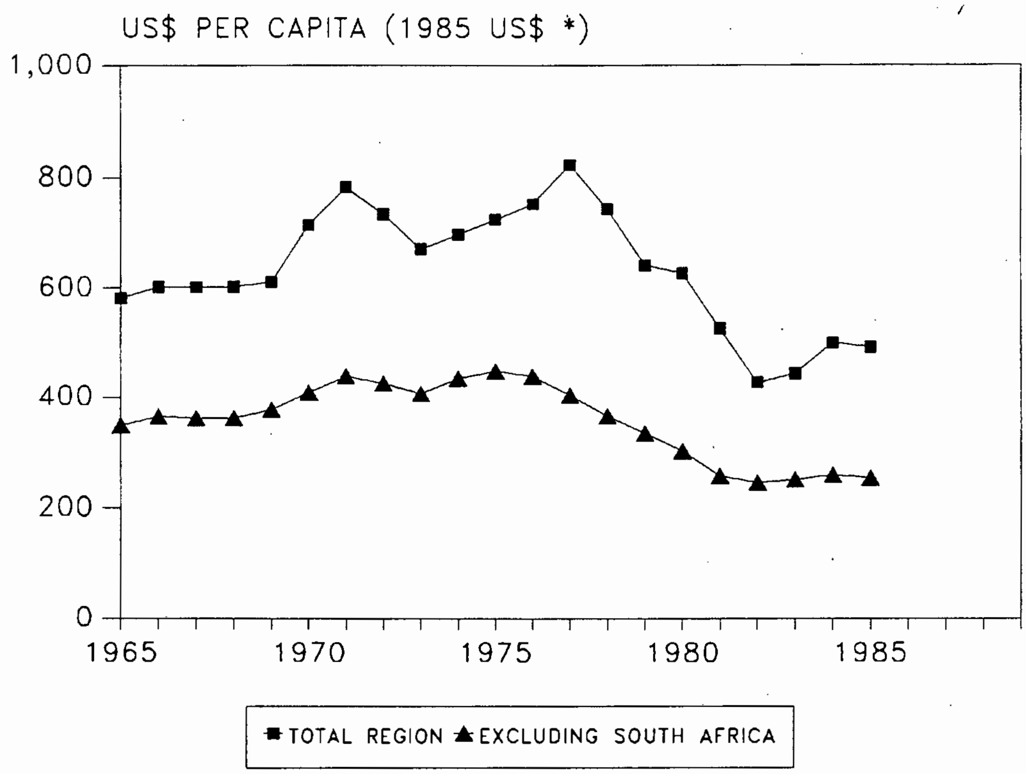


FIGURE 3.2: AVERAGE GDP PER CAPITA FOR THE REGION (Including and Excluding South Africa)



* GDP per capita is based on current local GDP converted to US$ at current exchange rates and then deflated with the US$ deflator for 1985.

Other economic problems in the region include excessive debt burdens, foreign exchange constraints, instability and high inflation rates. Because of the relative lack of private property institutions in the region, there are significant problems associated with over-exploitation of common resources and the social costs of externalities. Resources owned or regulated by the state, such as state lands, wildlife, water and the atmosphere are particularly susceptible to such problems. The state machinery is not sophisticated enough to cope with many of these issues, resulting in considerable costs to society. The inability of the region to generate sufficient export earnings to cover imports results in shortages of foreign exchange. Debt is also a serious problem in the region, with many countries unable to repay their long term commitments. This factor also discourages further foreign capital from entering the region. The situation is aggravated by tight exchange controls, which also inhibit foreign investment.

These economic issues have a direct impact on the energy sector and are constraining development and management. The most important external constraints on the energy sector include[25]:

high and inflating import costs of modern energy development, supply and utilization technologies.

high and escalating costs of energy imports, especially oil.

scarcity and high cost of external investment loans.

deteriorating terms of trade.

high external debt and debt service burdens.

unfavourable terms and conditions for transfer of energy technology.

powerful donor influence on energy sector management and development favouring replication of production and consumption patterns prevalent in industrial countries.

Countries in the region will need to boost economic growth to at least the level of population growth, simply to maintain the current per capita living standard. While countries aspire to positive real GDP per capita growth rates, these do not appear to be attainable at present. The constraints are largely institutional, and need to be addressed through regional trade liberalization and improvements in foreign investor confidence. It must be stressed that positive economic growth is already a difficult goal for the region to achieve. When taking into account the rate of growth and improvements in income distribution that would be required to ensure sustainable development, the outlook for the region is a cause for concern. To achieve greater efficiency and equity, many market reforms are necessary, because the existing institutional structures are stifling such development.

3.5 Energy Demand

This section examines the energy demand situation in the region. A description of the energy demand of selected countries of the region is given in Appendix E. Energy consumption data for these countries is contained in Appendix F. Estimates of regional energy consumption and indicators for the period 1971 - 1989 are contained in Appendix I.

3.5.1 Introduction

Estimates of the total final consumption of energy by ESA in 1988 are given in Table 3.6 a-e which is based on data contained in Appendix I. Regional data is presented including and excluding South Africa as this country's extraordinary large consumption of commercial energy distorts the regional statistics.

Energy consumption in the region is dominated by South Africa. It has been estimated that South Africa accounts for **37%** of all final energy consumed in the region, while the estimate for commercial energy consumption is much higher at **75,%** and that of traditional energy lower at **9%**. The total final consumption of energy in the ESA was estimated at 132,6 million tons oil equivalent in 1988, of which 76,5 million tons oil equivalent was in the form of commercial energy. The household sector is a large consumer of energy in the region, with the exception of South Africa.

3.5.2 Traditional Energy

The energy sector of the region is characterized by a large dependence on traditional fuels in the form of fuelwood. The reliance on fuelwood varies from country to country, ranging from 14% for South Africa, to 96% for Tanzania as shown in Table 3.7. The degree of dependence on wood at an overall national level is broadly related to the level of economic development[7]. It is estimated that on average the region, excluding South Africa, relies on fuelwood for 83% of its energy needs[32] as shown in Table 3.6 d. With the inclusion of South Africa, the regional reliance on fuelwood decreases to 58% due to the extremely large use of commercial energy by that country, relative to the rest of the region.

TABLE 3.6:

(reference: 10,12,15,20,36,55,56,57)

TOTAL FINAL CONSUMPTION DATA FOR THE EASTERN AND SOUTHERN AFRICAN REGION

(WITH SPECIAL REFERENCE TO THE CONSUMPTION OF ENERGY BY SOUTH AFRICA RELATIVE TO THE REMAINDER OF THE REGION)

(1988 OR LATEST YEAR AVAILABLE)

TABLE 3.6 a TOTAL FINAL CONSUMPTIONS 000'S TOE

	COMMERCIAL					TRADITIONAL	TOTAL
1988	COAL	OIL	ELECTRICITY	GAS	TOTAL		
RSA	16033,0	14100,0	11410,0	298,3	41841,3	6875,9	48717,2
OTHER	2457,6	9119,8	2597,5	132,1	14307,0	69617,4	83924,4
ESA	18490,6	23219,8	14007,5	430,4	56148,3	76493,3	132641,6

TABLE 3.6 b CARRIERS AS PERCENT OF REGIONAL CARRIERS

	COMMERCIAL					TRADITIONAL	TOTAL
1988	COAL	OIL	ELECTRICITY	GAS	TOTAL		(TRADIT.+COMM.)
RSA	86,7	60,7	81,5	69,3	74,5	9,0	36,7
OTHER	13,3	39,3	18,5	30,7	25,5	91,0	63,3
ESA	100,0	100,0	100,0	100,0	100,0	100,0	100,0

TABLE 3.6 c CARRIERS AS PERCENT OF TOTAL COMMERCIAL ENERGY

1988	COAL	OIL	ELECTRICITY	GAS	TOTAL
RSA	38,3	33,7	27,3	0,7	100,0
OTHER	17,2	63,7	18,2	0,9	100,0
ESA	32,9	41,4	24,9	0,8	100,0

TABLE 3.6 d CARRIERS AS PERCENT OF TOTAL ENERGY (TRADITIONAL PLUS COMMERCIAL)

1988	COAL	OIL	ELECTRICITY	GAS	TRADITIONAL	TOTAL
RSA	32,9	28,9	23,4	0,6	14,1	100,0
OTHER	2,9	10,9	3,1	0,2	83,0	100,0
ESA	13,9	17,5	10,6	0,3	57,7	100,0

TABLE 3.6 e CARRIERS AS PERCENT OF TOTAL REGIONAL ENERGY

	COMMERCIAL ENERGY					TRADITIONAL	TOTAL
1988	COAL	OIL	ELECTRICITY	GAS	TOTAL		
RSA	12,1	10,6	8,6	0,2	31,5	5,2	36,7
OTHER	1,9	6,9	2,0	0,1	10,8	52,5	63,3
ESA	13,9	17,5	10,6	0,3	42,3	57,7	100,0

TABLE 3.7 Traditional Energy as Percentage of Total Energy.[10,12,20,32]

COUNTRY	PERCENT TRADITIONAL
TANZANIA	96
UGANDA	94
BURUNDI	94
RWANDA	92
ETHIOPIA	92
MOZAMBIQUE	89
MALAWI	87
ZAIRE	83
KENYA	78
SUDAN	76
LESOTHO	75
ANGOLA	60
ZAMBIA*	60
BOTSWANA	53
ZIMBABWE	38
SOUTH AFRICA	14

* .. Estimate by Zambian Ministry of Energy and Water Affairs, IEA gives a figure of 18%.

The vast majority of fuelwood is consumed by the domestic sector. Wood is also used for small scale rural industries such as tea/ coffee/tobacco processing, lime making, and brick making. Traditional fuel on average accounts for 90% of energy consumed by the domestic sector[32] (excluding South Africa). The majority of this energy is used for the preparation of food[25]. The heavy reliance on traditional fuels can be attributed to the rural subsistence nature of a large proportion of the population of the region, for whom commercial fuels are expensive and not easily accessible, together with the low level of economic development, and the extensive and rapidly growing squatter settlements in the peri-urban areas. The lack of suitable institutional and transport infrastructure also plays a significant role.

The heavy reliance by the population on traditional energy, coupled with the large population growths experienced in the region[16,33], has resulted in increasing demand for fuelwood and the clearing of forests for agricultural production. This has led to deforestation and related environmental impacts, as well as a shortage of fuelwood in a number of areas. More and more time is being spent collecting wood at the expense of other activities.

The extension of the electricity grid system to rural areas, and the introduction of small-scale power generation by new technologies, such as photovoltaics, could reduce the usage of non-commercial energy sources, though finance is a restraining factor. In certain countries dependence on non-commercial sources of energy is becoming greater. This is because existing infrastructures have weakened, and biomass fuels are even being used in urban areas.

3.5.3 Commercial Energy

Modern commercial energy supplies are used mainly in and around the mining and urban enclaves to satisfy the needs of modern transport, industry, service, households and a small amount for commercial agriculture[25].

The commercial energy mix of countries within the region varies considerably and is, to a large extent, dependent on the composition of energy resources. Table 3.8 shows the importance of the various energy carriers for selected countries.

TABLE 3.8: TOTAL FINAL CONSUMPTION COMPONENTS AS A PERCENTAGE OF TOTAL COMMERCIAL ENERGY [10,12]
(For 1988 unless indicated)

COUNTRY	COAL	OIL	ELECTRICITY	GAS
ANGOLA	0,0	62,2	18,4	19,4
ETHIOPIA	0,0	91,3	8,7	0,0
LESOTHO	36,0	56,0	8,0	0,0
MALAWI(1986)	9,6	68,9	21,5	0,0
MOZAMBIQUE	8,7	76,2	15,1	0,0
SOUTH AFRICA	38,3	33,7	27,3	0,7
SWAZILAND(1985)	37,7	45,9	16,4	0,0
TANZANIA	0,3	88,5	11,2	0,0
ZIMBABWE	51,0	25,9	23,1	0,0
FRANCE	10,2	56,2	17,2	16,4
JAPAN	13,4	61,2	20,5	4,9
UK	10,3	46,2	15,3	28,2
USA	10,1	52,1	15,5	22,1

All the countries in the region rely on oil to a large extent. With the exception of South Africa and Zimbabwe, petroleum products represent the most important source of commercial energy. In all cases, besides Angola, the demand is met by imports. This causes a growing drain on the economies of many countries and uses up scarce foreign exchange earnings. In Tanzania, for example, although oil constitutes only 7% of total energy consumed, it cost the nation over 60% of its total export earnings in 1985[34]. The consumption of petroleum products also represents a key source of revenue for the region's governments through taxes and surcharges.

The role of coal in the energy sector varies considerably within the region. South Africa relies on coal for some 81% of its primary energy requirements while Ethiopia does not consume coal at all. In contrast to many developed countries, the region relies on gas for only a minor proportion of its energy needs.

Tables 3.6 a and b give regional carrier consumption in percentage terms, including and excluding South Africa. Excluding South Africa (figures including South Africa given in brackets), the ESA relies on oil for 64% (41%)of its final commercial energy requirements, electricity for 18% (25%), coal for 17% (33%) and gas for 0,9% (0,8%).

FIGURE 3.3 : SECTORIAL USAGE OF ENERGY AS A PERCENTAGE OF TOTAL FINAL CONSUMPTION(10,12,55)

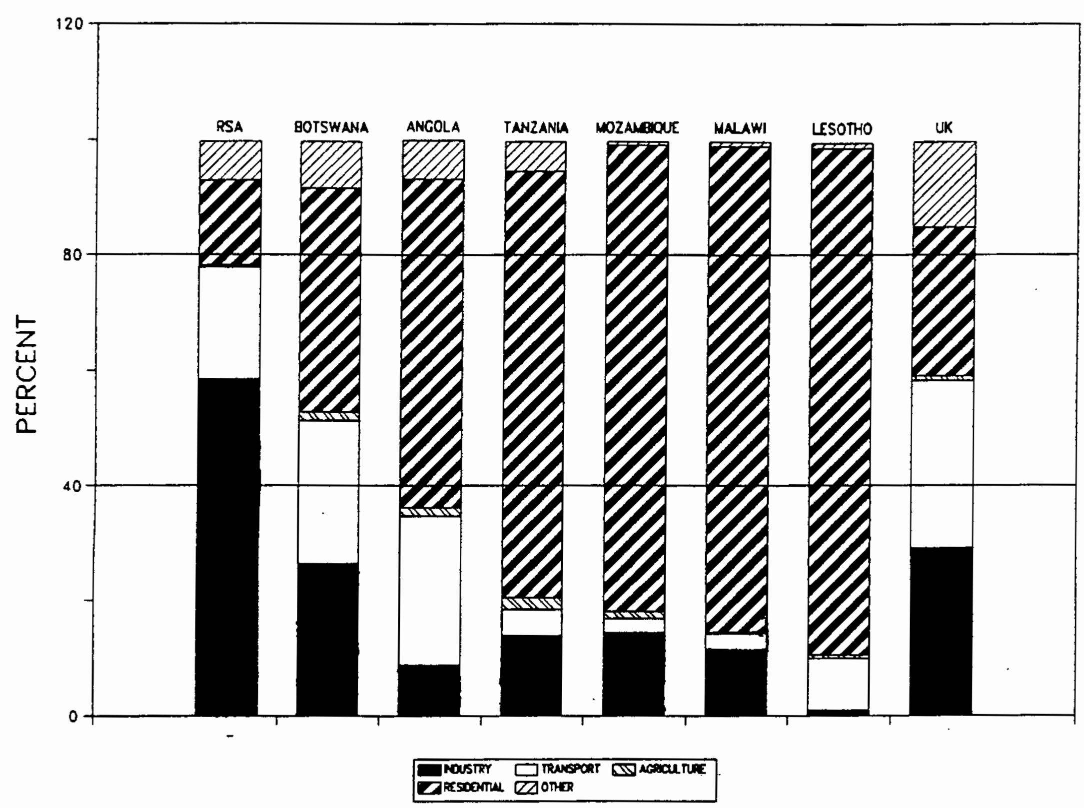


Figure 3.3 shows the sectorial usage of total final energy (traditional + commercial) for selected countries of the region, in percentage terms, and compares them to the UK. Besides from South Africa, sectorial consumption of energy displays similar trends throughout the region. The domestic sector is the single largest consumer of energy in most countries, South Africa being the notable exception. The transport and industrial sectors are responsible for the greatest demand for commercial energy, while the domestic sector's demand is mainly met by traditional fuel.

3.5.4 Energy Indicators

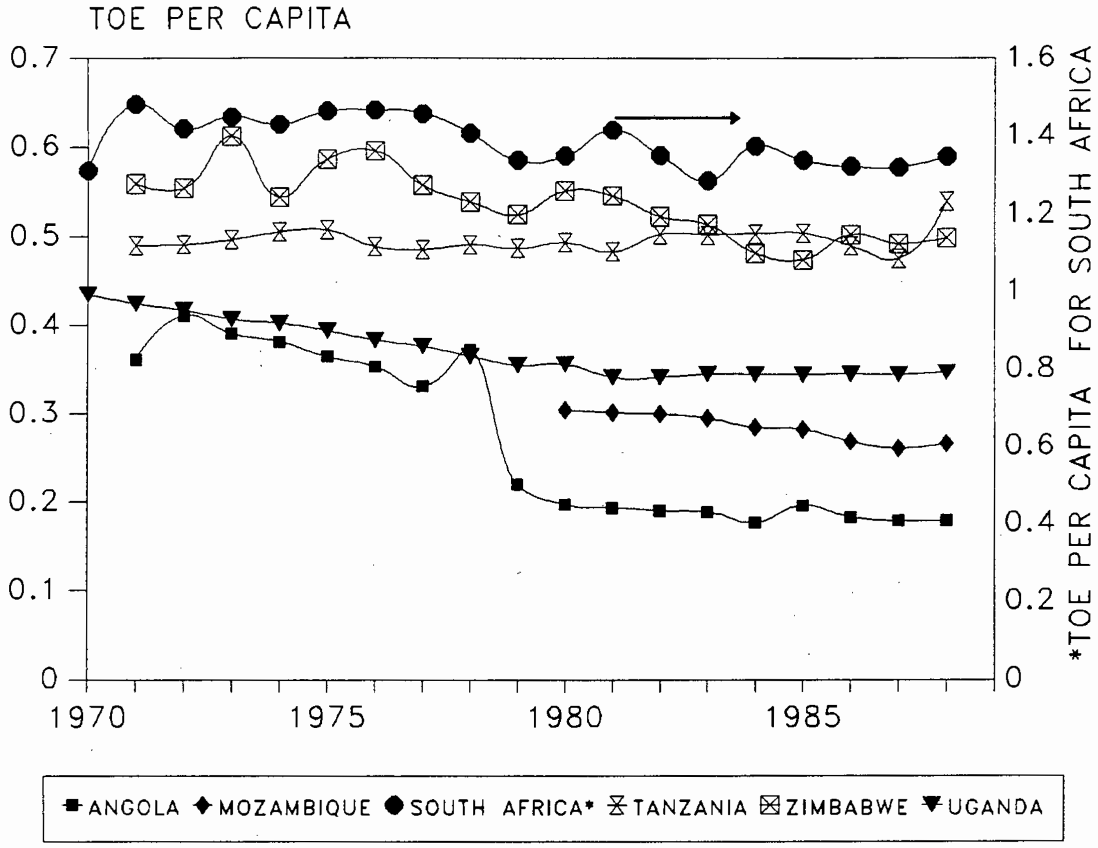
With the exception of South Africa, per capita final consumption of commercial energy is low, typically ranging between 0,01 and 0,4 Tons Oil Equivalent (TOE) per capita, reflecting the low level of development in the region. Conversely South Africa displays per capita consumption closer to that of developed nations. Excluding South Africa the ESA's average final per capita consumption of commercial energy is 0,06 TOE per capita. Including South Africa this figure increases to 0,2 TOE per capita. In general per capita consumption of commercial energy is declining, as would be expected for a region whose economic growth rate is on average less than the population growth rate. It could be expected that if real growth in GDP per capita is achieved this trend would be reversed.

Figures 3.4 shows the trend in total final consumption of energy per capita (including traditional) over the period 1970-1988 for a number of countries of the region. Total per capita final consumption ranges from 0,2 TOE per capita to 0,65 TOE per capita, although the figure for South Africa is much higher, at 1,4 TOE per capita.

Commercial energy per capita and total (commercial + traditional) energy per capita trends for the ESA region, including and excluding South Africa, are shown in Figure 3.5 a and b.

As shown in Figure 3.6, total final energy intensities (including traditional energy) vary greatly throughout the region. This can largely be attributed to variations in; development, the low end use efficiency and varying availability of traditional fuels, the availability of local commercial energy resources, as well as the effect of civil wars in certain countries. Most countries display energy intensities higher than major industrialized nations, which can mainly be ascribed to the large reliance on traditional energy in the form of fuelwood and charcoal which has a much lower end use efficiency than the commercial energy forms. These high energy intensities can also be partially ascribed to inadequate demand side management, the low priority of conservation and efficiency issues, inadequate pricing structures, price subsidies, as well as the large informal sector which is not accounted for in the measurement of GDP.

FIGURE 3.4: Final Consumption of Energy Per Capita For selected Countries[12]
(Commercial + Traditional)



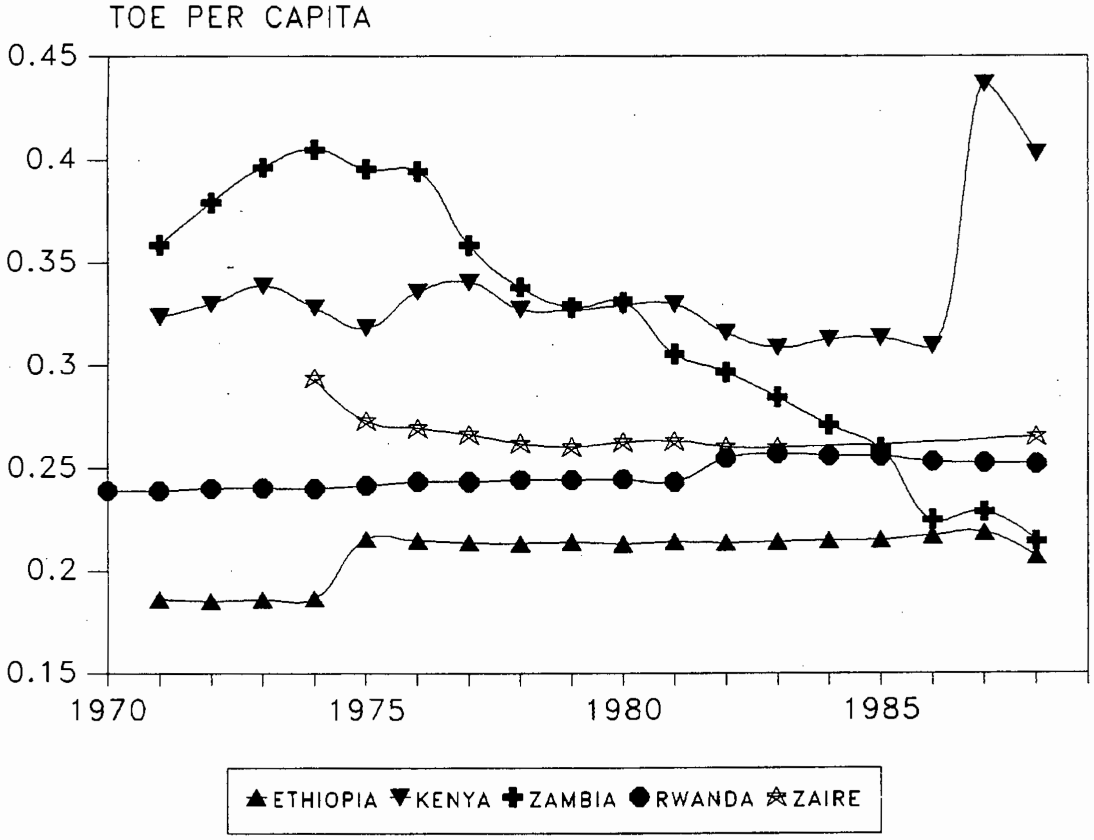


FIGURE 3.5 a : Commercial Energy per Capita for the Region.

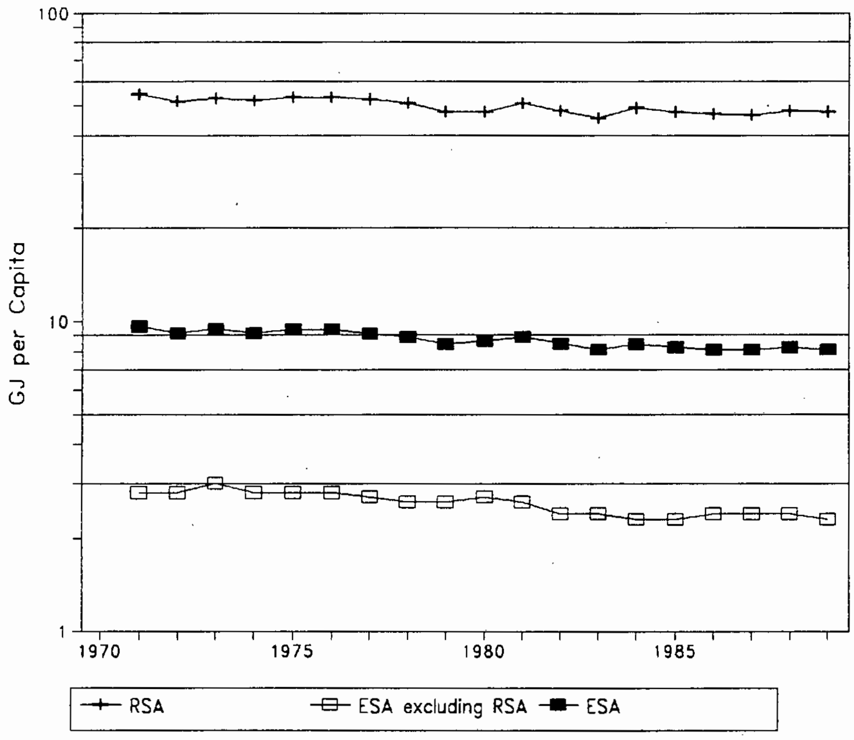


FIGURE 3.5 b : Total Energy Per Capita for the Region.
(traditional + commercial)

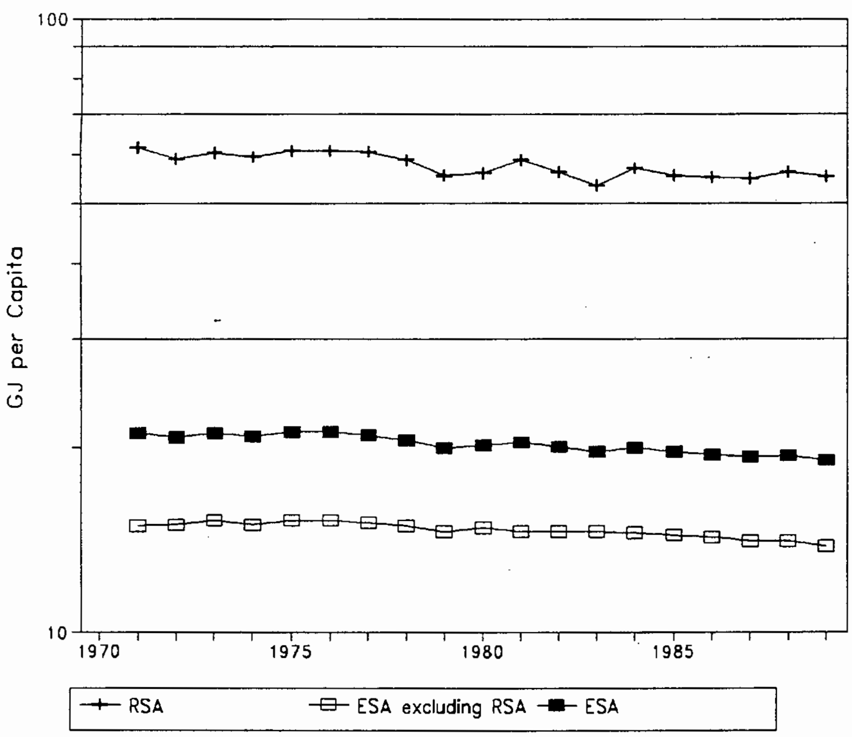
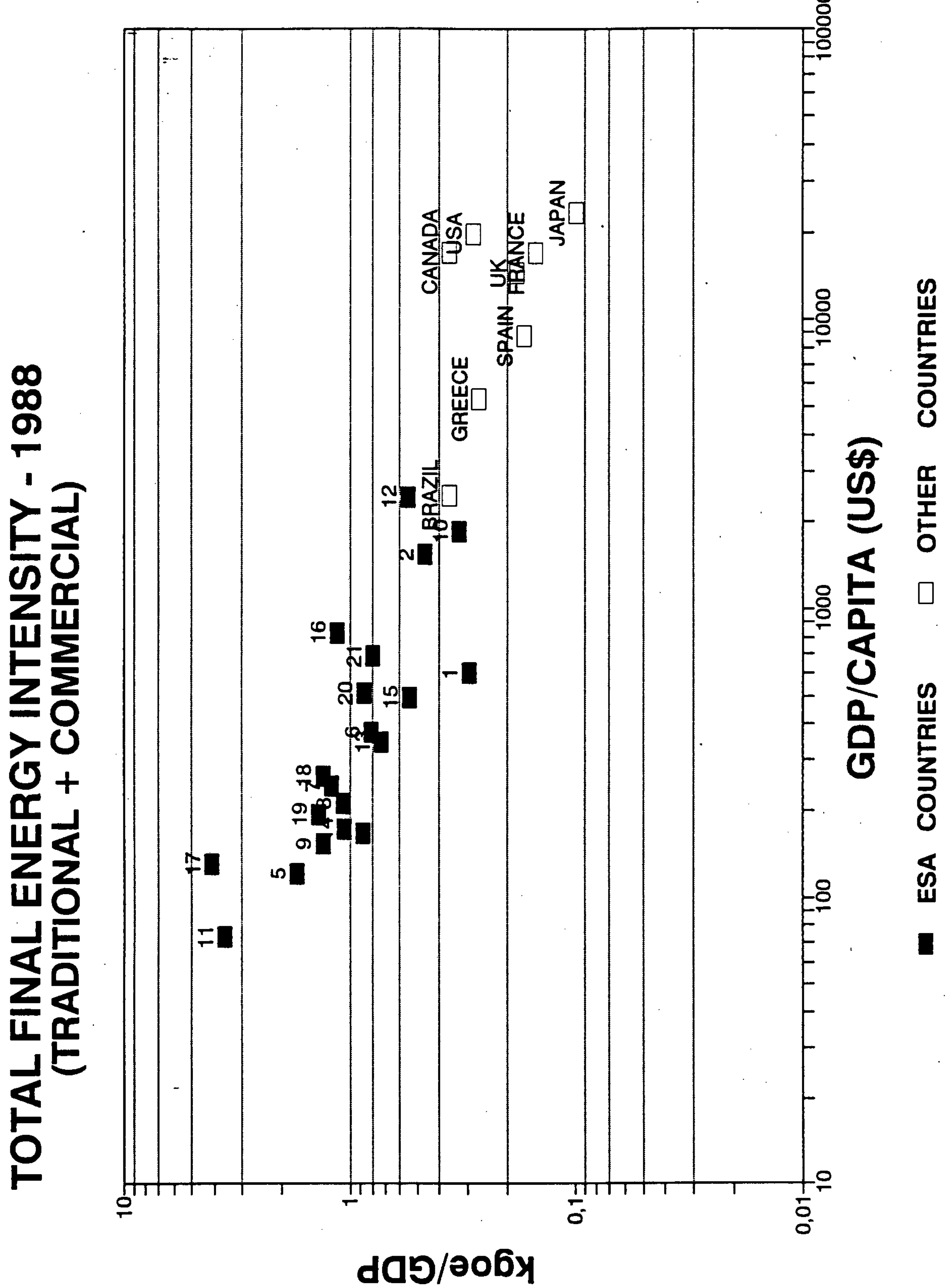


FIGURE 3.6: TOTAL FINAL ENERGY INTENSITY Vs GDP per Capita - 1988[10,12,55].



COUNTRY	SYMBOL
ANGOLA	1
BOTSWANA	2
BURUNDI	3
DJIBOUTI	4
ETHIOPIA	5
KENYA	6
LESOTHO	7
MADAGASCAR	8
MALAWI	9
MAURITIUS	10
MOZAMBIQUE	11
RSA	12
RWANDA	13
SOMALIA	14
SUDAN	15
SWAZILAND	16
TANZANIA	17
UGANDA	18
ZAIRE	19
ZAMBIA	20
ZIMBABWE	21

In general there is no clear historic trend in energy intensities of countries in the ESA region as shown in Figures 3.7. In this Figure, local real currency rates are used, as the US$ exchange rates do not adequately reflect the economic trends due to political and other influences, together with the fact that official rates in many cases are held artificially low. In some countries intensities are declining, while in others they are increasing.

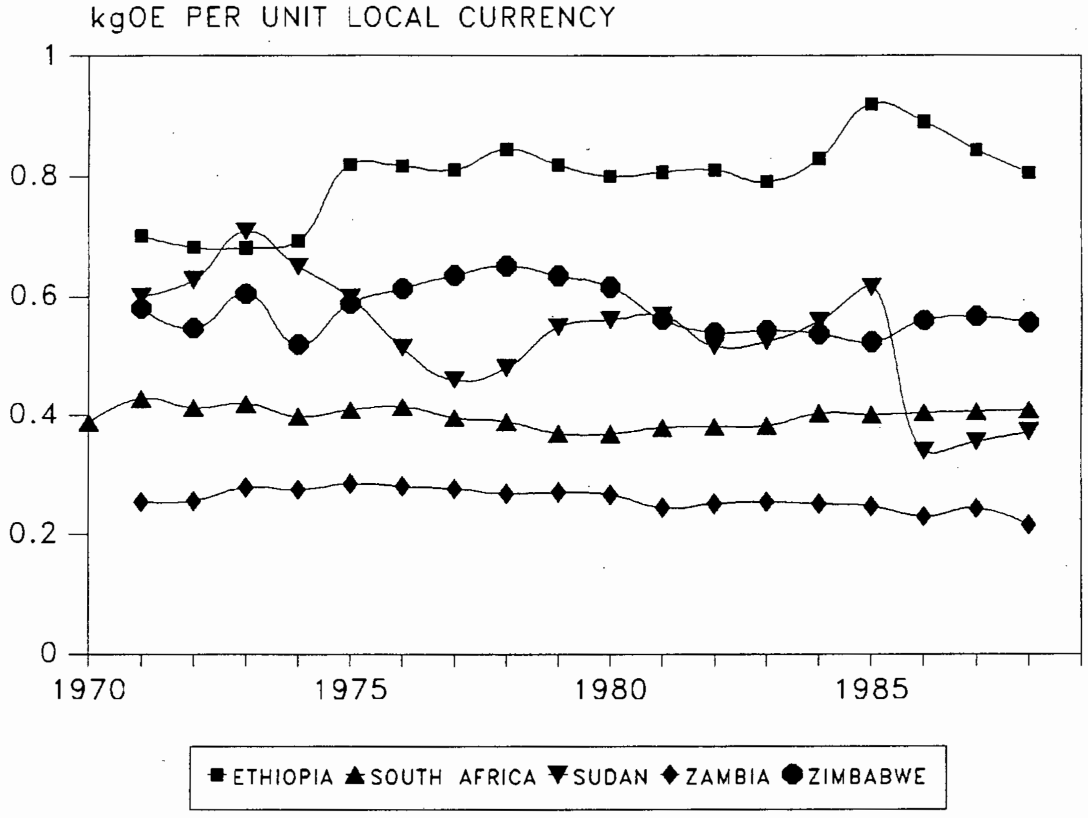
Commercial and total (commercial + traditional) energy intensity trends for the ESA region, including and excluding South Africa, are shown in Figure 3.8 a and b. Current local currency converted to US$ at prevailing exchange and deflated using the 1985 US$ deflator were used in the compilation of these graphs. They are based on the information contained in Appendix I.

Figure 3.9 shows the relationship between the wealth of a country expressed in GDP per capita, and the amount of energy (including traditional energy) used on a final per capita basis for countries of the region and for selected developed countries. It is apparent that on a world scale, the ESA countries have low GDP per capita and per capita total final energy consumption. However these countries conform to the generally accepted relationship between wealth and energy. (The large and inefficient use of traditional energy in the region should be noted when analyzing this graph.) It is therefore evident that as the economies of the countries of the region improve, the demand for energy will increase. Thus the provision of adequate energy supplies, both traditional and commercial, must be correctly planned for in an integrated manner in order not to stifle economic growth[5].

3.5.5 Electrification

Due to the growing drain on the economies of countries in the region by the import of various commercial energy forms, many governments and utilities have embarked on strategies aimed at reducing their dependence on imports by exploiting indigenous energy resources. This has resulted in the exploitation of hydro and coal resources for the production of electricity, and substituting it for imported energy forms. In many countries in the region, rural electrification projects are being undertaken by governments and electricity utilities, as part of their human development programmes. These projects are also aimed at an attempt to reduce the deforestation process. Many industries have substituted electricity as a more cost effective source of energy. This has resulted in electricity becoming an increasingly importance energy form in the region as a whole. However, progress has been slow and the region has the World's lowest electricity consumption per capita, despite the large coal, hydro, oil and gas reserves[35].

FIGURE 3.7: INTENSITY OF FINAL ENERGY CONSUMPTION (GDP in local real currency (1985))



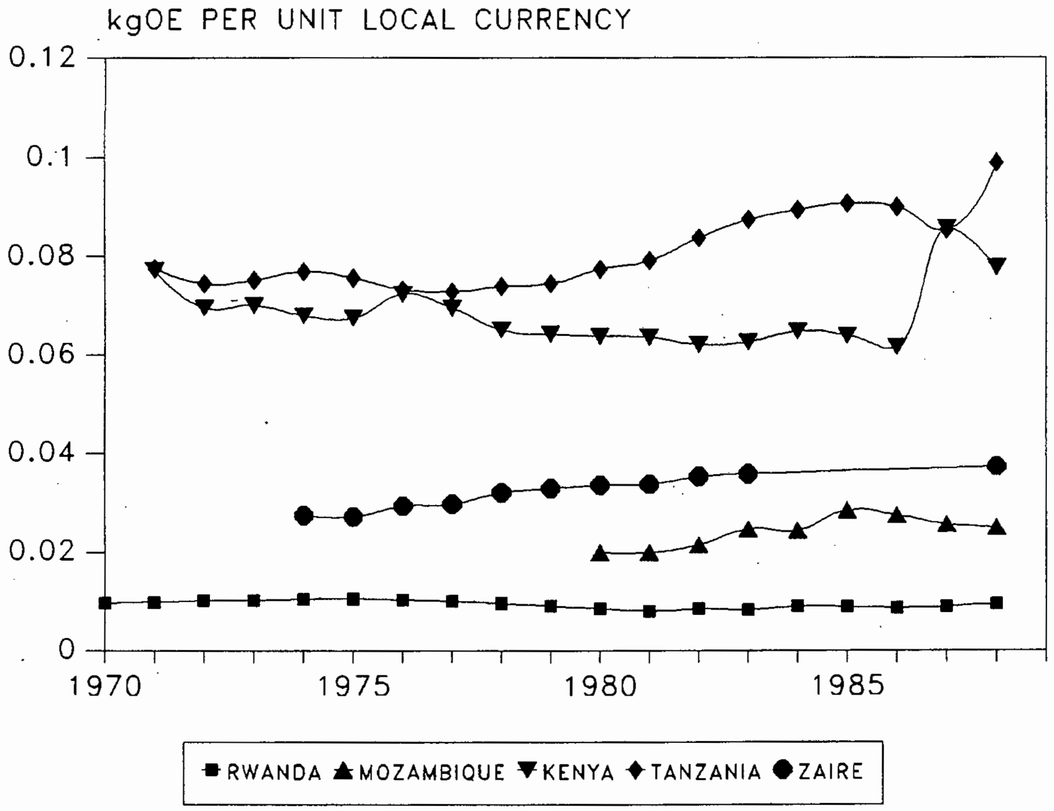


FIGURE 3.8 a : Commercial Final Energy Intensity for the Region.

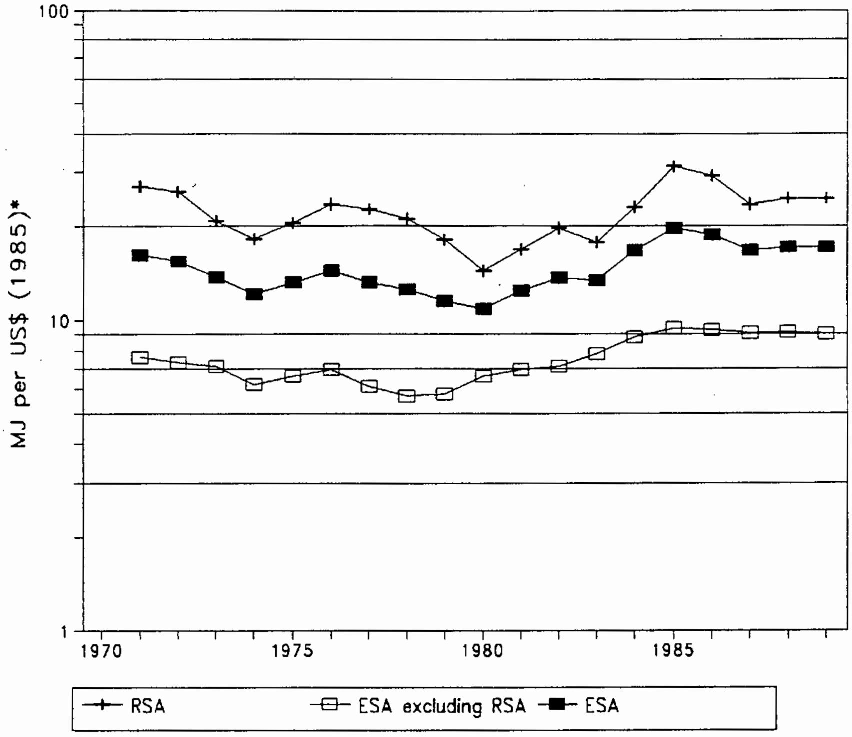
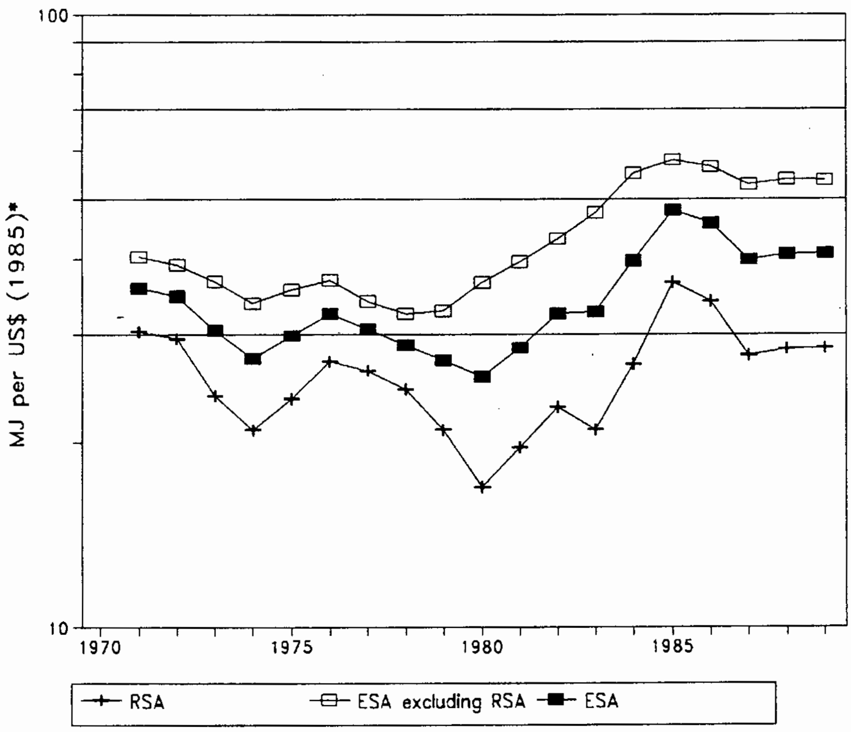


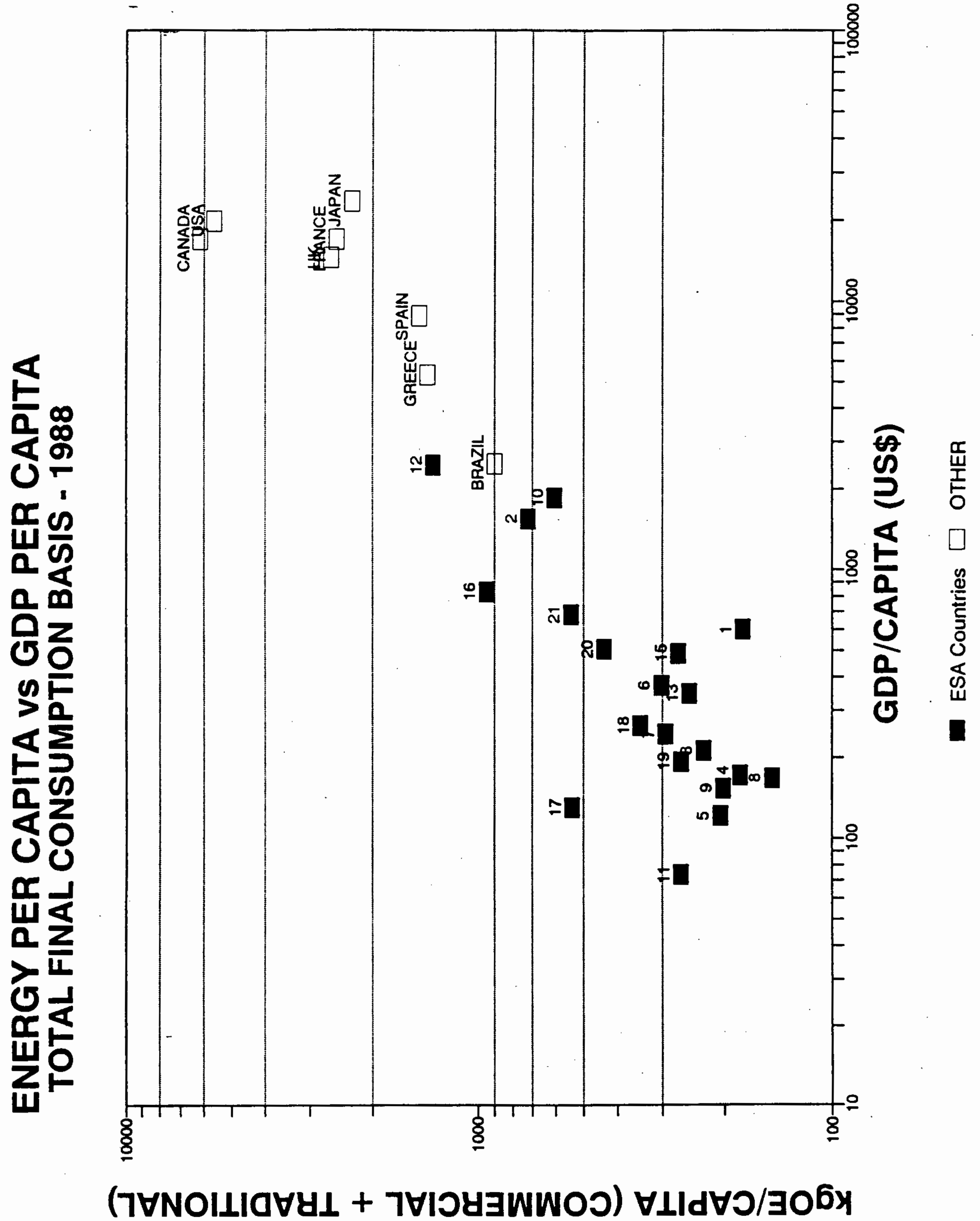
FIGURE 3.8 b : Total Final Energy Intensity for the Region.
(traditional + commercial)



* Local currency converted to US$ at prevailing exchange rates and deflated using 1985 US$ deflator.

FIGURE 3.9: ENERGY PER CAPITA vs GDP PER CAPITA - 1988[10,12,55]

For selected countries



COUNTRY	SYMBOL
ANGOLA	1
BOTSWANA	2
BURUNDI	3
DJIBOUTI	4
ETHIOPIA	5
KENYA	6
LESOTHO	7
MADAGASCAR	8
MALAWI	9
MAURITIUS	10
MOZAMBIQUE	11
RSA	12
RWANDA	13
SOMALIA	14
SUDAN	15
SWAZILAND	16
TANZANIA	17
UGANDA	18
ZAIRE	19
ZAMBIA	20
ZIMBABWE	21

In the more developed countries, such as South Africa, Zambia, and Zimbabwe, electricity is relatively more important[36]. However, lack of finance, inadequate institutional infrastructure, the squatter nature of the peri-urban housing, the large transmission distances, lack of suitably large local markets and large rural populations are hampering electrification projects. At present only a small percentage of the population has access to electricity as shown in Table 3.9. It has been estimated that less than 10% of the total population of the ESA has access to electricity[37].

Any further economic/industrial development in the region, together with further rural and urban electrification, will result in an increase in the relative importance of electricity. However, traditional energy will remain an important source of energy for the foreseeable future and will parallel population growth in the short to medium term.

TABLE 3.9 ACCESS to ELECTRICITY [36,38]

COUNTRY	PERCENTAGE OF POPULATION WITH ACCESS TO ELECTRICITY	YEAR
BOTSWANA	3,6	1983
ETHIOPIA	4,2	1985
KENYA	5,1	1987
LESOTHO	1,5	1982
MALAWI	2,4	1987
MOZAMBIQUE	2,7	1985
RWANDA	0,5	1982
SWAZILAND	9,4	1986
SOUTH AFRICA	33,0	1990
TANZANIA	13,3	1985
ZAIRE	2,1	1982
ZAMBIA	8,0	1982
ZIMBABWE	16,2	1987

Fuelwood resources will not be able to meet the forecast demand without large scale deforestation, domestic energy scarcity, and environmental degradation, which will have a serious impact on the lifestyle of a large portion of the population. Thus it is imperative that reforestation programmes are carried out in parallel with the development of commercial energy. This calls for integrated energy sector planning, and is reliant on the restructuring of the relevant institutions.

3.6 ENERGY RESOURCES AND SUPPLY ISSUES

This section describes the energy resources of the region and examines the energy supply situation. The energy supply infrastructure and markets are discussed, and issues and options identified. A description of energy supply and demand in selected countries of the region is given in Appendix E. Appendix G contains a description of the energy resources of these countries.

3.6.1 Energy Resources

The ESA as a whole has large commercial energy resources which could, if exploited and managed efficiently, supply most of its commercial energy needs well into the next century. However these resources are not uniformly distributed with regard to locality and form. Tables 3.10 a & b give an indication of energy resources of the region. It is intended to present a general picture rather than give accurate figures, as much of the area has not been adequately surveyed or explored.

Energy resources include oil, natural gas, hydro-potential, coal, peat, geothermal potential, and wood. In general the southern countries have large coal resources while the countries nearer the equator have relatively large hydro resources. Oil and gas reserves have been identified mainly along the east and west coastlines. The largest uranium reserves in the ESA have been identified in South Africa and Namibia, while the largest wood resources are found near the equator. Zaire has the largest hydro potential, while South Africa has the largest proven coal deposits and Angola has most of the region's oil deposits.

A large portion of the known resources have not yet been exploited. This is due mainly to the lack of suitably large indigenous markets, distances, location, finance and in some cases quality[18]. However there is much scope for the exploitation of these resources within the frame-work of regional interchange of energy. This would increase the viability of exploiting these resources, as well as making them available for indigenous consumption. The possibilities for regional interchange of energy have been hampered by the lack of transport infrastructure in the ESA, rugged or inaccessible terrain, instability/civil war, lack of finance, distance to suitable markets and most significantly, the importance governments/institutions/utilities place on the security of energy supply. As long as the region is plagued by instability, governments will prefer to either produce within their own countries or buy offshore, rather than import from within the region.

TABLE 3.10 a : ENERGY RESOURCES OF THE REGION

ENERGY RESOURCES OF THE REGION (Reference: 5,7,12,33)

COUNTRY	FORESTS & WOODLANDS M Ha	HYDRO-POTENTIAL *		OIL M TON				GAS (M METRES CUBED)	
		GWh/YEAR	MW	ESTIMATED	PROVEN	TOTAL	PROVEN RECOVERABLE	ESTIMATED	PROVEN RECOVERABLE
ANGOLA	53,60	86100	16000	-	156	156	156	30000	9000
BOTSWANA	32,56	0	0	0	0	0	0	0	0
BURUNDI	0,04	1445	289	0	0	0	0	0	0
COMOROS	0,02	50	10	0	0	0	0	0	0
DJIBOUTI	0,07	0	-	-	-	-	-	-	-
ETHIOPIA	27,15	20000	4000	0	0	0	0	6000	24000
KENYA	2,36	4800	1075	0	0	0	0	0	0
LESOTHO	-	2000	450	0	0	0	0	0	0
MADAGASCAR	13,20	39000	7800	-	-	-	-	-	-
MALAWI	4,27	6300	900	0	0	0	0	0	0
MAURITIUS	0,00	325	65	0	0	0	0	0	0
MOZAMBIQUE	15,44	60000	12500	0	0	0	0	320000	65000
NAMIBIA	18	-	-	-	-	-	-	28000	-
RWANDA	0,23	3000	600	0	0	0	0	-	40000
SOMALIA	9,05	250	120	0	0	0	0	-	6000
SOUTH AFRICA	1,30	5550	3500	-	-	-	-	-	28000
SUDAN	47,65	1900	380	-	41	41	41	-	85000
SWAZILAND	0,20	3000	600	0	0	0	0	0	0
TANZANIA	42,04	20000	6000	0	0	0	0	26710	163420
UGANDA	6,02	10000	2000	0	0	0	0	0	0
ZAIRE	177,59	750000	100000	0,1	23,6	23,7	15	-	1000
ZAMBIA	29,51	21406	3924	0	0	0	0	0	0
ZIMBABWE	19,82	13285	2515	0	0	0	0	0	0
TOTAL	500,11	1048411	162728	0,1	220,6	220,7	212	410710	421420

* Technically Exploitable Potential

TABLE 3.10 b : ENERGY RESOURCES OF THE REGION

ENERGY RESOURCES OF THE REGION (Reference: 5,7,12,33)

COUNTRY	COAL: BITUMINOUS M TON				COAL: LIGNITE AND SUB-BITUMINOUS, M TON				URANIUM **
	ESTIMATE	PROVEN	TOTAL	PROVEN RECOVERABLE	ESTIMATE	PROVEN	TOTAL	PROVEN RECOVERABLE	PROVEN (TON)
ANGOLA	0	0	0	0	0	0	0	0	0
BOTSWANA	33000	17000	50000	3500	0	0	0	0	0
BURUNDI	0	0	0	0	0	0	0	0	0
COMOROS	0	0	0	0	0	0	0	0	0
DJIBOUTI	-	-	-	-	-	-	-	-	-
ETHIOPIA	0	0	0	0	-	23	23	11	0
KENYA	0	0	0	0	0	0	0	0	0
LESOTHO	0	0	0	0	0	0	0	0	0
MADAGASCAR	1000	173	1173	173	42,6	11	53,6	-	0
MALAWI	-	15,78	15,78	1,95	0	0	0	0	0
MAURITIUS	0	0	0	0	0	0	0	0	0
MOZAMBIQUE	8593	938	9531	240	0	0	0	0	0
NAMIBIA	-	-	-	-	-	-	-	-	110100
RWANDA	0	0	0	0	0	0	0	0	0
SOMALIA	0	0	0	0	0	0	0	0	6600
SOUTH AFRICA	2282	121218	123500	55333	0	0	0	0	426300
SUDAN	0	0	0	0	0	0	0	0	0
SWAZILAND	1000	549	1549	208	0	0	0	0	0
TANZANIA	1500	304	1804	200	0	0	0	0	0
UGANDA	0	0	0	0	0	0	0	0	0
ZAIRE	720	86,6	806,6	54,3	0	0	0	0	1800
ZAMBIA	0	0	0	0	213	69	282	69	0
ZIMBABWE	27008	1535	28543	734	-	965	965	-	0
TOTAL	75103	141819	216922	60444,25	255,6	1068	1323,6	80	544800

** Recoverable at 130 US$/kg

At present, with the limited exception of electricity, the regional interchange of energy derived from local resources is relatively small[35]. The interchange of imported energy is limited mainly to the re-export by coastal countries to their landlocked neighbours.

Due to over exploitation, the energy resource base, in certain sectors of the region, is insufficient to meet demand until the end of this century. This is especially true with regard to fuelwood which, excluding South Africa, supplies more than 80 % of the region's energy requirements. In most countries in the region, demand exceeds sustainable supply, and this is already having a marked effect on the domestic sector, as well as on the many industries reliant on wood or charcoal for energy. In most countries of the region there are no incentives for the sound management of forest cover or optimization of its yields. The supply situation will get far worse in the years ahead as the demand for fuelwood escalates. Estimates based on present trends forecast that the demand for fuelwood would at least triple by 2020[18]. This together with the associated escalation in price for fuelwood is going to have serious consequences with respect to the well being of the population of the region.

Within the ESA there is much scope for implementing conservation and efficiency measures in order to extend finite, resources although finance is a major restraint. Reforestation programmes need to be implemented as a priority issue in order to obtain a sustainable supply of fuelwood and to prevent further deforestation and associated social and environmental impact. This will have to be undertaken in conjunction with encouragement from the various governments.

Due to the lack of significant regional interchange of indigenous resources the consumption patterns of individual countries are influenced, to a large extent, by their own energy resources[35]. In the southern countries coal is used extensively for electricity generation because of its abundance, while in the central and northern countries electricity generation relies heavily on hydro and is supplemented with oil fired stations.

Regional cooperation can facilitate the trans-boundary interchange of energy based on the exploitation of regional resources for the mutual benefit of the region as a whole. This would;

(1) enable more efficient use to be made of the region's resources,
(2) enable greater use of idle capacity in some countries,
(3) reduce the outflow of scarce foreign exchange from the region as a result of the associated decrease in the dependence on imported commercial energy, and
(4) improve the security of energy supply to the region as a whole.

This can only become a reality once political stability is achieved in the region.

3.6.2 Energy Supply and Markets

3.6.2.1 Introduction

Energy markets of individual countries in the region, with the exception of South Africa, are small and dispersed. This is due to the low level of development and industrialization of the economies of the region. South Africa on the other hand has an extremely large energy market by regional standards and is responsible for some 75% of all commercial energy consumed. Thus the economic exploitation of the natural energy resources is largely reliant on regional rather than local markets, and on the potential for export.

There are a number of separately operating energy markets within the region. The largest of these is ESKOM's Southern African electricity grid, which links South Africa and several of its neighbouring states. This grid (which has an installed capacity of some 36 000 MW) supplies the so called 'independent' territories within South Africa, as well as Botswana, Lesotho, Mozambique, Namibia and Swaziland. It is also indirectly linked to Zambia and Zimbabwe. The latter two countries have interconnecting grids, and Zambia also has links with Zaire. Kenya has a link with Uganda.

Proposals to expand this grid would lead to strengthened links between all the above-mentioned countries as well as the incorporation of Angola, Malawi and Tanzania. Within this system, countries with undeveloped generation potential such as Zaire, could provide a substantial boost to the entire regional energy economy.

Within the region, markets for fossil fuels and petroleum products are also somewhat disjointed, largely due to (1) great distances, (2) lack of transport infrastructure, and (3) the isolation of South Africa through oil sanctions. South Africa itself, has a well developed fuel market and efficient transport and distribution system despite sanctions. South African Oil imports have been supplemented by synfuels produced from coal by the SASOL project, and it is presently commissioning an 'oil from gas' plant at Mossel bay called MOSSGAS. Neighbouring countries such as Botswana, Lesotho, Namibia and Swaziland have benefited from South African petroleum supplies.

Elsewhere in the region, petroleum markets are poorly developed, and sensitive to changes in the oil price. Transportation presents a major problem, especially to landlocked countries such as Botswana, Burundi, Rwanda, Zambia and Zimbabwe. Petroleum products are frequently supplemented with ethanol.

Although the region has large coal resources, coal markets are poorly developed except for South Africa which has the largest resources and relies on coal for some 81% of its primary energy supply [i] [(12)]. The major constraints to the development of a regional coal market are the large distances involved, the lack of an adequate and efficient transport infrastructure and the lack of inter country cooperation. There is much potential for the substitution of oil and fuelwood by coal.

Gas Markets in the region are non existent except for a localized area in the South African Highveld.

3.6.2.2 Electricity

The electric power supply industry in the region is almost invariably government owned, highly centralized and politically regulated. Although the region has no shortage of the resource base for economic power generation and supply, there has been a deterioration in the performance of the electric power utilities, and a depression of the electricity markets of the region in the 1980's[(35)]. Lately, there has been widespread belief that the poor performance of the sector in this region is interlinked with the sector's organization policy framework and institutional infrastructure. A number of initiatives are being proposed to reform both the macro-economic policy and the energy sector policy framework to bring about a more competitive market environment for the electricity supply industry. These include private sector participation in the electricity markets.

Total installed capacity in the region amounts to some 47 000 MW with South Africa alone having some 36 000 MW. With the exception of South Africa, the infrastructure for electricity distribution and supply is still largely characterized by;

(1) isolated networks, with little or no interconnection between countries,
(2) low fuel use efficiency,
(3) low capacity factors, and
(4) high distribution and transmission losses[(39)].

---

i South Africa's electricity generation is based on coal and a proportion of petroleum products are obtained from coal.

Typical capacity factors and total system loss indicators for selected countries of the region are shown in Table 3.11. System losses are largely attributed to technical problems and theft.

In some countries isolated sub-national grids are still found. This is largely due to the long transmission distances that would be required for relatively small loads. In this region there are great opportunities for expanding power interconnections throughout Southern Africa, including the prospect of Angola, Botswana, Namibia, Mozambique, Zaire, Zambia, and Zimbabwe, feeding to, and being supplied from South Africa as welcome political reform and outward orientation in trade and economic relations mature[41]. There are excellent prospects for the interconnection of Sudan, Ethiopia and Djibouti, of Tanzania and Kenya and the enhancement of the existing Kenya-Uganda interconnections[41]

TABLE 3.11: Electricity Power System Performance - 1987 [39 4]

COUNTRY	TOTAL SYSTEM LOSSES (%)	CAPACITY FACTOR (Total Public)
Burundi	11	32
Djibouti	18	52
Ethiopia	17	27
Kenya	15	52
Malawi	16	38
Mozambique	12	02
Rwanda	40	33
South Africa[38]	7	57
Somalia	30	49
Sudan	22	30
Tanzania	24	23
Uganda	18	45
Zaire	7	20
Zambia	10	42
Zimbabwe	10	39
Typical Developed Country	< 10	>70

However further development of the grid system and exploitation of the large hydro resources of Central Africa are dependent on a suitably large market. For example the exploitation of Zaire's hydro potential is only economic in large block sizes. The only suitably large market in this region is South Africa. ESKOM of South Africa and SNEL of Zaire are already undertaking feasibility studies for the exploitation of this resource within the Chief Executive of ESKOM's vision of a Southern African Grid. The realization of this dream would provide an economic boost to the region as it would increase access to cheap energy, and would improve reliability and security of supply. A Southern African grid would enable more effective use to be made of idle capacity in a number of countries, would minimize interruptions presently being experienced in countries such as Zambia and Zimbabwe due to hydrological uncertainties, droughts, forced outages etc., and would ensure the exploitation of the most economical resources for the benefit of the region as a whole.

The easing of supply constraints and the development of regional grids are reliant on a number of factors[35]:

(1) the successful implementation of structural adjustment programmes in a number of countries.

(2) the shift away from traditional highly centralized public power supply systems towards decentralized structures.

(3) creation of opportunities for new participant in the sector and the attraction of much needed new capital and appropriate technology.

(4) the ability of governments to set adequate rules and guidelines for the operation of new market orientated systems.

(5) willingness of governments and utilities to support power trade.

(6) relaxation of price controls and acceptance of private sector investment and ownership.

The above policy guidelines will create real possibilities for the expansion and strengthening of electricity markets in the region. It is likely that ESKOM, which has a large national grid with 36 000 MW installed capacity, will play a leading role in the electricity sector in the central and southern part of the region since it has the necessary technical resource base and is adept with respect to the African environment.

3.6.2.3 Oil

The oil industry in the region is heavily regulated by governments[42] through the determination and control of prices and, in many countries, direct involvement and monopolistic control of procurement, refining and distribution activities. Governments are often major shareholders in the oil companies and refineries. Besides the well developed South African market, the market for petroleum products lacks adequate institutional infrastructure, is disjointed, and characterized by inefficient and inadequate transport and distribution systems. The inadequacy of the transport sector is especially detrimental to the landlocked countries.

The current state of the petroleum products industry in the region (excluding South Africa) is poor and the cost of supply and distribution is thus excessively high. This represents a fundamental obstacle to the economic development of the region. Much scope exists for a rationalized system which would enable large savings. It has been estimated that rationalization could enable a saving of US$ 270 million for the Eastern African region, with Tanzania and Zambia showing the largest potential for improvement[42]. The key problem areas which have been identified are[(42)i]:

procurement inefficiencies: due to lack of foreign exchange resources, poor credit standing, lack of proper purchasing skills or proper bidding procedures, and the concentration of procurement activities in the hands of entities with little or no incentives to minimize actual costs.

refining inefficiencies[ii]: the eleven local refineries (South Africa excluded), two of which are inoperative, are not competitive as opposed to direct imports from the World scale refineries of the Middle East and South Africa, which are in close proximity. The region's refiners generally suffer from poor outdated technical structures, are small in scale, lack appropriate maintenance and repair (lack of foreign exchange), have low utilization rates and operate in a small market. With the exception of Kenya and Ethiopia, utilization rates average 50%.

distribution inefficiencies: due to the poor state of storage and transportation infrastructure, the operation of which is effected by the lack of appropriate skills in the areas of logistics and service management.

unfavourable environment for investment: market operators face high levels of uncertainty, unpredictable changes in pricing formulas, high levels of inflation, currency devaluation and limited or no opportunity to repatriate dividends or capital. As a result, the level of investment in the industry over the last few years has been limited.

inadequate institutional set up: in particular, the current pricing structures and practices which provide inadequate incentives for operators to minimize the cost and improve the level of reliability and service, in the distribution of petroleum products.

---

i These do not strictly apply to South Africa.

ii It should be noted that the six refineries in South Africa, three of which are situated on the

In order to reduce the cost of supply the governments, industry operators and international agencies will have to encourage and undertake reforms within the sector. Changes in the institutional infrastructure are fundamental to solving the sectors problems. These should encourage increased competition and proper bidding procedures in the procurement process. Pricing mechanisms that reflect true economic costs should be implemented. Governments should constantly access their oil refining policies and, should rely on imports of finished products, if cheaper, rather than refine oil themselves[43]. Regional cooperation in transport corridor issues and refining policies should be encouraged.

There is also the need for investment in infrastructure and management systems in order to;

(1) lower transport costs by improving, repairing and expanding the transport system, especially the railways,
(2) improve storage facilities,
(3) lower the cost of refining operations, and
(4) to ease the problems of scarce foreign exchange and forward purchasing planning.

In order to attract the massive investment required for the above, it is essential to provide industry operators with a more favourable industry environment.

The refining area needs special attention. Due to the state of the region's refineries, excluding South Africa, enormous investment will be required in order to undertake the required rehabilitation and maintenance to keep them going. However, it is not economically feasible to modernize them all economically, due to the small market size. They are thus bound to become increasingly uncompetitive vis-a-vis imported products, and will eventually close. An alternative to the closure of all refineries is the upgrading of the Kenyan refinery, to enable it to serve most of the Eastern African region, and the conversion of the Tanzanian refinery into a regional supply center. The remaining requirements of finished products will need to be imported. In this regard South Africa could play an important role especially with regard to the Southern African region.

Angolan crude oil production could supply 86% of the regions total oil needs. The opportunities for using Angolan crude as feedstock for the South African and Kenyan

(continued)

---

coast, are relatively efficient, modern, are undergoing expansion, and are conveniently situated for processing crude for much of the region.

refinery needs to be investigated. Much depends on the refinery design, crude oil type, transport infrastructure, and costs, versus the Middle East crude.

3.6.2.4 Coal

Although the region has large coal resources, coal markets are poorly developed except for South Africa which has the largest resources, and relies on coal for some 81% of its primary energy supply. The barrier to a satisfactory trade in coal in the region is the inadequate railway system and the political situation in the region. Whilst there is a rail link between most of the countries of the region, most of the main links have been closed, or are operating extremely inefficiently due to sabotage and ongoing guerrilla activities. With a general improvement in the political situation in the region, these disruptions should decrease with time. However, even when the links are again open there will be a chronic shortage of rolling stock, a shortage of skilled technical staff, as well as a shortage of managerial skills to operate the links at an efficiency figure acceptable to the coal trade[44].

The need for coal trade to ensure adequate supplies will increase with the general deterioration in the fuelwood situation of the region. With fuelwood no longer being a sustainable commodity, the traditional energy sources are being replaced by the most expensive forms of commercial energy such as paraffin and candles. Under these circumstances, the use of coal is a cheaper alternative to supplying the basic energy needs of the developing sectors of the community.

3.6.2.5 Gas

Gas markets in the region are presently limited to a localized area in the South African highveld, using synthetic gas. This is in sharp contrast to the usage of gas in OECD countries, and the large gas resources of the region. The exploitation of the region's gas markets are reliant on suitably large markets. The market size of the countries in which the major resources are situated is not large enough on its own, indicating the necessity for trade of gas between nations. Investigations are presently under way to determine the viability of exploiting gas resources in Mozambique and Namibia to supply the Transvaal and Western Cape regions of South Africa. The gas from Mozambique could also be routed to Swaziland as a spur from a possible South African pipeline. Mozambique could also supply Zimbabwe and Zambia if projects with a significant gas demand were started. Tanzania has large gas resources and could supply the surrounding countries such as Kenya and Malawi.

3.6.2.6 Fuelwood

The vast majority of fuelwood is consumed in the domestic sector. Wood is also used for small scale rural industries such as; tea, coffee and tobacco processing, lime making, and brick making. Traditional fuel, on average accounts for 90% of energy consumed by the domestic sector[32] (excluding South Africa). The bulk of this energy is used for the preparation of food[25]. Few governments of the region have sought to play more than a nominal role, if any, in the supply of traditional energy or its use, although the majority of the population, rural and urban, depend on it to an overwhelming extent. The procurement and supply of fuelwood is thus carried out in an informal manner, and the sector is characterized by the lack of integrated energy policy and planning, which would ensure security and sustainability of supply to the domestic sector. As most use of fuelwood is used in the informal sector and outside the commercial channel, fuelwood supply figures are poor or non existent, and accurate and reliable fuelwood demand data, for the household and informal industrial sector, are rarely available, if at all[7,43,45].

Markets for fuelwood are generally highly fragmented, poorly developed and restricted to the area surrounding the resources. This is due to the low cost requirement for such a fuel and the high cost of transporting a low grade energy source. Charcoal markets are larger due to the higher energy density, but are still restricted to the nearest large population settlements as a result of transport costs. Some interchange of traditional energy does occur, but it is very site specific[44]. There are two distinct markets operating in this sector. In the urban and peri-urban areas fuelwood and charcoal are traded on a commercial basis. Charcoal is almost exclusively an urban fuel which is supplied from outlying areas. In the rural areas, fuelwood is invariably obtained non-commercially, where it is collected by the end user from communal lands. Wood is often supplemented by the use of dung or agricultural residues.

In many countries demand for fuelwood is greater than sustainable supply, which results in scarcities, especially in and around populated areas. Recently, in many parts of the region abundant standing stocks of trees, shrubs and other biomass have rapidly dwindled[27]. This is as a result of land clearing for agricultural production[i], and the need to meet the domestic and export demand for furniture timber, as well as timber for housing and other structures[7,43,27]. The demand for biomass fuel, especially around cities and other large settlements, has further aggravated the rate of

---

i To produce increasing quantities of food for the growing population as well as cash crops including export commodities deforestation in the region[45]. It has been estimated that the deforestation is taking place at rate of 3 million hectares a year in Africa[43]. This depletion of land resources, for whatever reason, jeopardizes wood and biomass resources in many areas.

The resultant scarcity of fuelwood is having a severe impact in many countries. In rural and poor urban households, women and children (who are traditionally the providers and users of energy supplies in the family) are having to range further and longer in search of fuelwood for the preparation of food[7,27]. In urban areas they queue for many hours and pay high prices for fuelwood and charcoal when these are available. As a result the consumption of cooked meals is known to have become irregular in a growing number of families, with an adverse effect on health and well being.

The deforestation process and associated scarcity of fuelwood is further aggravated by the common property institutions, or so called communal lands, which are abundant in the rural areas of the region. Common property institutional arrangements break down under the influence of the scarcity of resources, and other alternative arrangements are required. There is indisputable evidence that in many instances the lack of private property rights contribute to the wasteful use of natural resources[45]. This raises the issue of land tenure and ownership which has plagued the region.

In many countries the fuelwood crises in the urban areas has resulted in the conversion of wood from remote surplus areas, into charcoal, which is then transported to the urban areas. Due to its higher energy to weight ratio, it has a comparative advantage over wood in transport. However a major shortcoming of the majority of charcoal production methods practiced in the region is the extremely low charcoal conversion ratio which is further wasting valuable resources. The methods used minimize capital expenditure at the expense of efficiency.

There have been many programmes to encourage rural people to grow trees to meet their future energy needs. Most of these have been centered around the idea of communal woodlots but have had little impact. This again raises the issue of common property institutions and private ownership. There have also been many efforts to establish commercially viable fuelwood plantations, but their success has been rare, as they are unable to compete with natural woodland in the rural areas and in the urban areas they can't compete with commercial products such as petroleum and coal[7]. Any attempts at establishing fuelwood plantations in areas surrounding urban areas, or encouraging peri-urban fuelwood cultivation are are unlikely to succeed because [of(45)]; the high value of the land, and the preference for using the land for more profitable and economic activities. In this regard it should be noted that the large use of fuelwood is directly associated with the fact that it is "cheap" and in most cases "free" together with its widespread nature. Any attempt to commercialize its cultivation which increases its basic price puts it out of reach of much of the population, makes it uncompetitive in relation to other commercial energy forms, and is more economically marketed in forms such as furniture or construction timber.

Thus in the medium to long term the urban fuelwood crisis will need to be overcome by the more efficient supply of commercial energy in which electrification will play an important role. In the short to medium term the supply of charcoal from remote areas where fuelwood surpluses exist should be encouraged[45]. However to reduce the depletion of these supplies the efficiency of present charcoal production practices needs to be addressed.

The long term solution to the rural areas supply problem lies in the development of commercial supply infrastructure, electrification being the ideal solution. However, this will take time, and it should be remembered that fuelwood is one of the few abundant, cheap and widespread indigenous resources in the region. It is a resource which is more or less environmentally benign if consumed on a sustainable basis, a fuel that provides significant rural employment and saves foreign exchange, and a fuel that can be used indefinitely if properly managed[43]. Thus the remaining valuable resources should be farmed,not mined, and treated as a renewable resource to help ensure an indefinite source of energy. This calls for an effective reforestation programme to be implemented as a priority through agro-forestry and inter-cropping practices. In order to succeed this would need to be supplemented with an effective population stabilization programme which at present is a very touchy subject in the region.

In the rural areas, action to protect and manage the fuelwood resource base by the development of sustainable, multi-purpose land uses (with trees managed for a variety of end uses including fuelwood) should be promoted through national and regional programmes[43]. In order to succeed these programmes should build on the resource management systems of the local community who must be given control over the land resources on which they depend. Financial assistance should be channelled into setting up the necessary infrastructure to ensure adequate distribution of seedlings to these rural communities. A key to effective management of the resource is to ensure that those involved are fully aware of the large benefits that accrue from growing and managing trees. The use of agro-forestry and inter-cropping practices to ensure future supplies of fuelwood are seen as more viable options, as opposed to communal woodlots, as; there is a greater sense of ownership, inter-cropping may foster the growth of food as far as the role of the trees is concerned, inter-cropping bridges the gap between the establishment and harvest of trees cultivated for the purpose of fuelwood production as far as the role of the crop is concerned[45].

In order to encourage people to manage and grow trees the rural population must; have the right to own or use forest land and own the crops on the land, in particular, trees, they must be provided with simple inputs, such as seedlings, and training, if necessary, to manage the crops, they must be involved in any decision making process.

The reforestation programmes should be aided by the simultaneous initiation of improved efficiency fuelwood and charcoal stove programmes, and the improvement in the charcoal production process.

In the medium to long term commercial energy should increasingly be made available to the rural communities. Thus it is imperative that reforestation programmes form part of integrated national energy policy planning. In order to be effective, surveys have to be undertaken in order to determine supply and demand patterns so that forecasts can be made. This will enable an energy strategy to be formulated giving the various energy options, taking into consideration environmental costs and benefits.

3.6.2.7 Nuclear

In most cases the financial costs, amongst others, associated with nuclear power means that only a small number of developing countries can seriously contemplate the nuclear option[46]. Thus within the time scale of this report the only country which might consider the nuclear option is South Africa, and then it will mainly be for grid stabilization purposes.

3.6.2.8. The Potential for Regional Energy Interchange

Much of the interest on energy trade is based on the potential for electricity transfer, especially from the hydro-rich countries of the region to South Africa. The possibility for such a network of regional power transmission has been made possible by the developments in high-voltage transmission over large distances. Examples include the line between Cahora Bassa in Mozambique and South Africa, and the Inga to Shaba line in Zaire. The scale of construction necessary to make many of the schemes economically viable requires a large base demand. South Africa with its large energy market can potentially provide the necessary demand to enable the development of an economically large block of energy. Technical developments mean that there are no technical obstacles to the transfer of large blocks of power over long distances. Once this generation capacity is developed, smaller users can be incorporated economically. Although the increase in the interchange of electricity is likely to be the most dramatic in the next decade, there is also scope for energy trade in coal and gas.

Fuelwood and charcoal will not be considered since the potential for interchange is small, due to the low cost requirement for such a fuel and the high cost of transporting a low-grade energy source.

Electricity

There is already some electricity interchange in the region, but on a limited scale. There is electricity interchange between South Africa and its neighbours, and between other countries in the region. There is however large scope for increasing this interchange which would enable more efficient utilization of resources and increased reliability of supply.

The hydro potential of Zaire alone is 100 000 MW, of which 25 000 MW is possible in a short stretch of the river at Inga, downstream of Kinshasa. Thus from this one stretch alone, Zaire could provide the entire electricity demand of the whole region. There are however limits to the amount of electrical capacity which any country would be prepared to import from one source, and this total potential capacity is not realizable in the near future.

If South Africa accepted 15% of its total maximum demand from external sources, this would mean a market for some 3 000 MW of maximum demand and, if operated as a base load, would result in sales of 20 000 GWh per annum. At the present cost of production of electricity in South Africa, this would amount to US$ 600 Million per annum, which is some 10% of the total GDP of Angola, Zaire or Zimbabwe.[44]

In addition to supplying South Africa, the installation of transmission lines in the form of a super-grid would make electricity available to countries and areas through which the lines would pass, as well as earning them revenue. The interconnection of the national grids of a number of countries would also allow for the use of lower installed capacities, since stand-by capacity could be shared between the various utilities, increasing reliability of supply[44]

Including the South African demand, as well as that of ESA countries, and the forecast[i] growth to the end of the century, it has been estimated that there a potential market for some 6000 MW of transmitted power in the region [44]. This amount will grow as the demand in the region increases with economic development. Of this amount some 2 500 MW is already in place, including the various inter-country interchanges and the 1 920 MW of Cahora Bassa. There is therefore room for an additional 3 500 MW of electricity trade in the region. However, because of the economic downturn in the region, there is significant spare capacity, especially on the South African grid, and a significant increase in electricity trade will only take place once the spare capacity is used up. In the case of the South African grid, it is estimated that additional capacity will be required by the turn of the century[38].

An increase in trade in electricity will require a stronger transmission system. The existing links in many cases are not capable of transmitting the loads that might be required and a strengthening of individual sections will be required

Coal

In 1988 the region consumed approximately 18 MTOE of coal, of which South Africa consumed 87%. Half of the coal was used for electricity generation and the remainder mainly for industrial applications. In addition, there was an amount of 28 MTOE which was exported out of the region.

Because of infrastructure limitations in the region, namely transport, oil is often used for heating purposes since coal is not available. It is estimated that for heating purposes in Southern Africa, heat generated from pit-head coal is approximately 15% of the cost of heat from heavy fuel oil. For railage distances of 1600 km (e.g. from Johannesburg to Cape Town) the economics are worse, with coal totalling 60% of the cost of oil. Most of the countries south of the equator are within a distance of less than 1500 km of the coal fields of South Africa, Botswana, and Zimbabwe. Thus there is an incentive to use more coal where it can be railed or shipped at reasonable cost.

The potential trade for coal is likely to be between 3 and 6 million tons of coal per annum[44], if the infrastructure were in place to support such an exchange. The source of this coal would be South Africa, Botswana and Zimbabwe and to a lesser extent Mozambique, Swaziland and Tanzania. The main importers would be Angola, Kenya,

---

i See Chapter 5.

Namibia and Uganda. The shift to coal would be at the expense of oil imports. The amounts of coal trade would, in fact, be greater than this due to the fact that some countries, such as Zaire, may not be able to expand their coal production and may find it economical to import coal.

Gas

Gas is the growing energy source of the world and is taking over from oil and coal. In countries, in other parts of the world. where gas has been adequately developed, it amounts to between 15% and 20% of total final consumption of commercial energy. In the region gas has been found in Mozambique, Namibia, Rwanda, South Africa and Tanzania, and is associated with oil resources in Angola and Zaire. Investigations are currently under way on the potential of gas trade between Namibia and South Africa, and between Mozambique and South Africa. If gas was made available to South Africa it may be assumed that gas could supply 15% of commercial energy, amounting to approximately 6 300 thousand TOE[44]. This gas would be supplied from the Kudu gas field off Namibia, and from the Pande field in Mozambique. In view of the distances involved, the Namibian gas would be used in the south-western part of South Africa, whilst the Mozambique gas would be used in the industrial centre of South Africa on the Highveld.

The gas from Mozambique could also be routed to Swaziland, as a spur from the South African pipeline. Mozambique could also supply Zimbabwe and Zambia if projects with a significant gas demand were to be started.

Tanzania has large gas resources and could supply the surrounding countries such as Kenya and Malawi. However, it is likely that only Kenya could have a gas demand large enough to warrant possible development of the Tanzanian capability. The export to Kenya would amount to approximately 300 TOE[44].

Oil

There are only two countries producing oil in the region - Angola and Zaire. Of the two, the Zairean production is declining and is unlikely to be a significant source of oil for the region. The Angolan production is sold on the open market and there is presently no incentive for Angola to supply oil directly by rail or pipeline to other countries in the region.

There is however potential for a rationalization in the supply of refined products to make optimal use of the refineries in the region. At present a number of refineries are not working, or are working at a much reduced capacity because of maintenance problems, due to lack of skilled manpower and difficulties in obtaining foreign exchange. Trade in oil products is therefore an attractive possibility as opposed to the construction of new refineries.

3.6.3 Energy Technology and Efficiency

Generally, the efficiency of energy consumption is low in the region. This is particularly true for the household sector and for fuelwood in particular. Within the ESA there is much scope for implementing conservation and efficiency measures in order to extend finite resources although finance is a major restraint. At present programmes are focused on end use efficiency in the domestic sector, especially with respect to the use of fuelwood as deforestation needs to be addressed. The traditional concern of efficiency of plant operation is not as great a priority as is the use of adequate and appropriate plant, for which capital cost, maintainability, operability, cost and availability of spare parts and durability are important issues.

3.6.3.1 Energy Technology

In the past western type state-of-the-art technology has been employed in many countries of the region with detrimental effect. The large capital necessary to acquire, maintain and operate such state-of-the-art plant puts a large drain on the economy[27]. In the region the minimization of the capital cost of plant is of greater importance than the achievement of state of the art efficiency levels. The lack of local skilled manpower required to operate and maintain such plant, together with the lack of foreign exchange required to purchase spares has resulted in much plant operating below its design rating and efficiency, and falling into a state of disrepair[25]. A significant proportion of the power plant constructed in the region can reasonably be considered inoperative. Experience has shown that extraordinary institutional arrangements, and special resource allocation have had to be made to support these imported technologies before they can be operative[49]. Thus state-of-the-art plant and equipment designed to operate reliably and efficiently in the developed world environment will often perform less effectively in the long run than less elaborate plant based on well established "older technology", due to differing local conditions[52]. For example a modern pulverized coal fired power station will, in many cases, require an expatriate work force for its operation, maintenance and management. It also requires;

(1) abnormal provisions for its spare parts,
(2) special maintenance contracts with foreign firms,
(3) fully and comprehensively equipped workshops,
(4) special customs clearance procedures for the imported spare parts,
(5) special foreign currency provisions for its consumables and spares,
(6) expensive and time consuming modifications due to differing local operating conditions, and active lines of credit with the various countries from which the power plant components were purchased.

The above requirements, amongst others, will need to be fulfilled, before such a power plant can be comparable to similar power plants installed in developed countries[49].

Therefore the technology used should be appropriate to, and adequate for the conditions prevailing in the region and thus, the latest technology is not necessarily the best. The technology employed should take into account the lack of technical expertise, maintenance and operating constraints and the need to use local personnel to fulfill these functions, unique environmental conditions (lack of water, high temperatures, dust etc.), lack of capital and foreign exchange, and the need to keep the cost and import of spares to a minimum. In terms of socio-economic development, an ideal technology may be postulated as one that is[49]:

affordable and equitably distributable,

transferable and culturally acceptable,

economically efficient (capital vs technical efficiency),and

ecologically benign.

With regard to the last point, the technology employed should strike a balance between the quest for increased energy supply to support social upliftment and legitimate economic aspirations and benefits, and the impact on the local environment. The role of women in development, as well as their traditional role in the informal sector of the rural areas, together with the traditional and cultural influences on the use of energy in the household, need to be studied when considering technology suitable for application in the household sector[49].

Globally, the debate surrounding technology issues and impact on the environment has been dominated by the risks associated with nuclear energy, fossil fueled-fired generation and automobile exhausts. These are technologies that are not prevalent in this region[49]. In this **region** the domestic sector consumes a major proportion of total energy, mostly in the form of traditional energy. The improvement of end use efficiency in this sector will thus have a significant effect on energy usage in the region especially with respect to the usage of fuelwood[43]. Much scope exists for the development of technologies to improve the efficiency of wood usage and should be favoured[47]. Several improved fuelwood and charcoal stove programmes in the region have demonstrated efficiency improvements of 25% to 50%. The use of solar water heaters to supplement conventional heaters has much scope in the ESA.

For technology to be appropriate, it must, in its design, take cognizance of the natural limitations of the environment it is to serve and the internal and external environmental opportunities as well as threats[49]. Good availability of plant and equipment under local conditions overrides the effects of increased efficiency when considering suitable technology[52].

The technology employed should take into account the lack of technical expertise, maintenance and operating constraints and the need to use local personnel to fulfill these functions, unique environmental conditions (lack of water, high temperatures, dust etc.), lack of capital and foreign exchange, and the need to keep the cost and import of spares to a minimum.

In the region the minimization of the capital cost of plant is of greater importance than the achievement of state of the art efficiency levels.

Obstacles to the more efficient use and exploitation of resources in the local and regional context are the distances involved, and the associated lack of an adequate transport and distribution infrastructure. The viability of the exploitation of the large hydro potential of the region is reliant on the development of suitable technology, for the transmission of electricity over great distances, often at high altitudes. The Cahora Bassa-South Africa link is a case in point.

3.6.3.2 Technology Transfer

Technology transfer has traditionally been from the developed countries to countries within the region, rather than between the countries of the region. This has often been linked to the transfer of funds by donor countries and organizations. Thus, the type of technology used in the region has mostly been dictated to by the developed countries and has often been inappropriate for the unique requirements of the region. There is therefore a need to focus on the transfer of appropriate technology within the region, rather than on the import of "turnkey" technology. If the required technology is not available within the region, it will be necessary to adapt imported technology to satisfy local requirements. This requires the development of a skills base through adequate education.

It should be noted that South Africa, which has the most developed economy in the region, has much of the resource structure necessary to facilitate the transfer of appropriate technology within the region. This includes experience under local conditions. With the emergence of democratic rule in South Africa it can be expected that this country will play an increasing role in the transfer and development of technology appropriate to the conditions prevailing in the region.

At present the technology employed in the region is diverse in origin and type. For instance, as a rule, there is no interchangeability of power generation spares between and within countries of the region. There is a need to standardize the technology used in the region. This would reduce the cost of the procurement of spares through bulk orders, increase the viability of local manufacture of spares and improve local maintenance and operating experience and skills. As a starting point, energy supply utility personnel should establish contact with colleagues in neighbouring countries to discuss common technical matters to increase local understanding and to seek ways and means for collaboration(47).

The findings and results of foreign Research and Development programmes should be used where necessary after adaption for local conditions. Local Research and Development programmes should concentrate on issues and problems unique to the region (i.e., air condensers, long distance high altitude transmission lines, wood stoves) and the adaption of foreign technology for local conditions.

3.6.4 Energy Security

The energy scarcities, spreading rapidly in rural and urban areas, due mainly to constraints in the supply and uses of traditional as well as commercial energy forms, are disturbing dimensions of the socio-economic crisis sweeping the region(27,25). The energy crises in the region ranks second only to the food crisis in severity, as it poses a threat both to development and survival prospects in the most effected countries(27). Attaining and sustaining energy security, for the formal as well as informal sector, must therefore be a top priority for the region. This issue needs to be addressed at national as well as regional level.

At a national level governments need to restructure the energy supply industry to alleviate the present supply constraints. Institutional reform needs to be undertaken to allow integrated energy sector planning and policy formulation, encompassing both traditional and commercial energy supply systems. This would depend on a shift away from traditionally highly centralized commercial energy supply systems, towards a more decentralized structure encompassing the supply of fuelwood and its substitution for fuelwood.

At a regional level, the improvement in energy security is reliant on the willingness of governments, utilities and the energy supply industry to support the trade of energy within the region.

Historically areas the ESA have been characterized by instability and civil strife with conflict rather than cooperation being the order of the day. This has resulted in stronger connections between local countries and European nations than between neighbouring African countries(47). This has effected on energy policy. The energy policy of countries within the region are based on the political instability within the region rather than on the political events or economic trends outside the region. Countries thus strive to be independent from reliance on their neighbours for supply of energy, and import only the bare minimum from countries within the region, regardless of the economics, preferring to rely on their own resources or on imports from outside the region. This results in the fragmentation of energy supply systems in the region and the under utilization of capacity in countries which have resources to spare. Regional trade in energy would allow for maximum use to be made of idle capacity(47), the exploitation of the most economically viable resources and improved security of supply through collective self-reliance at sub-regional and regional level.

The ESA has large energy resources many of which have not been exploited. A change from confrontational to cooperational politics could facilitate regional interchange of energy and the utilization of local resources for the benefit of the whole region. This would provide the means for more efficient use to be made of the region's resources and reduce the dependence on imported commercial energy and improve the security of energy supply to the region as a whole. This can only become a reality once political stability is achieved in the region.

In the energy sector, the lack of adequate technical and management proficiency, necessary for the sound development, establishment, operation and maintenance of energy supply and use systems, is undermining the ability of the sector to provide a secure supply of energy[47]. Thus, a key issue in maintaining and improving security of supply within the ESA, is the use of adequate and appropriate technology. The unique climatic conditions, skilled manpower availability, economic financial and foreign exchange constraints, and the needs and priorities of the region, which differ greatly from those of more developed countries must be taken into account. This will help facilitate operation and maintenance by indigenous personnel as well as extending plant life under local conditions and save capital expenditure by reducing unnecessary and inappropriate specifications. The standardization of technology used in future projects in the region would increase the regions self reliance with respect to maintenance and operational requirements.

Another key issue in this regard, is the need to establish the necessary local technical skills base through appropriate education, and the interactive transfer of technology from industrialized nations as well as between countries within the region.

Reforestation programmes need to be implemented to ensure a sustainable and secure supply of fuelwood to the domestic sector which is the largest single user of energy in the region.

3.7 ENVIRONMENTAL ASPECTS

This section discusses the environmental issues arising from the use and exploitation of energy in the region. The differences between local and global environmental concerns are highlighted, and measures appropriate to the region indicated.

3.7.1 Introduction

Priorities in this region differ greatly from those in developed countries, for three reasons:

(1) governments are generally far more concerned with economic growth than environmental protection,
(2) the levels of greenhouse gas emissions are relatively low by international standards [43] (with the exception of certain districts in South Africa), and
(3) the prevalence of poverty is so great that most people are concerned with primary subsistence and developmental issues.

These primary issues include poverty, hunger, overpopulation (with respect to economic performance), inequality, and ecological damage such as water depletion and land degradation[48]. Poverty leads to pollution and environmental degradation[16,47], therefore, economic growth in the region will have a positive spin off for the environment. Poverty and population pressure in the region encourages the population to cultivate even more marginal lands. This further erodes the thin layer of top soil and depletes water resources thus creating even more poverty, as crop yields fall and women spend more hours each day collecting firewood and fetching water.

Table 3.12 shows the net additions to the greenhouse heating effect by carbon dioxide emissions attributed to the use of fossil fuels, and the loss of carbon dioxide sink due to land use change (deforestation), in the region, and for selected developed countries. The region's usage of fossil fuels for energy contributes only 1,6 % of the world's net additions by carbon dioxide to the greenhouse effect. South Africa is responsible for 86% of this. Thus, the remainder of the region's present contribution to the greenhouse effect through the use of fossil fuels is minimal. The region's net contribution to the greenhouse effect attributed to the loss of carbon dioxide sink as a result of land use change (deforestation) is almost double that attributed to the use of fossil fuels. Deforestation in the region is mainly the result of clearing and burning of forests for agricultural land, while the use of wood for energy plays a role especially in populated areas[43]. Thus it has been argued that in this region it is more appropriate to spend money on reforestation than on high technology emission control equipment.

It follows that the main environmental concerns in the region are with resource extraction, rather than with emissions. Deforestation, the loss of arable land and water depletion are all serious problems, which result in poverty, hunger and general economic decline. This, in turn, places additional pressure on remaining resources. This cause and effect chain needs to be addressed as a matter of urgency.

TABLE 3.12:

NET ATTRIBUTED ADDITIONS TO THE GREENHOUSE HEATING EFFECT BY CARBON DIOXIDE IN 1987 (REFERENCE 33)

LOCATION	COUNTRY	NET ADDITIONS ATTRIBUTED TO FOSSIL FUELS			NET ADDITIONS ATTRIBUTED TO LAND USE CHANGE		
		000's TON CARBON	AS % OF ESA	AS % OF WORLD	000's TON CARBON	AS % OF ESA	AS % OF WORLD
ESA	RSA	33250	86,0	1,36	-	-	-
	ZIMBABWE	1800	4,7	0,07	1800	3,0	0,15
	ZAMBIA	297	0,8	0,01	1800	3,0	0,15
	MALAWI	54	0,1	0,00	6800	11,2	0,57
	OTHER	3274	8,5	0,13	50400	82,9	4,20
	TOTAL	38675	100	1,59	60800	100	5,07
REMAINDER OF WORLD	USA	525710		21,56	2600		0,22
	UK	68210		2,80	-		-
	JAPAN	105850		4,34	-		-
	BRAZIL	21470		0,88	540000		45,00
	OTHER	1678885		68,84	596600		49,72
	TOTAL	2400125		98,41	1139200		94,93
WORLD	TOTAL	2438800		100	1200000		100

Concerns prevalent in developed countries, such as atmospheric pollution and related consequences such as global warming and acid rain, are of relatively little concern to many decision-makers in the ESA. There are pressing environmental issues in the ESA which deserve far more attention, both within the region and internationally. This does not mean that the traditional concerns of developed countries are of little significance. Air pollution is a problem in parts of South Africa. However the demands on scarce capital, and in particular, the foreign exchange required for pollution abatement technology discourage any serious attempts to address this issue.

3.7.2 Atmospheric Pollution and Global Warming

The most significant sources of atmospheric emissions of the region are found in South Africa, specifically in the Pretoria-Witwatersrand-Vereeniging and Eastern Transvaal areas. Sources of emission include thermal power stations, heavy industries, vehicle exhaust fumes and smoke from domestic energy use. All of these sources are significant yet still low by world standards except in isolated areas. ESKOM, South Africa's energy supplier, is a major contributor to air pollution, especially in the Transvaal's Eastern Highveld region, where there are a number of large coal-fired power stations. These stations emit carbon dioxide, sulphur dioxide, nitrous oxide and particulate matter.

As the country's largest producer of electricity, ESKOM, like most other electricity utilities of the region, is generally immune to pressure from environmentalists. Added to this, is the fact that by virtue of its size and strategic importance, ESKOM can resist moves to have stricter standards imposed by the legislature without its prior approval. Other utilities in the region are in a similar position, in that they can virtually set their own emission standards. Political and economic priorities in the region also act to discourage excessive investment in the reduction of emissions.

A current predicament faced in South Africa illustrates this point rather well. ESKOM has the option of installing desulphurisation plants in its major thermal stations at a cost of approximately 8 billion South African Rand (2.8 billion US$). Alternatively, it can electrify all those major urban settlements currently without access to electricity, at a cost of about 6 billion Rand (2.1 billion US$). Clearly, the second option is the more acceptable given the country's socio-economic environment.

It is also important to take into account the current effect of pollutants from household sources in un-electrified urban areas. Here the local concentration of pollutants can become excessive, resulting in serious health problems. Resources used include coal and wood, and usage of these is often wasteful when compared to the efficiency of large scale generation. Electrification also has the potential to introduce refrigeration, television and extended hours of light, all of which have positive economic benefits. Electrification has also been shown to reduce population growth rates.

If one considers the savings on costs of health care, the improvement in urban quality of life, the reduction of resource wastage and the potential spread of economic benefits, it is likely that the indirect environmental benefits of household electrification in low-income, high-density urban areas far exceed the benefits of emission treatment of power plants.

In countries other than South Africa, emissions attributed to fossil fuels are minor by world standards[43]. There are a number of small thermal and diesel power stations in the region, but these are dispersed over a wide area. It should be noted that Botswana and Zimbabwe have significant coal reserves, and both countries could expand their thermal production capacities.

As coal resources become increasingly scarce, utilities are looking for alternative sources of generation, and there are opportunities for production by more environmentally acceptable forms of generation such as hydro power and photovoltaics. However, it is important to note that there are no plans for any large reductions in thermal generation in the next few decades. The planning-time frame of producers such as ESKOM extends for up to twenty years, and existing technologies are being used in this process. The unwillingness to become too dependent on energy imports from neighbouring states, and the lack of suitable alternative advanced technologies encourage utilities such as ESKOM to plan according to traditional practices.

If international pressure dictates that carbon dioxide and other emissions need to be reduced, South Africa may be faced with a dilemma, as it is not in a position to change much of its existing generation system without incurring massive costs. These costs would have to be passed on to consumers, which would have a negative impact on economic development. Ultimately, the only way in which South Africa's limited contribution to global warming could be substantially reduced, would be through international funding of emission control technology.

It has been argued that developed nations which achieved high levels of affluence and power through the traditional exploitation of fossil based energy, should not, under the banner of a common **global** cause, deny **developing** countries the right to do the same. This is especially so, if the underlying premise for the resolution of the common problem implies a retention of the present inequality of lifestyle between the population of the region, and those whose privileged position has been built up and is largely responsible for the vast majority of global emissions now causing concern[48]. It would be naive to expect that due to the perils of **global** warming, the **region** should not go down the well trodden path for development but instead, should pursue energy policies and programmes that to date remain unproven as guarantees of economic and social development and are beyond its financial resources[48]. This is especially true given that the shift towards a more fossil based energy structure offers opportunities to resolve the regions **own** environmental problems arising from increasing deforestation, desertification and inability to cope with the problems of under development.

Developed countries thus have an ethical responsibility to assist developing countries and especially the LDC's, meet "acceptable" emission standards taking into account the twin goals of economic prosperity and environmental sustainability. For example, there is little use in implementing a clean air act for the EEC in 1992 unless they are economically enforceable, in appropriate form, in developing countries via financial and technical assistance from developed countries. Nothing will be gained from environmental policies and programmes that exclude members of the global village[49]. It is also important to ascertain whether it is more appropriate, in **global** terms, to spend money on further reducing emissions in OECD countries or on reforestation and improvement in low efficiency plant in regions such as ours.

Unless the resolution of the wider international environmental problems are perceived as facilitating rather than hindering the region's primary objectives of development, they will be perceived as irrelevant and inimical to the region's interests[48]. This could possibly be achieved by the adoption of a global CO_2 tax which addresses the differing aspirations, needs and environmental concerns of the various regions.

3.7.3 Other environmental hazards

Resource depletion is a serious problem in the region[50]. Rapid population growth and inequitable land distribution has led to large numbers of people living in marginally productive areas. These areas are incapable of providing sufficient resources to sustain such numbers. Vegetation cover is lost through deforestation and overgrazing. This is frequently followed by topsoil loss, which reduces the overall carrying capacity of the land. Vegetation and topsoil loss also cause increased water run-off and result in the depletion of ground water resources.

The process of resource depletion is difficult to stop because of its complexity. The underlying causes of this process are usually socio-economic and political. Only solutions that address these underlying causes are likely to be successful. The ability to implement such solutions is also restrained by certain institutional factors. These need to be considered, along with the role that energy production plays in the process.

The greatest source of energy is fuelwood. It is estimated to account for approximately 80% of domestic energy consumption in developing countries. In Africa, deforestation rates are significant. This is a problem that requires urgent attention, since its effect is a significant global warming factor as well as air pollution. The increase in the felling of trees is indicative of rapid population increase, and the excessive pressure being placed on marginal lands. The solutions to these problems must be established by addressing the structural causes of population growth, and their relation to energy provision and development.

The region has sufficient hydro potential to supply most of its energy requirements well into the future, and the development of this potential would seem to provide the obvious solution to global warming concerns. It should be noted that the construction of big hydro schemes also have certain environmental impacts, especially in rural areas where cultivated or arable land or forests are submerged[7], and a large number of people are displaced. This has caused large problems in the past an example being the Kariba lake scheme. Thus, it is important to consider impacts of construction, flooding of land, as well as the effect of new long distance heavy duty transmission lines that would have to be built[18].

Other environmental concerns in the region include the risk of oil spills, which have occurred in the past along African coastlines. Adequate attention should be paid to transportation routes in order to avoid hazards of this nature. In addition to the problem of air pollution, the large coal fired thermal power stations in the Eastern Transvaal region of South Africa are also associated with issues of ash disposal and land surface disruption related to open cast mining.

Another concern that is currently restricted to South Africa is the question of nuclear energy. ESKOM is currently operating a nuclear plant at Koeberg in the Western Cape. The construction of this plant took place using established technologies, and the low and intermediate level waste disposal site being used is reputedly one of the safest in the world. There is no high-level waste repository and all spent fuel is presently stored in the fuel pool on site. ESKOM is currently securing possible future sites along the South African coastline although no new plants are expected to be built within the time scale of the commission.

With regard to the region as a whole, nuclear energy will not have an impact before 2020, as it is not considered a viable option[40] due to the high capital cost, the relatively cheap alternative energy resources, the high tech nature of a nuclear plant which requires technical expertise, the large investment required in safety, the non-existence of an adequate nuclear industry and the lack of incentives to eliminate environmental hazards caused by emissions from the generation of electricity. With reference to South Africa, if the potential for regional trade is realized this country could rather import hydro generated electricity, at a smaller cost, and a reduced environmental hazard factor. Nuclear plant would only be considered for grid stabilization purposes in the long term.

In considering other environmental hazards, secondary effects should be taken into account. As an example, photovoltaics would appear to be a logical option for the region where solar energy is abundant and water scarce. The apparent attraction of this source on environmental grounds, however, is partially offset by secondary effects associated with the manufacture of solar panels. For example, the production of steel required for panel casings has significant associated environmental impacts.

3.7.4 Public and political significance

The prevailing institutional structures in the region have created a culture where public perceptions are relatively unimportant in the derivation of policy. In the case of most environmental issues this is certainly true. It is likely that international public pressure may effect on policy in the region, though this would take some time.

In South Africa, public awareness of environmental issues is low, although it has increased in recent years. It is much higher in affluent sectors of society. These sectors are frequently quite vocal over certain issues, giving an impression of greater public concern than actually exists. Elsewhere in the region, environmental concerns are closely linked to resource depletion concerns, and are thus ultimately also economic concerns. Members of the public are unlikely to perceive environmental issues separately.

Surveys carried out in South Africa indicate that there is some concern over air pollution and the generation of nuclear power[51]. However, the level of ignorance is very high, and the majority of the population appear to be uninformed and unconcerned. The existing concern over air pollution and nuclear power may increase over time, however, and it is worth considering the longer term effects of these concerns coupled with international pressures.

It would appear that hydro generation and solar power are publicly acceptable, although local communities displaced by hydro schemes could be seriously affected which could generate a public outcry. However, the public appear to be far more concerned with the affordability of energy sources than with their environmental acceptability.

Ultimately it is governments who make the decisions on environmental controls and standards. Although they have to take their constituencies into account, they are most likely to use economic criteria, based on developmental priorities, in the decision-making process. At present, environmental interest groups in the region have insufficient lobbying power to materially affect policy decisions. It should be noted, however, that international groups such as Greenpeace, do have the potential to have an impact in certain cases.

Although the harnessing of hydro power from sources in central Africa has the potential to provide cheap and relatively environmentally benign electricity to the entire region, political issues have prevented this option from becoming a reality. South Africa, for example, is reluctant to become too dependent on electricity imports to supply its needs. This is because of the high risk associated with political instability in the region. The Cahora Bassa line supplying South Africa from Mozambique provides an example of such concerns. The line has been out of commission for a number of years due to sabotage, and will take considerable time and money to repair.

3.7.5 Summary

Environmental issues in the region are more concerned with resource extraction and depletion than with those traditionally associated with developed nations. The environmental and socio-economic consequences of deforestation, land degradation and the lack of water, deserve greater financial attention than the reduction of emissions taking into account the twin goals of economic prosperity and environmental sustainability.

The region does not have the ability to address the issues of emissions and pollution through the use of "modern clean air technology" due to resource constraints which are mainly financial in nature. Any substantial programme aimed at reducing emissions and solution in the region would be reliant on international assistance.

It is clear that sustainable development and environmental concerns would benefit greatly from regional political stability. This would happen as a result of improved economic prosperity in the region, and the positive spin-offs of regional cooperation, rather than any measures brought about by collective public action. It is therefore clear that the key to solving many of the region's environmental issues must be regional institutional change.

Although local governments and energy sector policy makers are reluctant to introduce modern clean technology due to; cost, questions surrounding appropriateness to the region, and the preoccupation with economic growth, they may have little choice as a result of international developments and the globalization of the world economy. For example, although it has been argued that the introduction of lead free petrol would not be appropriate for the region, car manufacturers will soon only produce engines running on lead free petrol thus making the argument irrelevant. There is also the possibility that developed countries will, in the future, only import products produced and manufactured in an environmentally friendly manner, through the implementation of environmental audits.

The fact that environmental concerns of developed countries are not significant in the region at present is no reason not to take cognizance of their mistakes[43]. Any expansion and development should be undertaken in the light of lessons learnt by the developed countries in order to minimize measures that will be necessary once these environmental issues become significant[47].

Scope exists to address **local** environmental concerns of resource depletion, in the medium to long term, through the efficient exploitation of the large commercial energy resources with which the region is endowed. This will only be possible through regional cooperation and trade in energy. There is thus an urgent need for the return of stability to the region and the fostering of trust between countries.

Finally it is important that both women, men and children be involved, sensitized and mobilized about local and environmental threats.

3.8 Financial Resources

This section discusses the issues surrounding the financing of energy sector projects and activities. It is based on an unpublished report for the South African Committee of the World Energy Council[31].

3.8.1 Introduction

Financial resources place a major constraint on the development of the energy sector in the region. Large capital investments are required to implement new generation projects, yet such amounts are not readily available within the region. It is necessary to raise funding from foreign sources, yet past experiences with African countries and the debt crisis have made foreigners reluctant to invest in the region. A few institutions such as the World Bank are still willing to invest, but subject to certain terms and conditions (so-called structural adjustment loans).

Domestic sources of funds are often under utilized. Tariffs are seldom determined by market forces, and prices frequently subsidized. As a result, potential sources of funds are lost. International funding opportunities may be lost when finance ministries and reserve banks impose unnecessary constraints on the ability of energy institutions to raise foreign capital. Further constraints may be imposed by the unfavourable balance of payments accounts.

The coordination of financial resources can also be problematic in the region. Apart from internal coordination between government departments, there may be problems between governments and aid agencies, especially where disagreement may arise as to the exact application of funds.

It is difficult to determine the amount of capital investment required in the region over the next 30 years. This is due to of a number of factors. First, the projected rate of economic growth and, therefore, energy demand in the region is likely to vary considerably depending on the extent of economic reform that takes place. Secondly, the amount of investment will vary according to the mix of energy sources used. Thirdly, the extent of trans-boundary exchange and cooperation will affect the amounts invested by specific countries. Finally, it is uncertain to what extent governments will take account of environmental factors and enforce the use of controls which may push up costs.

Despite these uncertainties, some crude estimates of future capital requirements have been made. The World Bank believes that some US$ 11 billion in foreign resources will be required during the 1990's simply to finance additional capacity(4,300 MW) in the electric power sector in the region[41](excluding South Africa). Details of required investment in the oil and fuelwood sectors are hard to come by. What is certain, is that the amounts required are considerable, and there is much concern as to whether these requirements could be met. In addition, there is cause for concern regarding the recovery of recurrent costs, such as interest payments and maintenance expenses. The fact that many governments set tariffs below market prices, sometimes even below cost, creates much cause for concern[53].

3.8.2 Financial resources

Although the projected future investment requirements for the region are relatively small in proportion to the global total, these amounts are nevertheless significant in an African context, and available resources are limited. The lack of any well developed capital markets, and the past performance of African countries with respect to debt repayments have led to a situation where many donors and lenders are reluctant to provide funding.

The contributions of official multilateral and bilateral financing sources have increased markedly vis-a-vis the contributions of private creditors. The World Bank has become the single largest provider of foreign debt, and concessionary finance is playing an ever increasing role. Private creditors are reluctant to invest in new projects because of the past experiences with payment defaults, and because of the low commercial viability of existing institutions.

International funding in the form of bilateral programmes with certain developing countries is a source of finance available to several countries, but is also often subject to certain conditions, and dependent on the objectives of the lending country. Projects in the region have become decidedly unattractive to international lenders in the commercial sector, and marked visible improvements will be necessary to reopen this potential channel of external financing.

Internal sources of funds are seriously limited, with the only notable capital market being in South Africa. As a result, most utilities are not able to raise funds from domestic sources, having to rely primarily on internal sources (ie. funds generated from operations of from the government treasury). The intensive competition between various state sectors for treasury funds makes the viable pricing for operational revenue a good policy option.

3.8.3 Coordination of financing

The coordination of financing is an issue of prime importance to the ESA, because of the difficulty associated with the raising of capital and coverage of recurrent costs. It is essential to examine the nature of the institutions involved in financing, their political agendas, approval procedures, and the inherent delays associated with them. Institutions such as governments and development banks are the key players in the financing of most African energy projects. The World Bank plays a particularly prominent role as the largest single source of external capital for energy development.

In some instances the Bank and governments fail to agree over the exact implementation of such projects. Nevertheless cooperation between the two is ultimately essential, if the projects are to succeed. Furthermore, many projects overlap with other development programmes, and coordination with these is often poor. The same applies to the coordination with other projects in the energy sector, where various donors could benefit greatly by creating joint efforts in related projects, thereby improving the efficiency of the whole development effort.

Other areas of institutional change which would greatly improve the efficiency of the financing process include the decoupling of utilities from government, thus allowing for projects to apply independently for funds. Current procedures usually depend on approval from finance ministries, and frequently the whole cabinet. The general consolidation of energy activities (by, for example coordinating activities in the commercial and traditional sectors, the latter which usually are dealt with by agricultural or other departments) and the distancing of these activities from central government are seen to be vital keys to improving the prospects of raising finance[54] These moves would allow the autonomy and pursuit of financial viability which are necessary to attract external sources of funds.

3.9 CONCLUSION: Strategies for Solutions

There is a need to increase the awareness of governments of the critical importance of an adequate and reliable energy supply in order to enable economic development and to obtain social equity. Governments should be encouraged to improve their effectiveness in the formulation of sustainable energy policies, in the planning and development of efficient energy supply systems, in sectorial coordination and in regional cooperation. In order to achieve this, institutional reform is necessary. Reforms are needed nationally, regionally, and within the energy sector itself. Political and market orientated reforms are needed to create the right environment in which the energy industry can flourish. Reforms within the energy industry will help speed up the process. Without substantial reforms, progress in the energy sector is likely to be limited.

At a national level governments need to restructure the energy supply industry in such a way that present supply constraints are alleviated. Institutional reform needs to be initiated in order to allow integrated energy sector planning and policy formulation to be undertaken, encompassing both traditional and commercial energy supply systems. This would depend on a shift away from traditionally highly centralized commercial energy supply systems, towards a more decentralized structure encompassing the supply of and substitution for fuelwood.

At a regional level the improvement in energy security is reliant on the willingness of governments, utilities and the energy supply industry to support the trade of energy within the region.

Economic reform is necessary to alleviate the various economic related restraints hampering the adequate and efficient development of the energy sector. There is an urgent need to redress the adverse macro-economic policies and to correct the institutional deficiencies that have largely disabled the economies of the region. In addition to the increasing political will to adopt reform programmes, it will be necessary to improve and strengthen the institutional capacity of government departments, regulatory agencies, and sector enterprises to plan and formulate appropriate reform programmes. Considerable technical assistance may be required to support and to guide the evolution of efficient market systems and structures, to articulate and communicate their operative rules and incentives, so as to attract the much needed capital and technology in the energy sector and others.

A massive injection of new capital and technology from both private local and international sources is required. This should include private capital in the form of equity investments and other mechanisms and instruments. Given the current level of public and foreign debt, it is impossible for public finance alone to meet the huge investment required for the additional infrastructure necessary for commercial energy production and supply. Furthermore there is a need for governments to appreciate that private ownership of commercial energy production and supply facilities, does not necessarily imply the surrender of the public interest and political stake of governments in the energy supply industry, given an appropriate regulatory framework.

The ESA has large energy resources much of which have not been exploited. A change from confrontation to operational politics could enable regional interchange of energy, and the utilization of local resources for the benefit of the whole region. This would enable more efficient use to be made of the region's resources, and reduce the dependence on imported commercial energy and improve the security of energy supply to the region as a whole. This can only become a reality once political stability is achieved in the region. The promotion of the exploitation of energy resources in the ESA is reliant on regional cooperation and energy interchange. The energy community transcends political and ideological barriers, and through their regional initiatives they can play a leading role in paving the way for regional cooperation between governments.

There are significant economical opportunities for regional cooperation in the energy sector in the region. However, this will require political will of governments, regional political stability and mutual trust, as well as appropriate institutional structures for regional cooperation in the development of joint facilities. Joint development, ownership and operation of hydro power generation plants and grid interconnections, of oil refineries and pipelines, of gas resources and pipelines, and of coal resources and railways could reduce the overall cost of commercial energy supply, and improve the reliability and security of supply for most countries of the region. It will also ensure that the most appropriate resources are developed and spare capacity in the region is used effectively. Special technical assistance in the formulation of projects, licensing, supply and tariff agreements, and in the establishment of appropriate regional enterprises to develop and manage the joint systems will be required. ESKOM could play a leading role, particularly with regard to the establishment of a Southern African grid. It has already been responsible for a number of regional initiatives.

As part of the regional strategy, funds and means should be directed towards regional projects in order to foster cooperation, which in turn leads to better use of available resources and overall economic development.

Environmental issues in the region are more concerned with resource extraction and depletion than with those traditionally associated with developed nations. The environmental and socio-economy impacts of deforestation, land degradation and the lack of water, deserve greater financial attention than the reduction of emissions, taking into account the twin goals of economic prosperity and environmental sustainability.

Scope exists to address **local** environmental concerns of resource depletion, in the medium to long term, through the efficient exploitation of the large commercial energy resources with which the region is endowed. This will only be possible through regional cooperation and trade in energy. There is thus an urgent need for the return of stability to the region, and the fostering of trust between countries.

The region does not have the ability to address the issues of emissions and pollution through the use of "modern clean air technology" due to resource constraints, which are mainly financial. Any substantial programme aimed at reducing emissions and pollution in the region would be reliant on international assistance.

It would be expedient to take cognizance of the current environmental concerns of developed countries, even though these are not significant in the ESA yet. Any expansion and development should be embarked upon in the light of these issues to minimize measures necessary once these issues become significant.

Reforestation programmes need to be implemented as a priority issue to obtain a sustainable supply of fuelwood, prevent further deforestation and associated social and environmental repercussions and ensure security of supply to the domestic sector which is the largest single user of energy in the region. Reforestation programmes should be based on agro-forestry and inter cropping practices. Addressing the issue of population growth is a fundamental requirement for any lasting solution. In order to encourage people to manage and grow trees the rural population must;

have the right to own or use forest land and own the crops on the land, in particular, trees,

they must be provided with basic aid, such as the provision of seedlings, and training, if necessary, to manage the crops, and

they must be involved in any decision making process.

In the medium to long term the urban fuelwood crises will need to be overcome by the more efficient supply of commercial energy, in which electrification will play an important role. In the short to medium term the supply of charcoal to urban areas, from remote areas where fuelwood surpluses exist, should be encouraged. However, to reduce the depletion of these supplies the efficiency of present charcoal production practices needs to be addresses.

Although electrification, based on the vast hydro, coal and gas resources, is considered to be the most suitable end use form of energy as a substitute for traditional and transitional energy forms in rural areas, long lead times, economic restraints, and logistical problems exist. This implies that fuelwood will remain an important source of energy in the rural and peri-urban areas in the short to medium term. Thus it is imperative that reforestation programmes are carried in parallel to the development of commercial energy. This calls for integrated energy sector planning and is reliant on the restructuring of the relevant institutions. It is important that both women, men and children be involved, sensitized and mobilized about local and environmental threats.

In the energy sector, the lack of technical and management proficiency necessary for sound development, establishment, operation and maintenance of energy supply and use systems, is undermining the ability of the sector to provide a secure supply of energy. Thus a key issue in maintaining and improving security of supply within the ESA is the use of adequate and appropriate technology, taking into account the unique climatic conditions, skilled manpower availability, economic financial and foreign exchange constraints, as well as the needs and priorities of the region, which differ greatly from those of more developed countries. This will help facilitate operation and maintenance by indigenous personnel as well as extending plant life under local conditions and save capital expenditure by reducing unnecessary and inappropriate specifications. The standardization of technology used in future projects in the region would increase the region's self reliance with respect to maintenance and operational requirements.

Another key issue in this regard is the need to establish the necessary local technical skills base through appropriate education, and the interactive transfer of technology from industrialized nations and between countries within the region.

In this **region** the domestic sector consumes a major proportion of total energy, mostly in the form of traditional energy, and the improvement of end use efficiency in this sector will thus have a significant effect on energy usage in the region especially with respect to the usage of fuelwood[43]. Much scope exists for the development of technologies to improve the efficiency of wood usage, and these should be favoured[47]. Several improved fuelwood and charcoal stove programmes in the region have demonstrated efficiency improvements of 25% to 50% The use of solar water heaters to supplement conventional heaters has much scope in the ESA.

Within the time scale of this thesis the only country which might consider the nuclear option is South Africa, and then it will mainly be for grid stabilization purposes.

Finally, the structure and terms of trade between the ESA region and the OECD countries are particularly discriminatory, through excessive protectionism, transfer pricing and other "illegitimate practices". These must be reviewed and rectified. Furthermore the overall level of aid to the region should be substantially increased for any prospect of economic recovery and growth. In particular, given the emergent will for political reform and economic restructuring, the time should be ripe to review and pardon much of the foreign debt that has crippled the region.

4. ENERGY - SOUTH AFRICA

This chapter gives a profile of the energy sector of **South Africa (RSA).** The institutional infrastructure, demography and economy of RSA are discussed in order to give a background to the country and indicate how these influence the energy sector. Energy supply and demand, markets and resources, amongst others, are studied.

4.1 Introduction

4.1.1 Political Background

Interest was first shown in the southern part of Africa by the Dutch East India Company which established a refreshment station at the site of present day Cape Town in 1652. In 1910 the four provinces of South Africa were united to form the Union of South Africa under the British crown, with a constitution which gave the white minority an almost complete monopoly on political authority.

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. Dr. 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 the other section wished to enter the war in support of Britain. Jan Smuts had the greater support 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 was fought by the National Party on the issue of race relations under the concept of apartheid and to surprisingly they won a parliamentary majority. Malan formed a government, and the National Party has won every subsequent election. In 1962 South Africa was declared a Republic as a result of a 'white' referendum.

Under the rule of the National Party, the system of apartheid has undergone successive significant modifications. Apartheid was entrenched in Acts such as the Immorality Act, 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 not recognized by the world at large.

The Policies of the South African government had a detrimental effect on relations with other African countries especially in the light of the alleged destabilizing nature of some of her actions. This lead to the isolation of South Africa and the formation of the Patriotic front by members of the front line states in order to initiate change.

International pressure, such as comprehensive economic, cultural and sporting sanctions on South Africa, resulted in a move towards democracy in the country in the late 1980's. 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. Political parties of all races and ideology are presently negotiating for a democratic South Africa.

4.1.2 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 Caucasian population which dominates 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 "white" 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' which 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 4.1 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[59] which can partially be attributed to the redefinition of boundaries, the influx control laws and the forced removals of this period.

Table 4.1 Population growth rates[60]

	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[36]. 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[60].

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%[61]. These figures understate reality as informal urban settlements in the 'Homelands' are not considered urbanized. The rate of urbanization increased in subsequent years due to the abolition 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 urbanization.

The overall population density including the 'Homelands' was 30,3 per km^2 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.

Since the 1950's, the rate of urbanization in South Africa has been rapid . In 1990, 57% of the population was considered urbanized[16], which is average for the third world, but high by ESA standards. The speed at which urbanization has taken place, especially in the last decade, has not allowed the government time to plan and provide for the needs of the increasing urban population.

Urbanization in South Africa has been complicated by "apartheid" which enforced population segregation with respect to colour. For generations, the urbanization of black people was made difficult by forcing them to live in areas far from the main cities. With the lifting of restrictions on where people may live and work, many unemployed people from the homelands migrated to the major South African cities in search of work. The shortage of accommodation in cities has forced them to live in shanty towns or squatter camps. In 1989 the Pretoria-Witwatersrand-Vereeniging (PWV) area contained 412 000 formal houses in black townships, with 422 000 shacks in their backyards and 635 000 shacks on vacant land[(81)]. The housing shortage for blacks, outside the homelands is estimated at, at least 850 000, and more than 7 million people throughout the country live in shacks.

This has resulted in an increase in the number of urban people who need energy, land, water, health care and schooling. The informal and temporary nature, and high density of a large portion of the housing in the rapidly growing peri-urban settlements, makes the provision of an adequate commercial energy supply infrastructure a daunting task, especially with regard to electrification. The low densities in the rural areas result in financial and logistical difficulties with respect to electrification.

The high density of these peri-urban settlements together with the large, and often inefficient usage of coal and wood for heating and cooking results in high levels of pollution in these areas. Electrification would minimize the impact of airborne pollution in these areas as coal is burnt more efficiently and emissions are reduced via the use of precipitators and spread over a wider area, in electrical power stations[i].

4.2 Economy[ii]

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 practiced, and the public sector is large. The

---

i South Africa relies primarily on coal for the generation of electricity.

ii Economic data for South Africa is contained in Appendix D.

government committed itself in principal to privatization and deregulation, with the passing of the Deregulation Act of 1986. This has not as yet produced much in the way of concrete results, other than the privatization 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.

Table 4.2 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

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 4.2 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 4.1 shows the GDP (factor) in current and real 1985 prices during the period 1910-1989.

FIGURE 4.1:

GROSS DOMESTIC PRODUCT
(FACTOR)

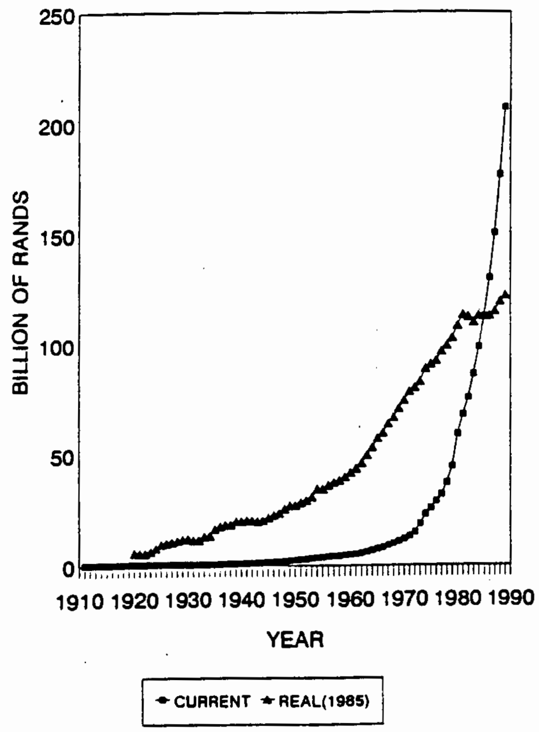


FIGURE 4.2:

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

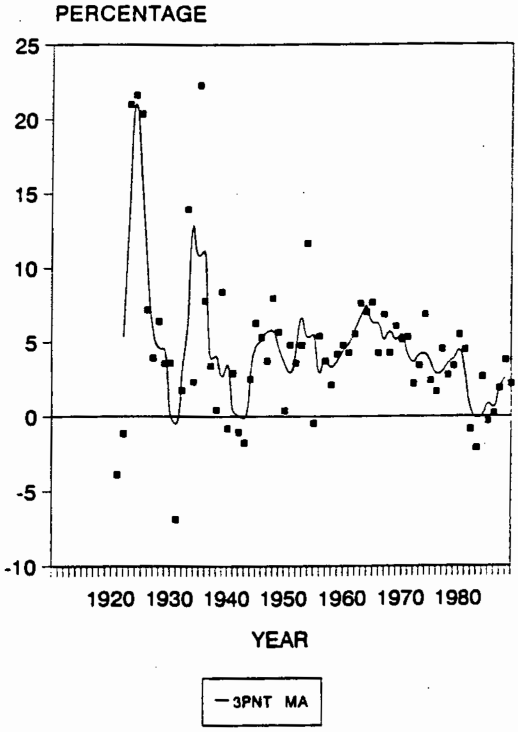


FIGURE 4.3:

GDP PER CAPITA

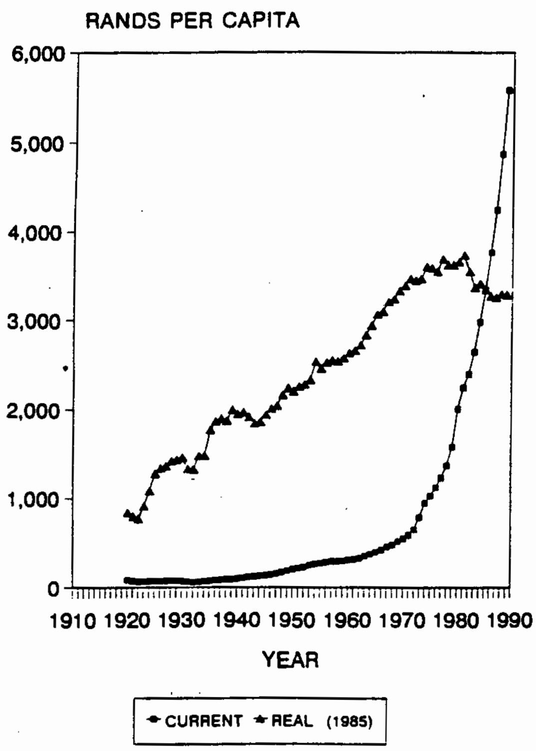
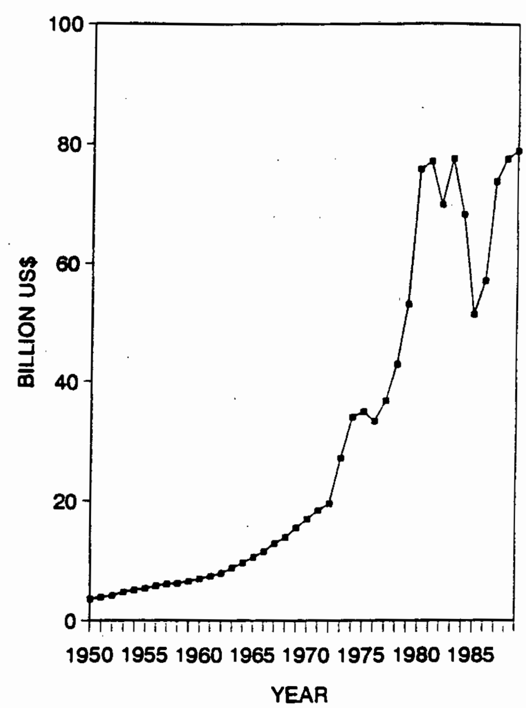


FIGURE 4.4:

GDP IN US$*



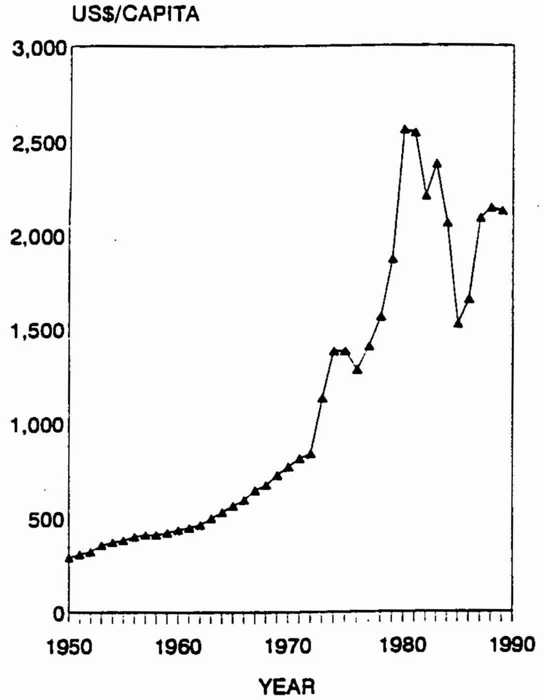
* CURRENT RANDS CONVERTED TO US$ AT CURRENT EXCHANGE RATES

In current terms GDP has been increasing exponentially. Real GDP displays the effects of the First and Second World wars, the depression of the 1930'sand the oil crisis of the early 1970's, on the economy. It is characterized 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 4.2, 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 stabilized at 1968 levels, as shown in Figure 4.3 of current and real GDP per capita.

Figures 4.4 and 4.5 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 4.5:

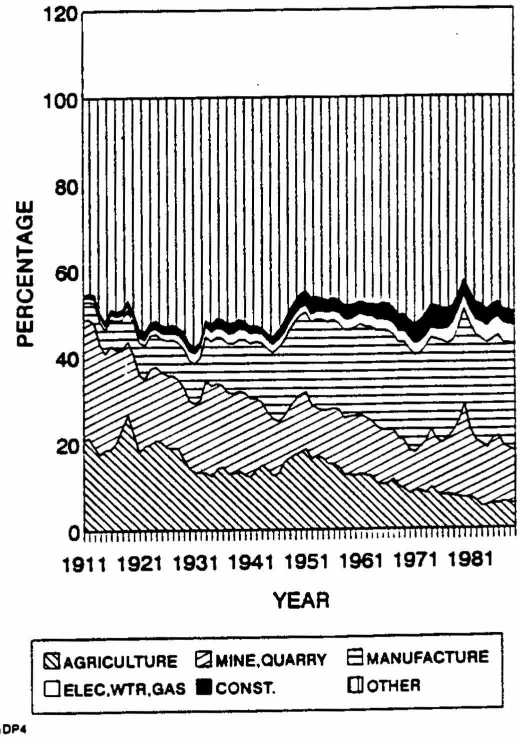
GDP PER CAPITA - US$*



CURRENT RANDS CONVERTED TO US$ AT CURRENT EXCHANGE RATES
SA2/GDP12

FIGURE 4.6:

GDP COMPONENTS
AS PERCENT OF TOTAL



SA2/GDP4

Figure 4.6 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 of that year. This demonstrates the dependence of the mining sector as well as 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[59]. 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, because of 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 non-whites into the formal 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 4.6.

4.2.1 Discussion

Recent developments in South Africa has raised hopes of major political reform. The South African government has begun dismantling 'apartheid'. At the same time, the various political parties have embarked on a programme of negotiating a constitutional settlement, leading to democracy and majority rule. These changes will hopefully encourage prospects for the resumption of growth and development. Thus it is imperative that the supply of sufficient energy to meet the increased demands associated with economic growth is ensured.

Due to the large size and sophistication of South Africa's economy, it is expected that she will play a large role in the development of the region in future, and act as an economic growth point once democratization has been accomplished. The same can be said of the energy sector. Although South Africa is an economic giant in regional terms, it has a very poor economy in per capita terms when compared to Western Industrialized countries (see Table 3.1). To ensure that South Africa is able to play a positive role in the region, increased investment and aid from abroad is be needed.

When considering South Africa's future role in the region it is important to note the fears of a future South Africa dominating the region and the associated problem of industrial polarization. Thus, measures need to be taken to allay such fears.

4.3. Energy; General

4.3.1 Introduction

With respect to energy, South Africa is a regional power which has a well developed energy infrastructure compared to 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).

In spite of the fact that South Africa has large reserves of coal and uranium, hydro-potential is limited. 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 because of South Africa's greater level of development in comparison to the region, as well as low energy costs, the Government's 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.

4.3.2 Energy Institutions

The South African energy scene is characterized by a mixture of centrally controlled and private sectors. Although 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 setting the price of petroleum products, especially gasoline and diesel fuel. For instance, there was also control on 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 sale of petroleum products as carried out by oil companies which represent most of the international majors. Refining is 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 coast 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.

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 will be funded directly by the 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.

4.4. Energy Resources

4.4.1 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 effect and it is estimated that by the year 2000 natural woodland will almost entirely be denuded[(62)].

4.4.2 Petroleum and Gas

Although South Africa imports all its crude oil requirements, indigenous coal and gas are also used as feedstock 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 m^3 [(36)]. These reserves form the feedstock for the MOSSGAS project, in which the gas 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[(63)]. However, controversy surrounds its economic viability and cost to the taxpayer.

4.4.3 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 for miners, short transport distances to the ocean and dependability and reliability of supply, give South African coal a competitive edge in the export market[64].

Proven reserves in place amount to 121 000 million tons, of which 55 333 million tons are currently estimated to be economically recoverable reserves. These are the fourth largest reserves in the world and amounts to 10% of the estimated world inventory[65,36]. More than 50% of these reserves are situated in the eastern Transvaal Highveld and are largely exploited for use by pithead power stations, by SASOL synfuel plants, and 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 higher quality washed coal.

Considerable quantities of discards are generated by the mining and beneficiation processes and are presently not exploited. Research is being carried out 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.

4.4.4 Hydro-electricity

South Africa has a hydro-electric potential of 3 500 MW, of which 540 MW have been exploited[66]. This potential is limited because the river flow rates are relatively small (as shown in Table 4.3), 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. This potential would therefore 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[67].

Table 4.3 Average flows of main rivers in the subcontinent

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

(Source: ESKOM)

4.4.5 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(65).

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(59). 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 largely on gold production[i]. It has been forecast that gold production will drop sharply in about 2005 and will terminate in 2035(65). This could have a large impact on any future nuclear programme based on local resources.

4.4.6 Biomass

Dung is used to supplement and in some cases as a 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(62).

---

i In many cases uranium is obtained as a by-product of gold mining as it is associated with gold ore.

Potential exists for the use of organic refuse as a source of energy, either by direct combustion or by conversion to biogas via micro-biological 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[68]. The National Energy Council (NEC) and the Council for Scientific and Industrial Research (CSIR) are evaluating this resource under local conditions.

4.4.7 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 4.4 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.

Table 4.4 Average yearly insolation[70]

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

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)[69]. 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[69].

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 generally not a windy country. Most of the coastal areas show some wind potential, particularly along the southern and south-western Cape coasts. Table 4.5 shows the mean annual wind speed (normalized to 10 metres above sea level) for a number of sites.

Table 4.5 **Mean annual wind speed** (Normalized to 10m)[71,72]

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

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[71].

Wind energy in South Africa has been used extensively for the pumping of water in rural areas[73]. Although large scale wind-farms are not viable in South Africa, due mainly to the availability of cheap grid electricity[73], 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.

4.4.8 Geothermal

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

4.5. Energy Supply and Demand[i]

4.5.1 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 4.5 Economy). The ratio of traditional fuel to total final 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 4.7) 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 4.6. Figure 4.8, 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.

---

i Energy data for South Africa is contained in Appendix F.

Table 4.6: Total final consumption of commercial energy for selected countries [8,12] (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 (1989)	147950	2585
USA (1989)	1392710	5598

FIGURE 4.7:

TOTAL FINAL CONSUMPTION OF COMMERCIAL ENERGY

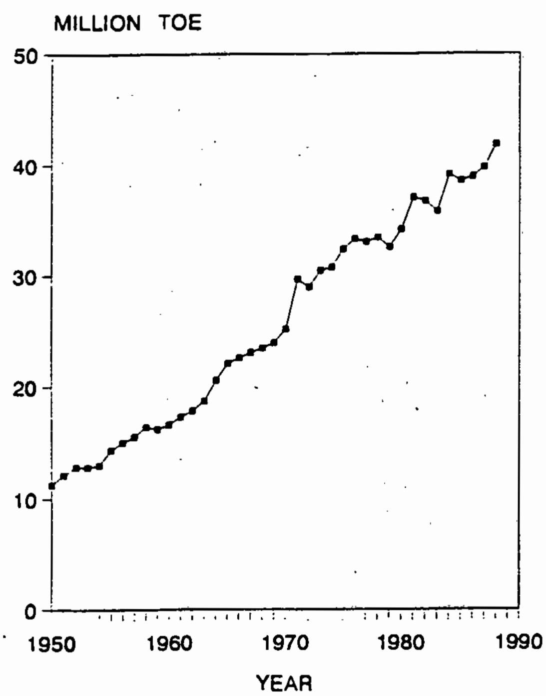
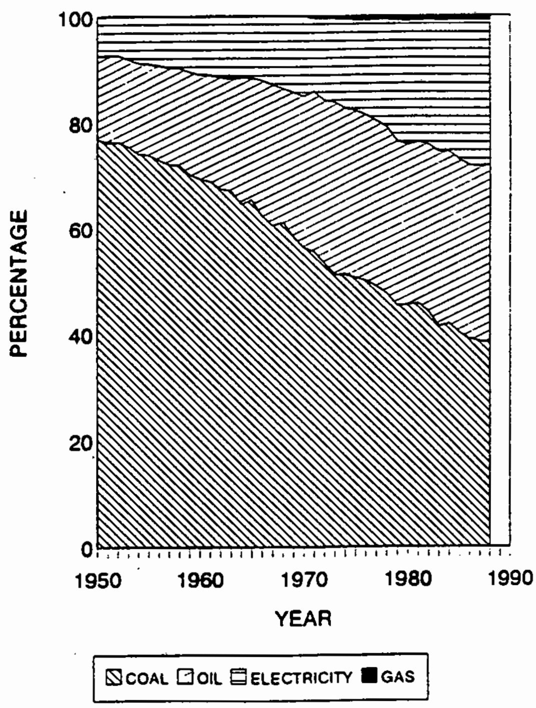


FIGURE 4.8:

TFC OF COMMERCIAL ENERGY COMPONENTS AS A PERCENTAGE OF TOTAL



TFC - TOTAL FINAL CONSUMPTION

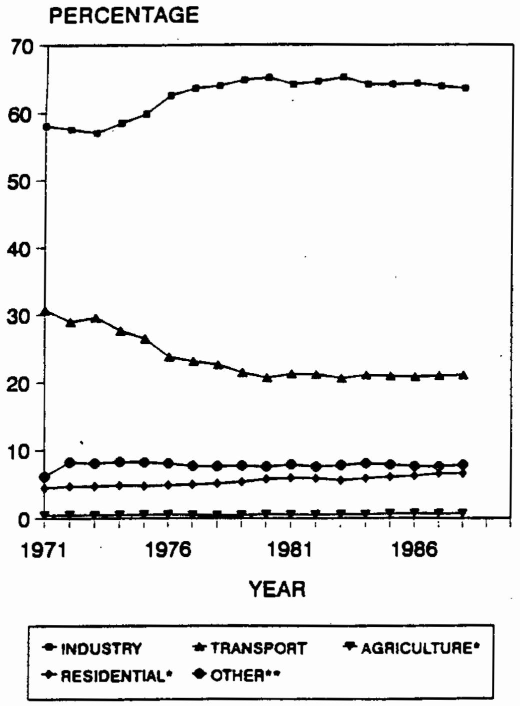
In 1988 coal was still the largest single commercial energy carrier, accounting for 38,3% of TFC, although, in 1950 the corresponding figure was 76,9%. In 1988 electricity accounted for 33,7% of TFC, oil 27,2% and gas 0,71%. The importance of coal in the energy economy is much greater than these figures suggest, as electricity is mainly coal based and a proportion (estimated at 25%[(10)]) of local liquid fuel needs are derived from coal.

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%[(10)]. While secondary energy usage patterns are changing, coal remains the most important primary energy form.

Figure 4.9 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 agricultural 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.

FIGURE 4.9:

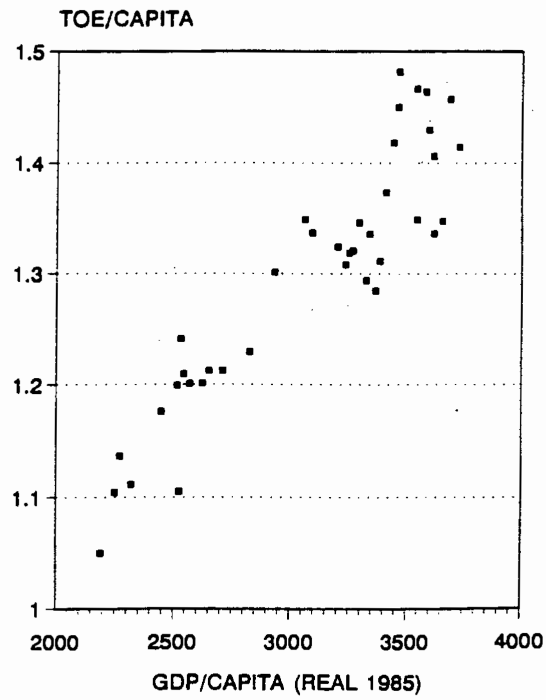
TOTAL FINAL CONSUMPTION OF COMMERCIAL ENERGY :
SECTORIAL BREAKDOWN (AS A PERCENTAGE OF TOTAL)



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

FIGURE 4.10:

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



Energy usage correlates with economic activity, as shown in Figure 4.10 of TFC of energy per capita versus GDP per capita. The generally accepted relationship between energy and economic activity is adhered to. The relationship between TFC of commercial energy and real GDP growth rates is shown in Figure 4.11 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 4.12, 4.13 and 4.14. 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 the 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 4.15 shows the intensity of total final consumption of commercial energy for 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[74]. It should be noted that overall, the trend has been downward.

FIGURE 4.11:

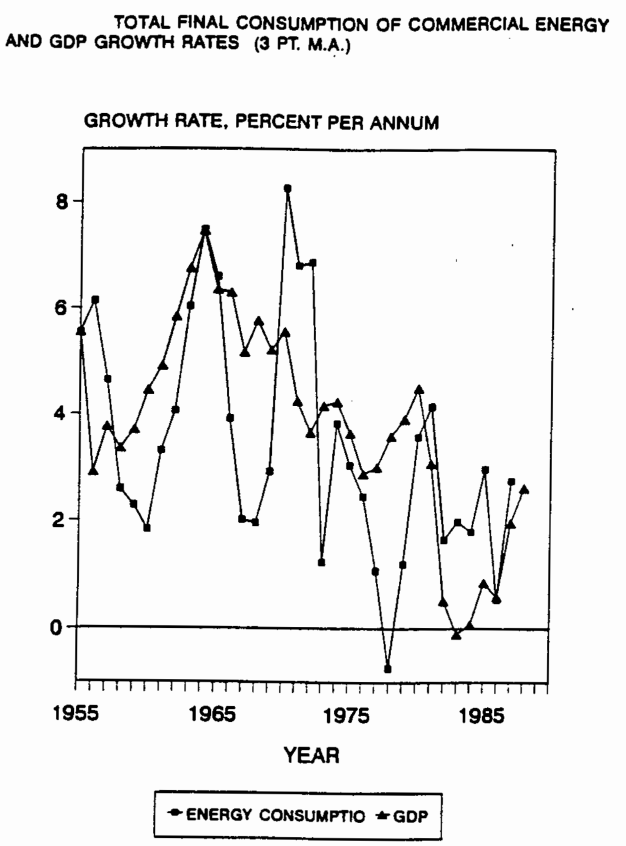


FIGURE 4.12:

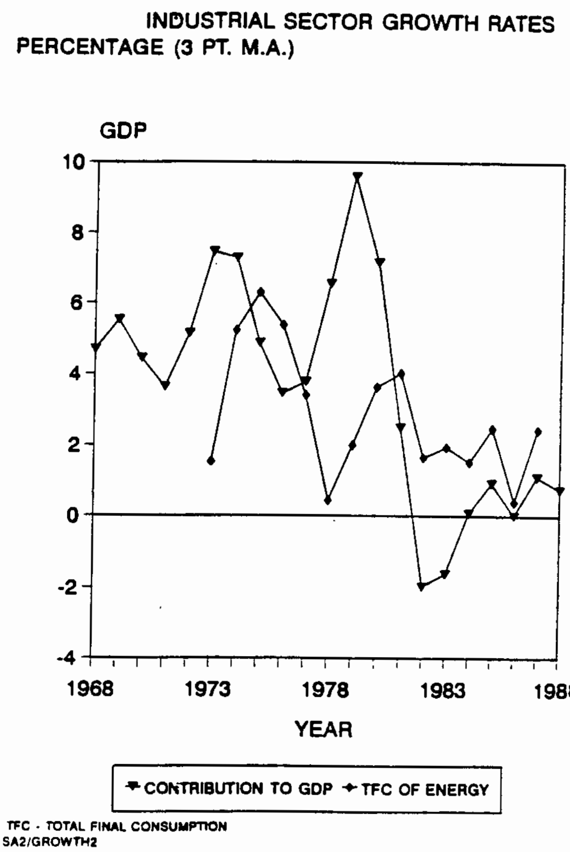
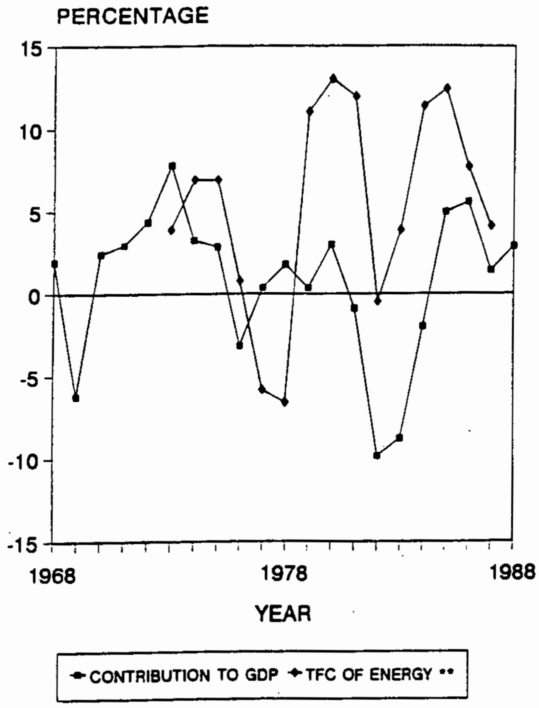


FIGURE 4.13:

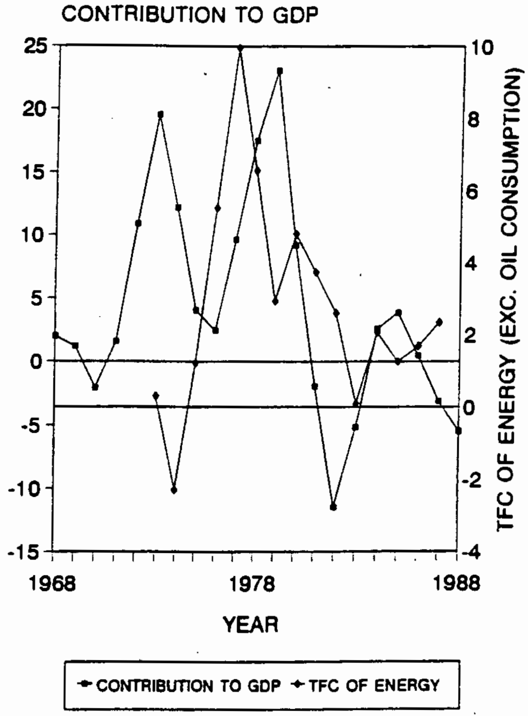
AGRICULTURAL SECTOR GROWTH RATES
3 PT. M.A



TFC - TOTAL FINAL CONSUMPTION
** TFC OF ENERGY EXCLUDES CONSUMPTION OF OIL

FIGURE 4.14:

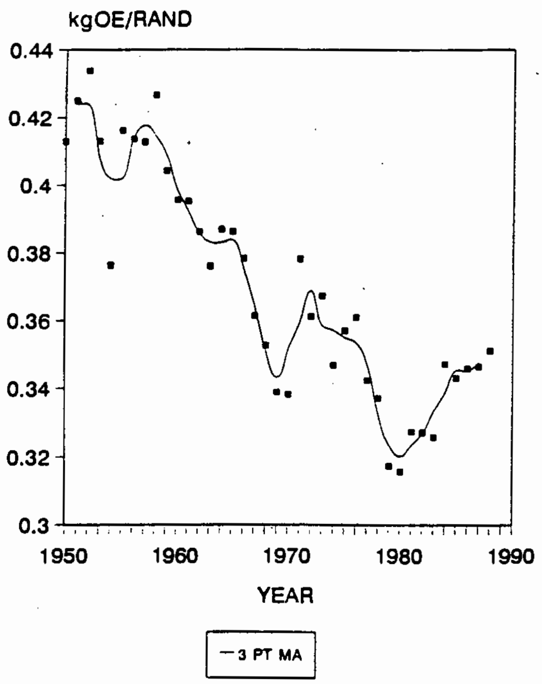
MINING SECTOR GROWTH RATES
3 PT. M.A (TFC EXCLUDES OIL CONSUMPTION)



TFC - TOTAL FINAL CONSUMPTION
SA2/GDP

FIGURE 4.15:

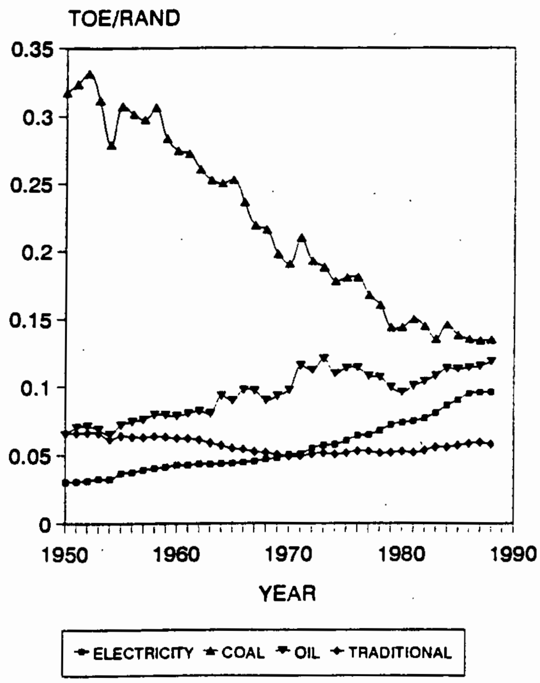
COMMERCIAL ENERGY INTENSITY
TOTAL FINAL CONSUMPTION OF ENERGY PER UNIT REAL GDP (1985)



kgOE - KILOGRAMS OIL EQUIVALENT
SA2/TFCINT

FIGURE 4.16:

TOTAL FINAL CONSUMPTION OF ENERGY INTENSITY
kgOE PER UNIT REAL GDP (1985)



kgOE - KILOGRAMS OIL EQUIVALENT
SA2/TFCINT1

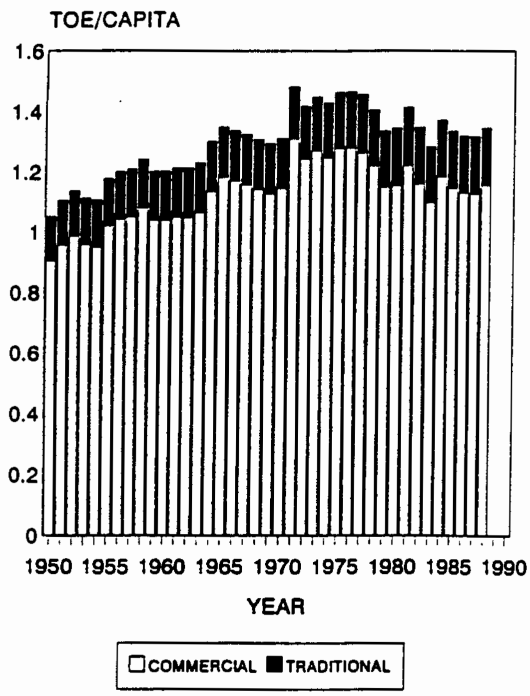
It is anticipated that the reform process taking place in the country will increase the number of blacks, previously excluded, entering the formal economy. This, together with the priority that a future government will place on the development of the black population, will most likely see energy intensity following the trends of a developing country. Thus, it is expected that the commercial energy intensity will continue to increase for some time.

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(74).

FIGURE 4.17:

TFC OF ENERGY PER CAPITA
TOE PER CAPITA



TFC - TOTAL FINAL CONSUMPTION
TOE - TONS OIL EQUIVALENT

Figure 4.16 above, 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 4.6). Figure 4.17 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 crisis, 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.

4.5.2 Fuelwood

In 1988 fuelwood consumption amounted to 6876 TTOE[10] 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[62]. 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[75] 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[62].

Fuelwood demand is exceeding supply[62] 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 further and are spending more time collecting fuelwood. Eberhard[62] 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 increased urbanization, particularly 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 to cause a major shift in energy consumption patterns in the rural and especially the peri-urban and township areas, with an increase in the substitution of electricity, coal and gas for fuelwood over the next few decades.

4.5.3 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)[10] and the Energy Research Institute of the University of Cape Town.

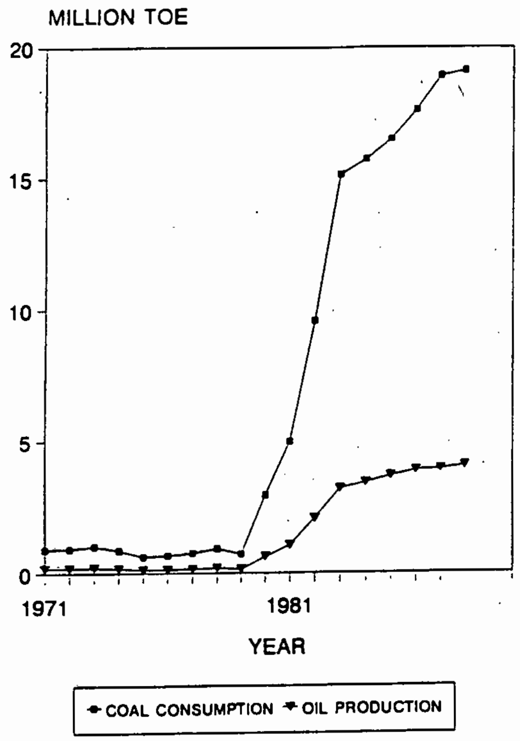
South Africa does not produce any crude oil and was entirely dependent on imported crude until the mid-1950's. In the face of sanction threats and in an attempt to reduce South Africa's dependence on imported crude oil three plants were built to convert coal into oil. The first and by far the smallest 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[59] 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[59], approximately equivalent to one year's supply. In 1991 following the political reform initiated by President de Klerk and the resultant easing of international pressure on South Africa, the sale of these stockpiles has commenced and the proceeds are financing social programmes.

Figure 4.18 shows the IEA estimates of coal consumption and oil production by the SASOL plants in terms of tons of oil equivalent (TOE) for the period 1971-1988. The rapid increase in output from 1979 to 1987 was due to the start up of SASOL 2 & 3. The overall energy transformation efficiency in terms of TOE of oil produced per TOE of coal consumed averaged 21% for 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 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 gas into liquid fuel and is due to start up in 1991/92.

South Africa has four conventional refineries. The Caltex refinery 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 4.18:

SASOL: COAL CONSUMPTION, OIL PRODUCTION, TRANSFORMATION EFFICIENCY.



SA2/SASOL

FIGURE 4.19:

19 OIL TOTAL FINAL CONSUMPTION

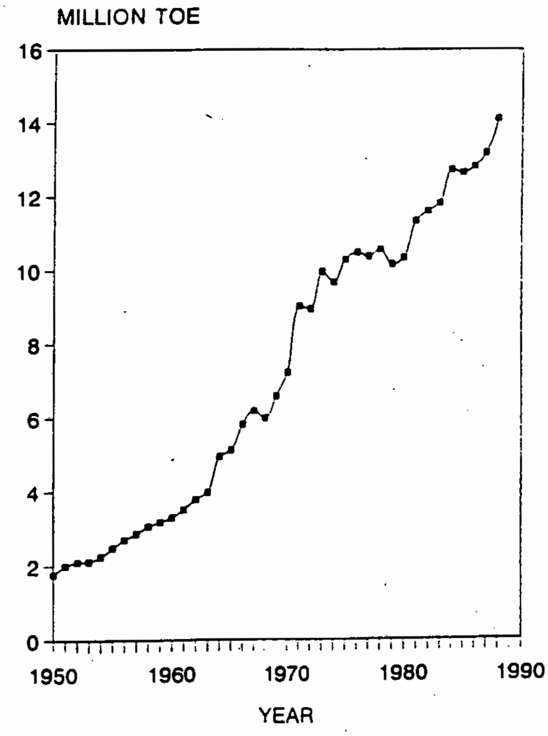


FIGURE 4.20:

OIL PRODUCT CONSUMPTION BY TYPE

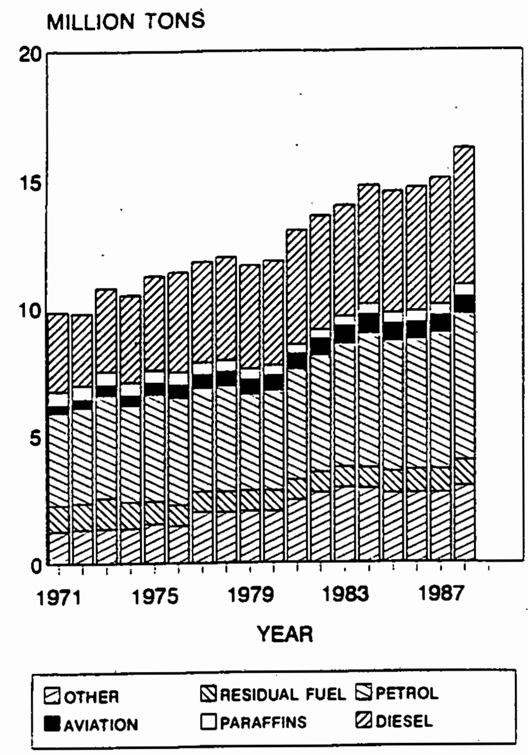
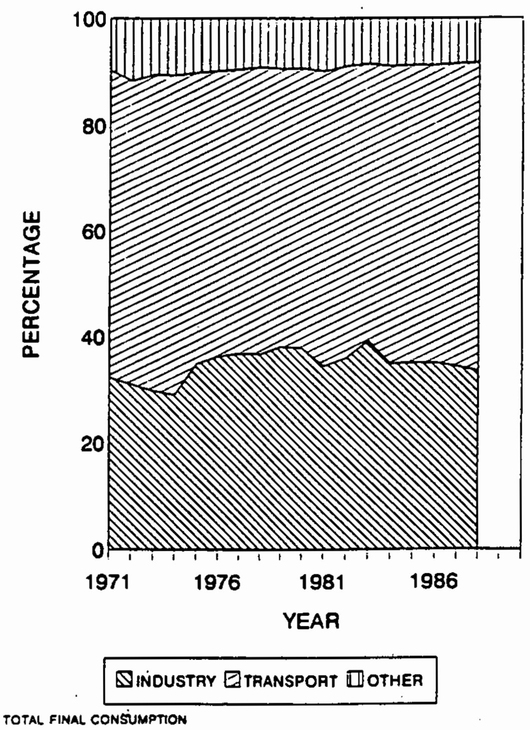


FIGURE 4.21:

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



TFC - TOTAL FINAL CONSUMPTION
SA2/SECTOR1

Figure 4.19 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 crisis, oil embargo and economic downturn can be seen. Figure 4.20 shows the oil product consumption by type for the period 1971-1988. Gasoline and diesel together are the dominant oil product forms. This is reflected in Figure 4.21 which gives the sectorial breakdown of TFC of oil, where transport accounts for almost 60% of consumption.

Figure 4.22 shows the ratio of diesel to petrol according to IEA data[10]. 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[68]. 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 persistence 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.

4.5.4 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 exports large quantities of coal in spite of the imposition of sanctions against the country.

Figure 4.23 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 fluctuated around 16 million TOE per year. This can be attributed to the increasing substitution of 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 4.24 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 for 1988 (1971 figures in brackets) accounted for only 21% (46,5%) of primary consumption in 1988, while liquefication 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 obsolescence of the steam locomotive, the consumption of coal by the transport sector has diminished from 21,8% of TFC of coal in 1971 to 1,7% in 1988.

FIGURE 4.22:

RATIO OF DIESEL TO PETROL

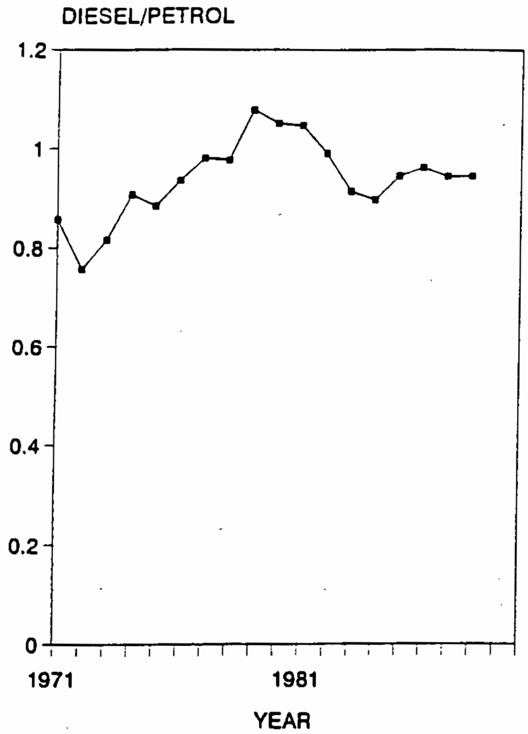


FIGURE 4.23:

TOTAL FINAL CONSUMPTION OF COAL

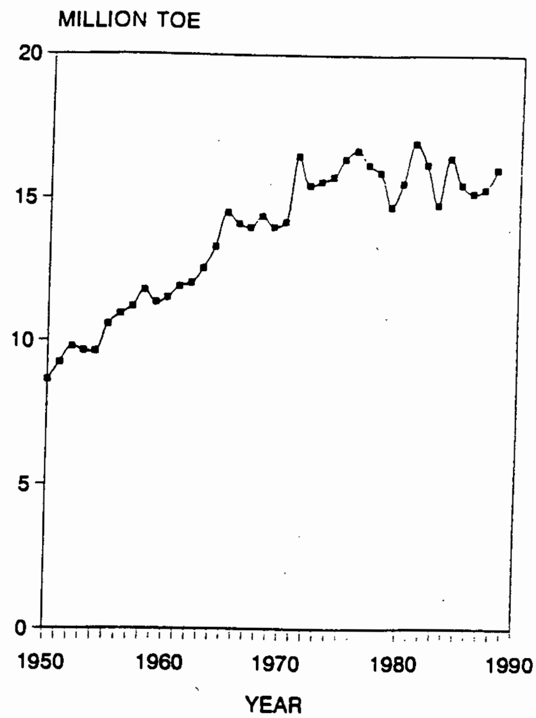


FIGURE 4.24:

COAL ENERGY BALANCE

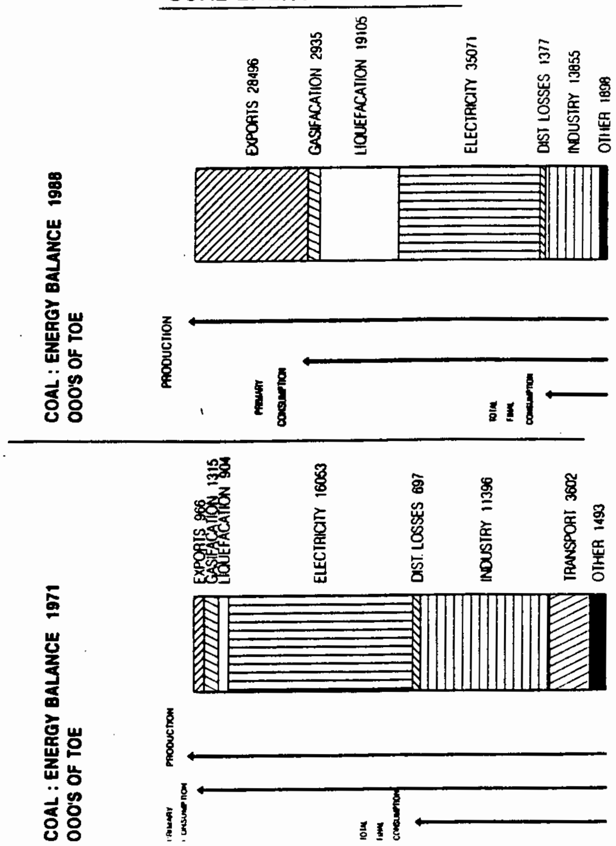


FIGURE 4.25:

COAL PRODUCTION AND EXPORTS

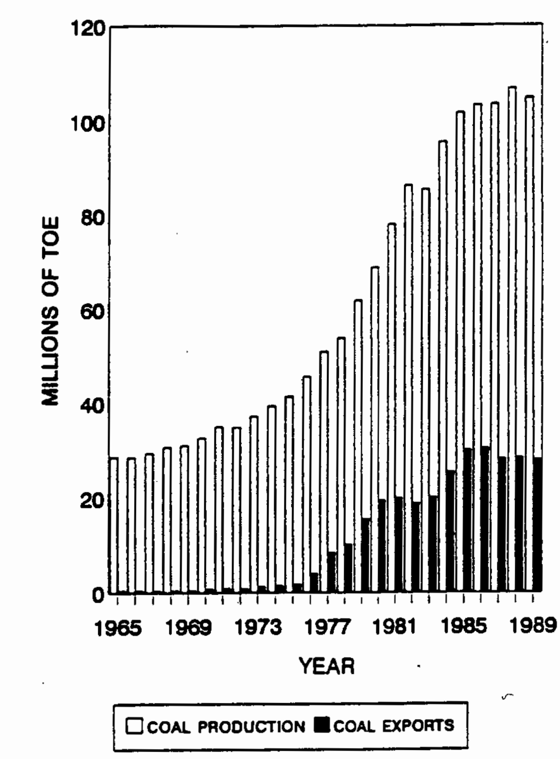


Figure 4.25 shows the production and export of coal during the period 1971-1988. The rapid increase in production since the mid 1970's is mainly due to increased exports, SASOL and electricity production.

Figure 4.26 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.

FIGURE 4.26:

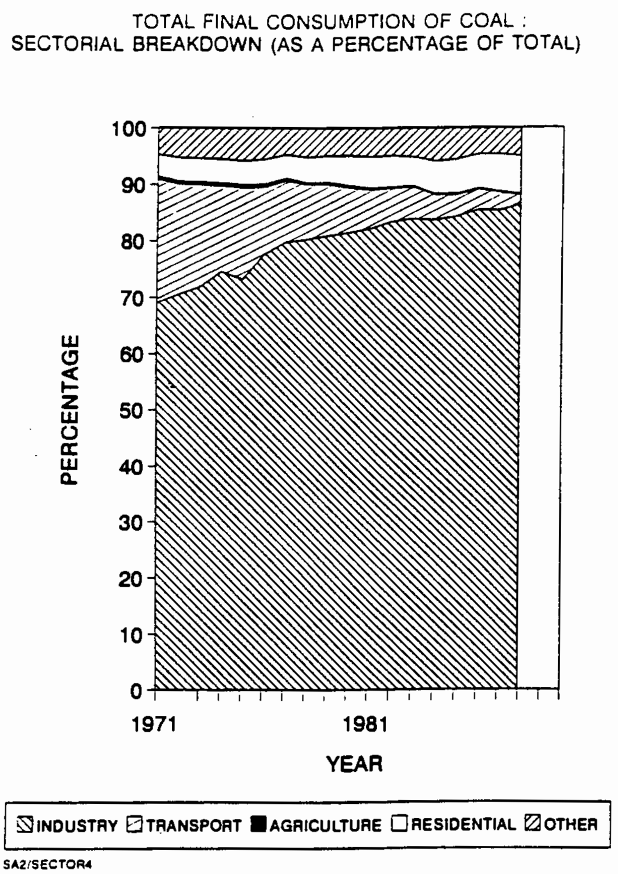
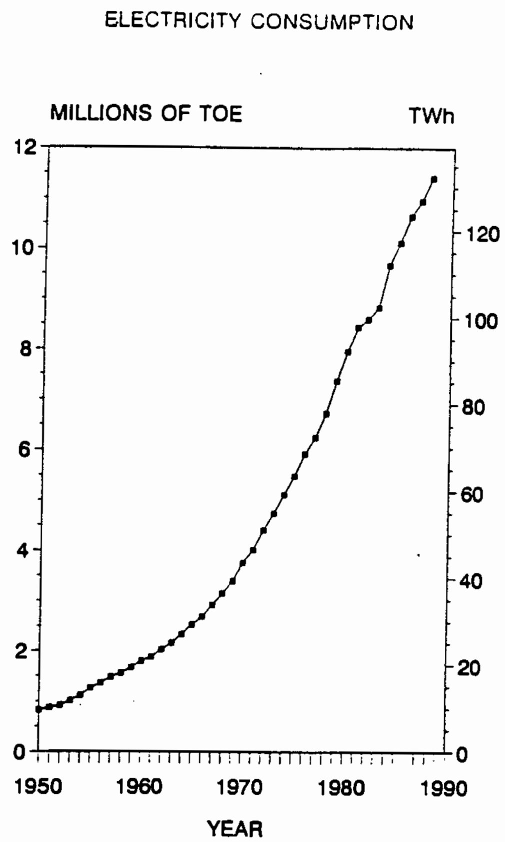


FIGURE 4.27:



4.5.5 Electricity

South Africa is the greatest single producer of electricity in Africa, accounting for 56% of all electricity generated on the continent in 1988[67]. 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[38].

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[76,37], which is low relative to the West. Large-scale urbanization 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 4.27 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 5 488 TTOE and by 1988 it had more than doubled to 11 410 TTOE.

The sectorial consumption of electricity during the period 1971-1988 is shown in Figure 4.28. 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 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[38].

Figure 4.29 shows the installed capacity on an assigned sent-out basis and maximum demand on the integrated system for 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 mainly 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 4.31 shows the average yearly growth in ESKOM's electricity sales during the period 1929-1990. When ESKOM's newest 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 economic conditions and as a result ESKOM had 4 686 MW of surplus generating capacity in 1990[38]. 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[65].

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[38]. 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[65]. The excess capacity excludes the Cahora Bassa scheme in Mozambique, which was built to supply power to South Africa but has been out of commission for a number of years due to sabotage of the power lines in Mozambique.

4.5.6 Pricing and Marketing

4.5.6.1 Oil and oil products

The price of gasoline diesel and kerosene is 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 cooperation 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 informed 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, while the remaining funds are intended for road development, etc. The tendency now is to classify all the tax as part of Treasury income without earmarking any of it for any 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.

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

4.5.6.2 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 so 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 usually who needed protection, usually the low-income user in the Black townships, did not receive it. Even though 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 for a long time being higher than that of the higher grade coals.

The marketing of coal used to be under the control of the Transvaal Coal Owners' Association, but since that body's disbandment, it has been under the control of individual mining houses. The price of coal for power stations and steel production was not controlled, with supplies coming from the utility's own mine or more often from a tied-colliery operated by a mining house. When 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 (a large iron and steel producer).

4.5.6.3 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 criteria there is room for maneuvering in terms of how long-term loans are to be paid off. This tactic has been used in the past by the Government to limit price increases, to decrease the national inflation rate.

Municipalities set their own tariffs, and there is a significant cross-subsidization of municipal rates.

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

4.5.6.4 Other energy

There is no price control of other energy sources; fuelwood for example, and prices are dictated by supply and demand considerations.

4.5.7 Comment

Although South Africa's energy sector has its own unique problems and shortcomings, a number of which are related to the oil embargo and sanctions, it has a well developed infrastructure, market and technical resource base in comparison to the remainder of the region. South Africa's location, energy "know-how" and more favourable terms of trade (compared to Western industrialized countries), make it ideally suited to assist with developing and implementing programmes aimed at rehabilitating and improving the energy infrastructure of the region. However these would need to be carried out in conjunction with funding agencies such as the World Bank and the IMF. ESKOM through its regional initiatives is assists other utilities in the region with respect to maintenance, operating, feasibility studies and training. Similar opportunities exist within the oil and coal industry.

Internally South Africa needs to speed up the process of deregulation of the energy industry. With the lifting of sanctions and the oil embargo, it is imperative that the South African Government remove the legislation restricting access to information and data concerning oil and oil products. Without accurate and detailed information regarding the supply and demand of oil and oil products, adequate energy sector policy formulation and planning is almost impossible.

4.6 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 requirements, and most of the boiler fuel being coal-based. The price of coal is very low compared to other energy forms and compared to 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 in the hands of private enterprise or parastatal bodies. There is however, significant indirect control of the pricing of liquid fuels. This is carried out by the Government and until recently the price of coal was also 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 MOSSGAS project. There is also indirect control of the parastatal electricity utility, ESKOM, with Government appointments of members of the Board of that organization.

In the energy context South Africa is a regional power which has a well developed and sophisticated energy infrastructure compared to the other ESA 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).

The political reform presently taking place, and the easing and lifting of sanctions is paving the way for South Africa to take its rightful place in the energy community of the region. With its relatively well developed energy infrastructure and large technical skills resource base in comparison to the rest of the region, it is expected that South Africa will play a large role in the energy sector of the region. Much scope exists for South Africa to assist with energy related projects (including; maintenance, operating, training, design, refurbishment, project management, equipment procurement, etc), as it has the technical infrastructure necessary and is familiar with the conditions and operating environment of the region.

Although South Africa has large reserves of coal and uranium, hydro-potential and water resources are limited. The ESA region has considerable hydro-potential which could be exploited, initially to supply the South African market, but ultimately for the benefit of the whole region. This will only be possible once political stability is achieved. South Africa is the only energy market large enough to enable the economic exploitation of gas resources in Mozambique and Namibia which, once undertaken, would at the same time make the supply of this resource to smaller users economically viable. There is also the possibility of coal trade between South Africa and countries that do not have economically exploitable resources.

There is therefore much scope for energy interchange of energy between South Africa and other countries of the region which will benefit the entire region. It is envisaged that the import of energy to South Africa would stimulate the economy of the exporting countries and eventually the region as a whole. Energy imports to South Africa would also have an important bearing on the environmental aspects of energy supply[44$] . With the growing concentration of coal based electricity generation in the Eastern Transvaal and the associated rise in emission levels, legislation will need to be enacted to reduce particulates and sulphur dioxide. The importation of electricity would be more effective in reducing the emission levels in these localized areas. As discussed in Chapter 2, a global carbon tax is likely to be implemented in order to reduce global warming. As South Africa relies on coal for a large proportion of its energy needs, it is likely to be taxed heavily once the above is introduced. The import of electricity based on hydro would assist in reducing South Africa's production of carbon dioxide and reduce the tax payable.

5. Energy Demand Forecasts: 1990-2020

This chapter forecasts the future total final consumption of energy in the region and in South Africa to the year 2020. Data collected and trends identified in chapters 3 and 4 are used as a basis for this forecast.

5.1 Introduction

In order to predict future energy use based on economic trends, the relationship between GDP and energy consumption needs to be explored. However, in certain cases energy consumption is a function of population, as in the case of traditional energy in many parts of Africa, rather than of the economy, and this must also be considered. The relationship between economic activity and energy consumption is often expressed in terms of two concepts[77]:

(1) Energy Elasticity (EE) - the ratio of the change in energy use to the change in GDP. Thus for an EE of 1,5 and GDP growth of 2%, energy consumption will change by 2% x 1,5 = 3%.

(2) Energy Intensity (EI) - the consumption of energy per unit of GDP. (GDP is usually expressed in real terms)

EE gives the normalized slope of energy versus wealth. Thus for cases where energy consumption increases at the same rate as wealth EE = 1. Where energy consumption increases at a faster rate than wealth, EE > 1 and for energy consumption increasing at a rate slower than economic growth, EE < 1. For constant energy consumption EE = 0, and for decreasing energy consumption EE is negative. Thus EE can be used in forecasting energy demand as a function of anticipated changes in future economic activities[77] and is therefore useful when comparing a number of scenarios.

EI gives the energy consumed to produce one unit of GDP. It is a concise measurement of the efficiency of economic activity, and is usually relatively stable, as it is primarily a function of the sectorial structure of the economy, energy efficiency within the various sectors and sub-sectors, as well as behavioural changes. The total EI is a function of the energy intensities of the various economic sectors and their relative contribution to GDP. The energy intensity of each sector is therefore a function of the intensities of the various industries or concerns within the sector. Thus, with sufficient historical data of the various industries, and other sectors, as well as estimates of changes in energy efficiencies, growth and structural changes within these, it is possible to predict future energy usage using EI.

EI is usually calculated using local currency, which makes comparisons between countries difficult, primarily due to exchange rate conversion problems. When EI is plotted against wealth, a slope of zero occurs where energy consumption and economic activity are increasing at the same rate at which point EI is a local maximum or minimum, and EE = 1. The relationship between EE, EI and wealth for a typical energy consumption curve is shown in Figure 5.1.

FIGURE 5.1: Relationship between typical energy indicators for a typical energy consumption trend vs Development.

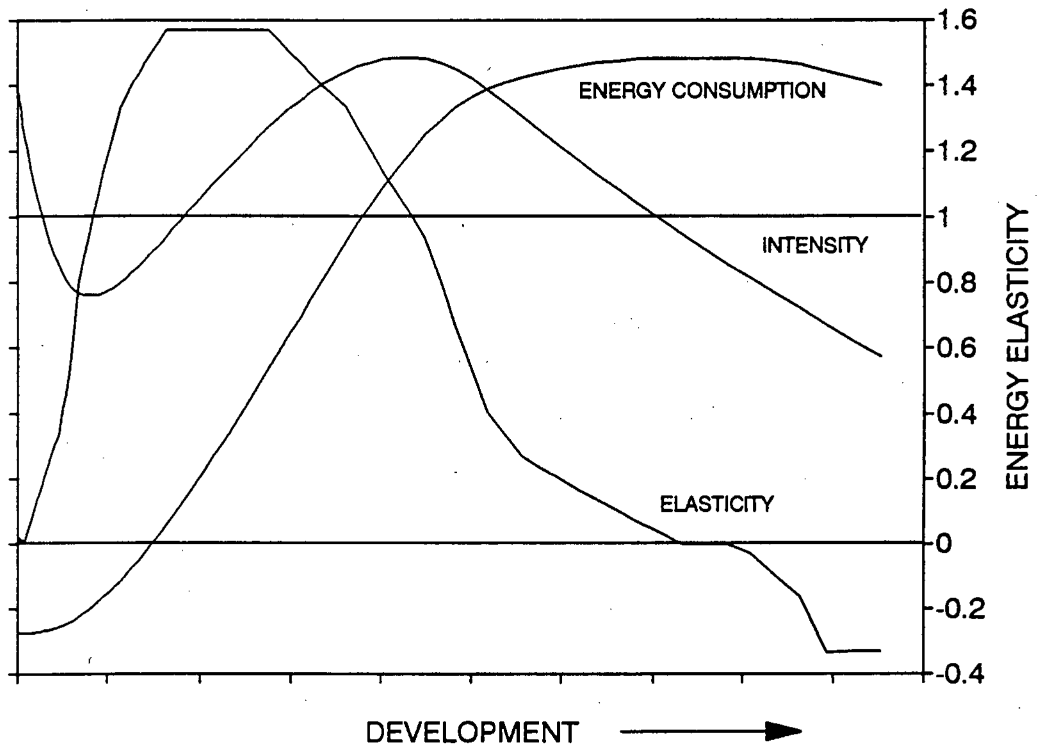
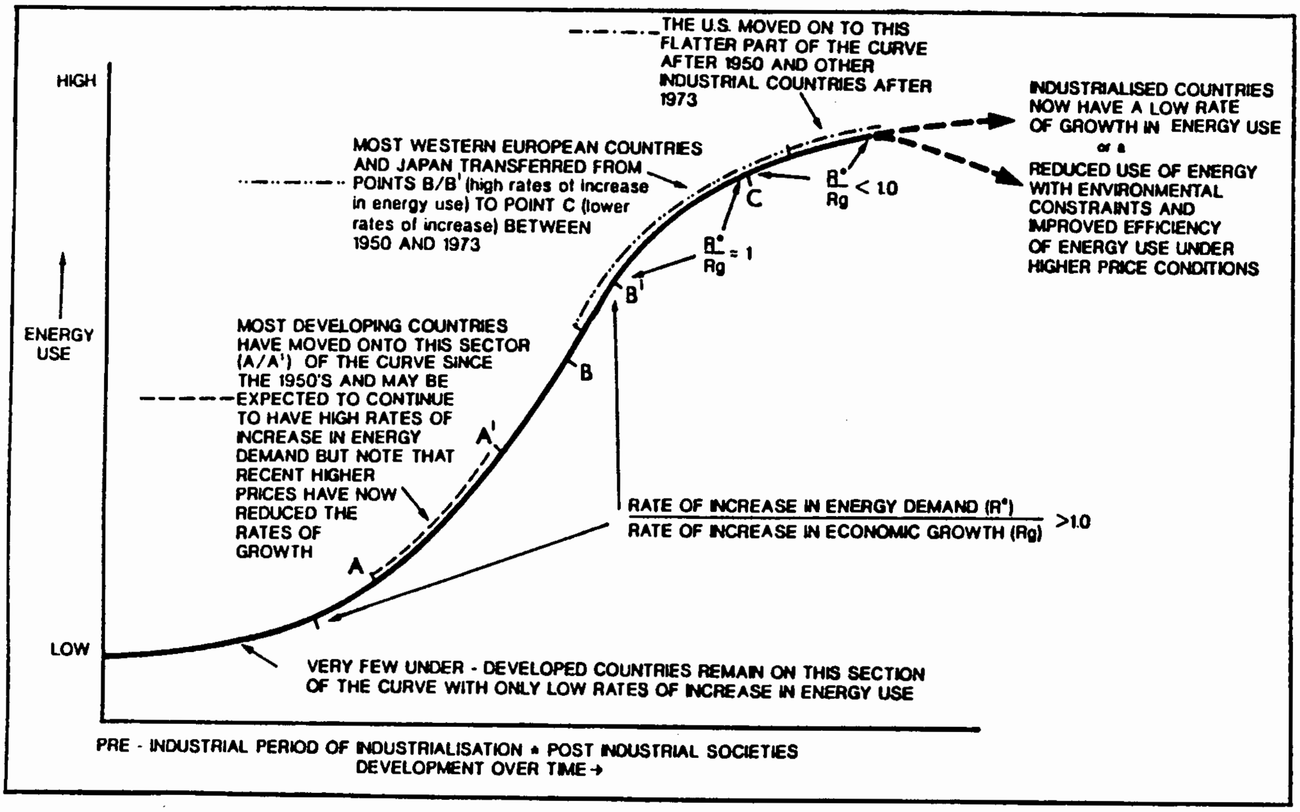


Figure 5.2 shows the typical energy consumption pattern versus development (Wealth). This takes the shape of an S curve and is derived from the typical economic development pattern of a country. As can be seen EE (= R_e/R_g) gives a good indication on which portion of the curve a country is situated and thus an indication of development. The transition from a developing country to a developed country occurs when EE decreases approximately below 1, which corresponds to a maximum on the EI curve. As EE is normalized and EI is a gross measure, it would seem that EE would give a better indication of state of development, however this depends largely on the accuracy of the statistics, as EE is relatively unstable as opposed to EI[77].

It should be noted that the typical trends and curves depicted in Figures 5.1 & 5.2 are based on relatively stable economies with continuous positive development and growth. The typical effects of negative growth in the economy are not shown. The situation, where economic growth is unstable and often negative as is the case in most of Sub-Saharan Africa complicates matters, as future developments cannot strictly be based on the above typical trends without taking into account the unique developmental history of the region.

FIGURE 5.2:



Source: **Odell, PR. 1989. Draining the world of energy.**

The above discussion would seem to indicate, depending on the availability of adequate data, that EI is best used when predicting energy usage, using a detailed bottom up sectorial approach, EE can be used to give an estimation of total energy usage and carrier usage based on various scenarios anticipating future economic growth. The availability and reliability of data will have a large influence on the accuracy of the results and the method used to obtain them.

The concept of EE as a function of economy can be extended to include the traditional energy sector. In this case EE_p is determined by the ratio of change in energy use to the change in population. Another indicator which could be used is energy per capita.

5.2 Overall Methodology

The region can be divided into two distinct areas with respect to energy usage patterns. Firstly there is RSA which relies mainly on commercial energy, 86%, and consumes 75% of the region,s commercial energy and secondly, the remainder of the region which is primarily reliant on traditional energy which provides some 80 % of its total final energy requirement. Data is also more readily available for the RSA than for other countries of the region. The use of traditional and commercial energy is driven primarily by different forces. Overall commercial energy is driven by economic growth and wealth generation, where as traditional energy is more a function of population growth.

After considering the above, it was decided to make independent predictions for RSA and the remainder of the region. Further more, it was decided that within these two areas traditional and commercial energy would be treated separately. The end product would be the integration of all four individual predictions.

To make the above predictions a number of economic growth scenarios had to be outlined. Three economic growth scenarios were decided on: Scenario 1, low growth; scenario 2, medium growth; and scenario 3, high growth. Figure 5.3 shows real GDP growth rates which form the basis for these scenarios. Scenario 1 has growth rates rising from 1% in 1989 to 2,5% in 2020, which in per capita terms results in an economic decline as the average population growth in the region is approximately 3%. Scenario 2 and 3 start off with growth rates of 2,3%, which is the population growth rate of South Africa, the economic giant of the region. Scenario 2 sees growth rates quickly reach 3% slightly over the average population growth rate of the region. Thus under scenario 2 per capita economic development shows a marginal improvement in the long term. Under Scenario 3 growth rises quickly reaching 5% near the end of the period and real per capita economic growth thus reaches some 2% at that time. Figure 5.4 shows per capita economic development under these three scenarios based on historical GDP in 1985 US$[i].

The future final consumption of energy by the region was then accessed using the indicators described above. This analysis is based on a "business as usual" situation under the different GDP growth scenarios in which the present supply constraints and electrification and inter fuel substitution trends based on the findings of chapter 3 and 4, persist. Saturation levels of the various carriers and the present trend in traditional energy resource depletion were also considered. The population growth for South

---

i 1985 US$ - local currency converted to US$ at prevailing exchange rate and then deflated using the US$ deflator for 1985.

Africa and the remainder of the region are assumed to average 2,3% and 3% per annum respectively.

FIGURE 5.3: Real GDP growth scenarios.

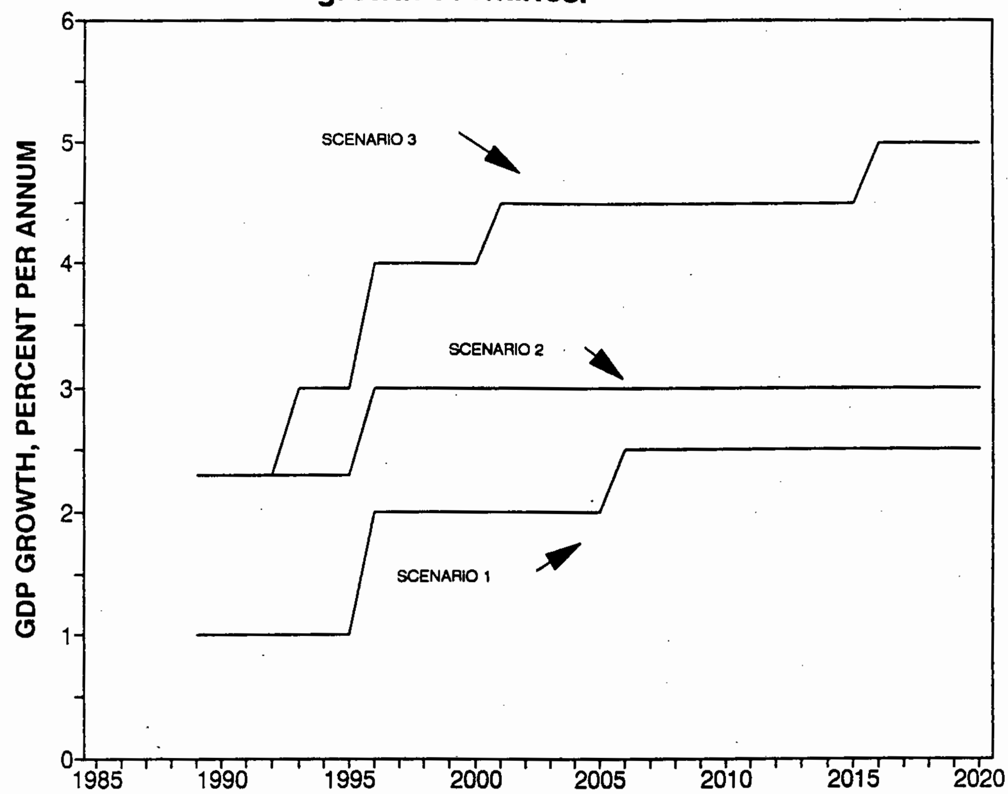
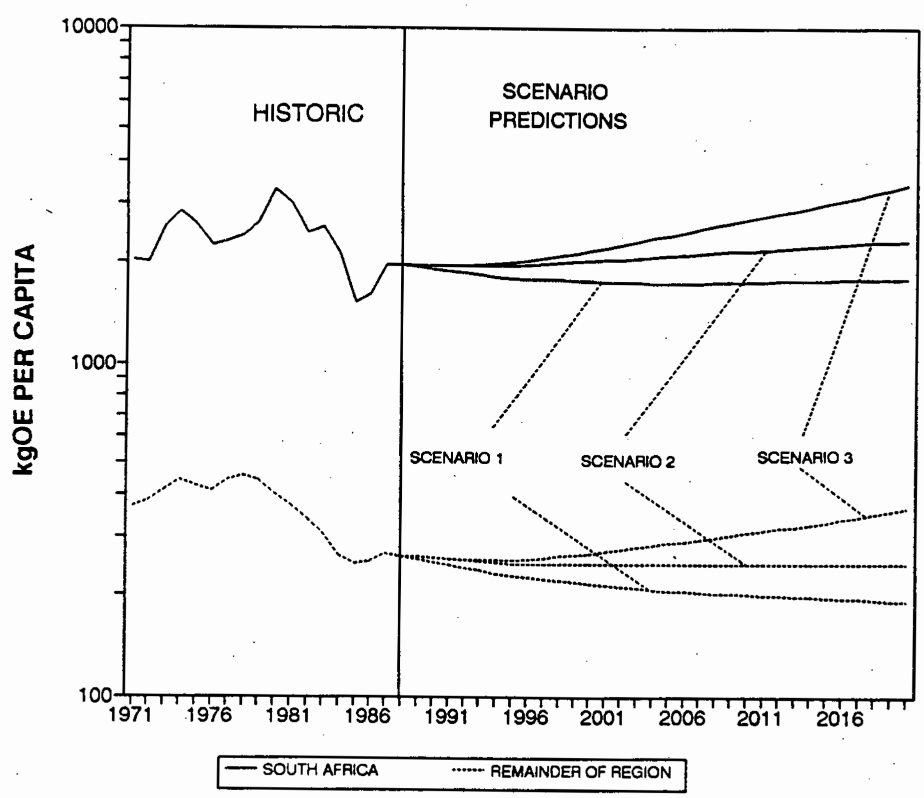


FIGURE 5.4: GDP per Capita: Historic and Scenarios



5.3 Results of Demand Analysis

Throughout this section data will be given for the whole region (ESA), for South Africa alone (RSA), and for ESA excluding South Africa (Remainder or Other). This is necessary as South Africa's large economy and consumption of energy overshadows trends, if data is only represented in regional terms.

Gas is included with oil as at present it represents less than 1% of Total Final Consumption of commercial energy, the majority of which is consumed in South Africa. This trend will continue as long as present supply constraints persist.

5.3.1 RSA

The predictions for South Africa are based on real (1985) Rands rather than real) US$.

5.3.1.1 Commercial Energy

To predict future overall energy intensity a detailed investigation of the historical and future energy usage/efficiency and wealth creation by the various sectors and sub-sectors of the economy needs to be undertaken. As the necessary statistics of the various sectors were not readily available, it was decided that Energy Elasticity (EE) would be used to predict RSA's future energy usage.

Energy Elasticities for RSA

The energy elasticities for the various commercial energy carriers and total commercial energy for the period 1950 - 1988 are shown in Figure 5.5 in a three point moving average form. The low and negative economic growth rate in 1955 and the 80's gives rise to big sways in elasticity. However for the period 1957 - 1980 it can be seen that in general, electricity elasticity has been increasing as would be expected for a developing country, while that of coal and oil have been decreasing, coal at a faster rate than oil. To make an initial forecast of future elasticities the average slope of the carrier and total energy elasticity was calculated. This slope was then applied to the elasticity values in 1988 and values extrapolated to 2020 as shown in Figure 5.6. It is interesting to note that according to this forecast, energy elasticity decreases to a value below 1 in 2015 indicating that the energy intensity curve reaches a maximum in 2015 and then begins decreasing.

Using these forecasts of EE, together with the three scenarios of economic growth to predict future energy consumption, it was found that electricity consumption increased beyond acceptable limits. This was attributed to the fact that the phenomenon of Electricity Saturation[78] had not been included in the prediction process.

FIGURE 5.5: Energy Elasticity - Real 1985 Rand basis.

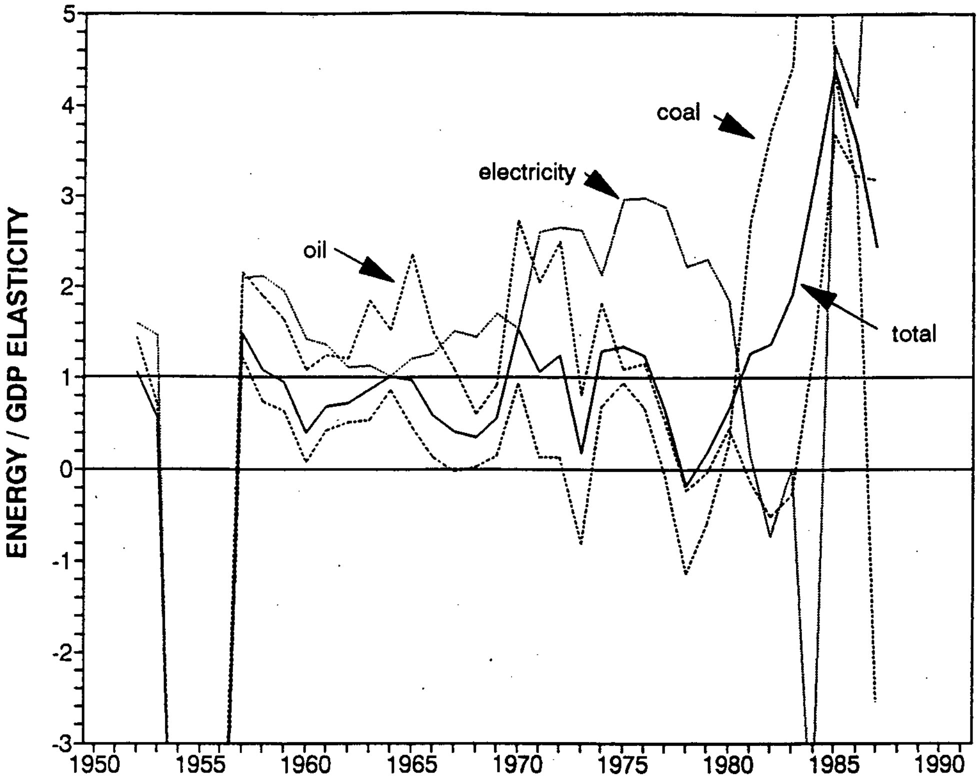
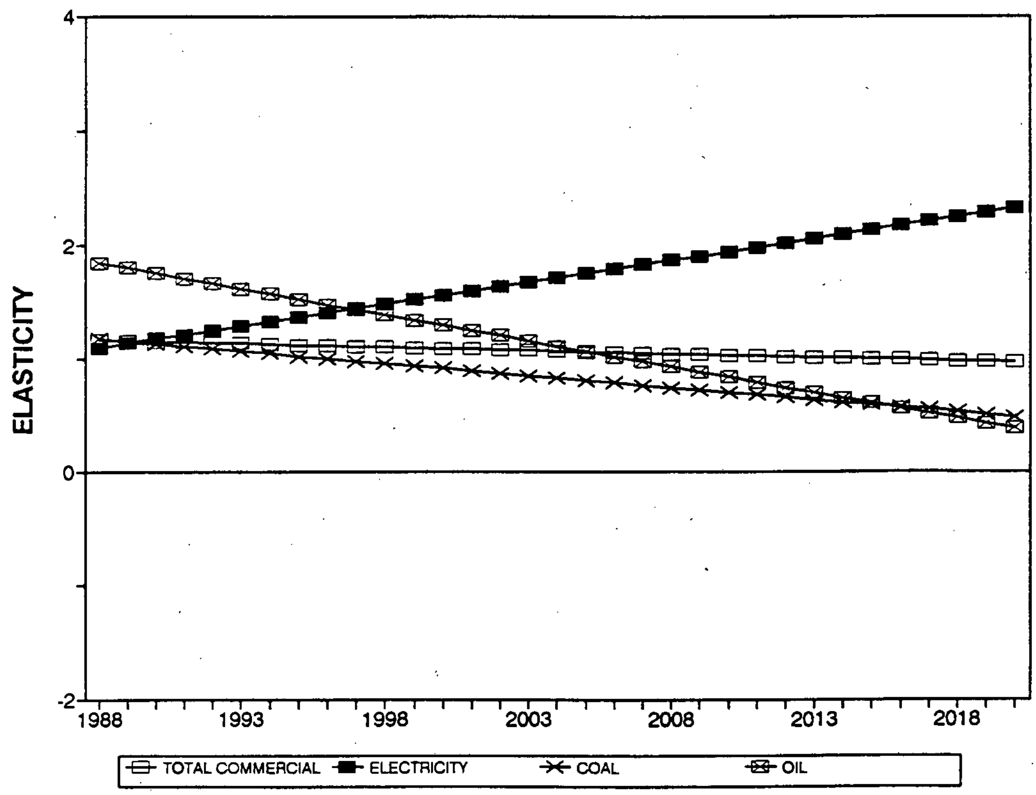


FIGURE 5.6: Initial Energy Elasticity Predictions 1989 - 2020



According to Dutkiewicz and Stoffberg[78] electricity as a percentage of commercial energy would saturate at around 33%. The consumption of the various carriers was then calculated for consecutive years using the elasticities shown in Figure 5.6 for the three scenarios, until electricity's contribution had reached approximately 33% of commercial consumption. (Total commercial energy consumption was obtained from the addition of the individual carriers). In all three cases it was found that at this point the percentage share of oil and coal was within 1,7% of 33% of total commercial energy. This compares favourably with the Dutkiewicz and Stoffberg[77] predictions of 34% for coal, and 33% for oil. The point at which electricity had risen to 33% of the total occurred in 2007, 2010 and 2012 for scenarios 1, 2 and 3 respectively.

For each scenario it was assumed that a steady state will exist from the above mentioned years onwards. Therefore the percentage contribution of each carrier was subsequently held constant until 2020, while total energy for this period was calculated using the forecast elasticity curve for total energy (Figure 5.6), instead of the elasticity of individual carriers used up until this point, from which individual carrier consumption was calculated. The EE and EI curves resulting from this modified analysis are shown in Figure 5.7. The crude manner in which electricity saturation was taken into account, results in the step change in the EE curve. Refinement of this analysis would give a better electricity saturation transition over the period concerned, but would not effect the overall results to any significant degree.

Table 5.1 shows the results of the above analysis for the years 2000, 2010 and 2020, as well as data for 1988. Graphs of historical data and predictions for the period 1950 - 2020 are contained in Appendix K and a more comprehensive table of results is contained in Appendix J.

FIGURE 5.7: Final Energy Elasticity and Intensity Forecast for the three scenarios

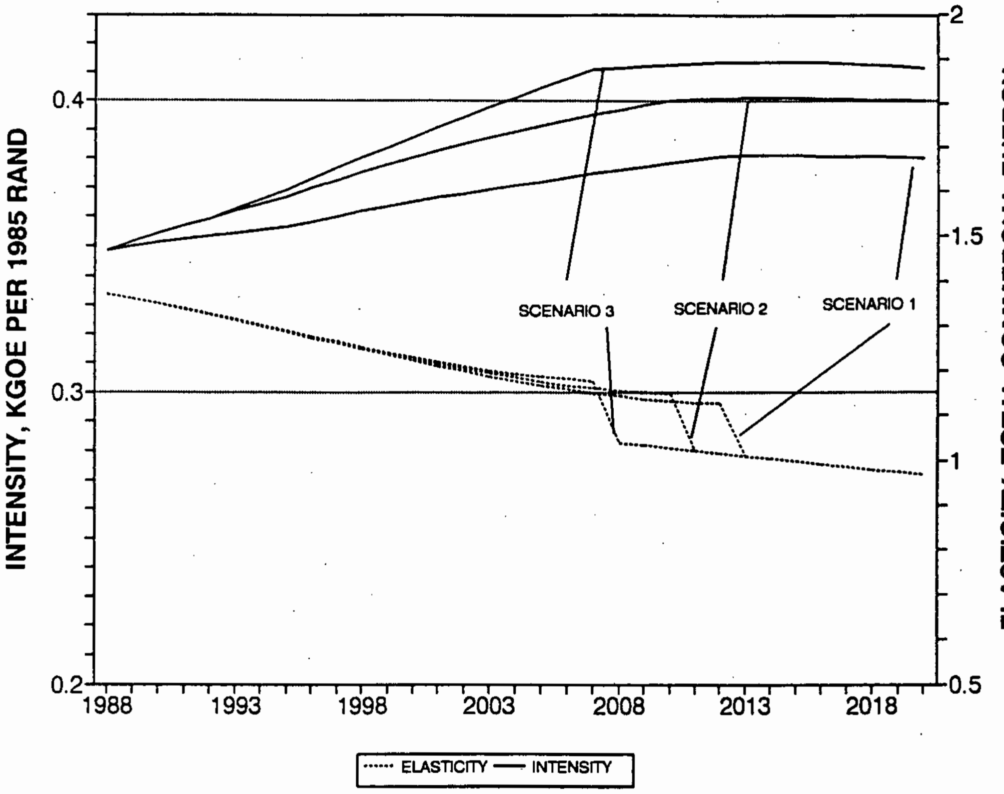


TABLE 5.1: COMMERCIAL ENERGY - TOTAL FINAL CONSUMPTION
1988 AND PREDICTIONS
SOUTH AFRICA
000 's TOE (PERCENT OF TOTAL IN BRACKETS)

YEAR	Scenario	ELECTRICITY	COAL	OIL	TOTAL
1988		11410 (27)	16033 (39)	14100 (34)	41453
2000	1	14393 (28)	19005 (37)	18128 (35)	51526
	2	17272 (28)	21938 (36)	22442 (36)	61651
	3	19032 (28)	23469 (35)	24739 (37)	67240
2010	1	21294 (32)	22656 (34)	22778 (34)	66729
	2	28938 (33)	27760 (32)	30505 (35)	87203
	3	36628 (33)	34729 (31)	39856 (36)	111213
2020	1	28535 (33)	28466 (33)	28760 (34)	857616
	2	38828 (33)	37247 (32)	40930 (35)	117005
	3	58089 (33)	55078 (31)	63208 (36)	176376

5.3.1.2 Traditional Energy

In South Africa the primary use of traditional energy is for cooking and heating by the household sector. Consumption of traditional energy is therefore closely related to population growth and is also effected by resource depletion. In order to predict future traditional energy usage in South Africa the trend in the traditional energy elasticity with respect to population, EE_p, was investigated.

Overall, EE_p averaged approximately 1 for the period 1951 - 1988 as would be expected for energy consumption paralleling population growth, but also displayed a downward trend reflecting the effects of resource depletion. Future elasticities were then forecast by calculating the average slope of the historical data from 1951 to 1988 and these were used to extrapolate from the 1988 value to 2020. The historical EE_p and the forecast elasticities are shown in Figure 5.8. The large fluctuations in the historical data after 1971 are a result of the inaccuracies in population figures from year to year as a result of the establishment of 'homelands'.

The elasticity forecast, together with a prediction of 2,3% for population growth, was used to predict future traditional energy consumption to the year 2020.

Table 5.2 shows the results of the above analysis for the years 2000, 2010 and 2020 as well as data for 1988. A more comprehensive Table of results is contained in Appendix J.

5.3.1.3 Total Energy

The results of the analysis carried out in 5.3.1.1 and 5.3.1.2 were combined to obtain predictions of TFC of energy to the year 2020 for the three scenarios. Table 5.2 shows these results for 2000, 2010 and 2020 as well as data for 1988. Graphs of historical data and the predictions for the period 1950 - 2020 are contained in Appendix L. A comprehensive Table of results is contained in Appendix J. Figure 5.9 shows the historical trend in traditional energy as a percentage of total energy, as well as predictions based on the above analysis.

TABLE 5.2: TOTAL FINAL CONSUMPTION OF ENERGY
1988 AND PREDICTIONS
SOUTH AFRICA
000's TOE

YEAR	Scenario	COMMERCIAL	TRADITIONAL	TOTAL	PERCENT TRADIT-IONAL
1988		41543	6876	48419	14
2000	1	51526	7735	59261	13
	2	61651	7735	69386	11
	3	67240	7735	74975	10
2010	1	66729	8011	74740	11
	2	87203	8011	95214	8
	3	111213	8011	119224	7
2020	1	85761	7840	93601	8
	2	117005	7840	124845	6
	3	176376	7840	184216	4

FIGURE 5.8:

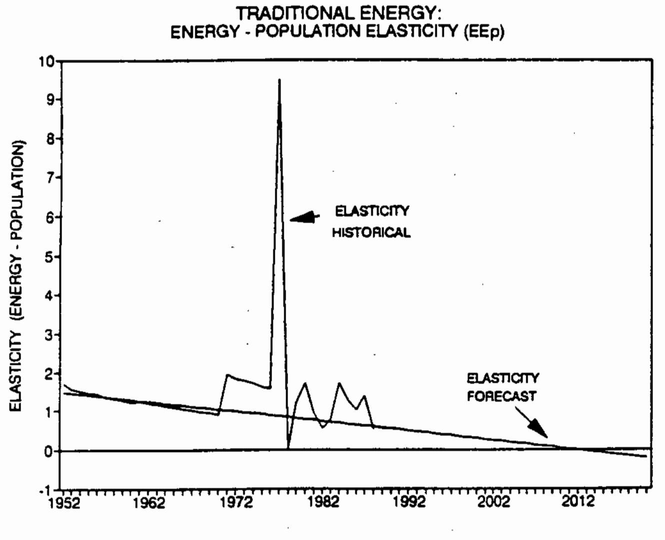
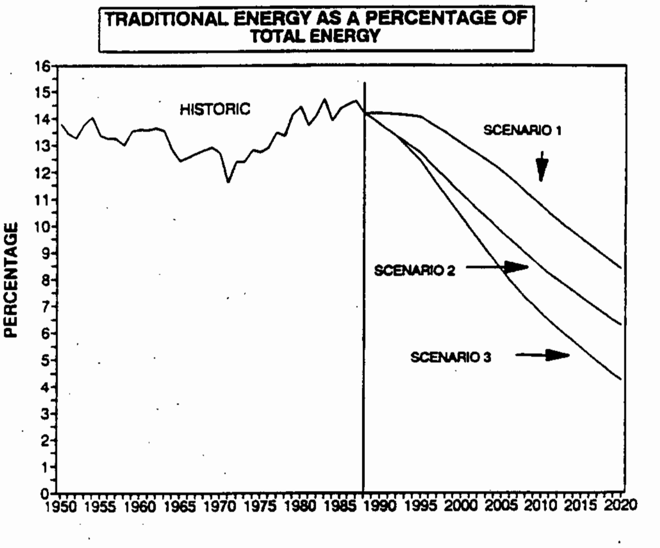


FIGURE 5.9:



5.3.2 ESA EXCLUDING South Africa (RSA).

5.3.2.1 Introduction

A complete set of statistics and data of energy consumption and economic indicators is not available for a number of countries, and their accuracy is also questionable in many cases. In order to obtain a reasonable set of statistics on which to base predictions, a sample set of 14 (of the 23) countries with reasonable statistics was chosen to represent the region. Data for these countries was compiled for the period 1971 - 1988, and where data was not available interpolation was used. Economic data was expressed in 1985 US$[i] to make the calculation of total GDP possible.

The data for the 14 individual countries was then combined and scaled up using suitable factors to obtain an estimation for the statistics of the 23 countries making up the ESA region - excluding South Africa. These estimates are contained in Appendices H and I. This data was then used as a basis for predicting future energy usage.

5.3.2.2 Commercial Energy

Due to the fact that:

(1) EE calculations gave very erratic results owing to the nature of the raw data, and
(2) the assumption that under the influence of the real growth in GDP, upon which the three Scenarios are based , EI would most likely display a constant increase over the time scale of the predictions because of the developing nature of this sub-region,

predictions of future commercial energy consumption were based on EI rather than EE.

Forecasts for future EI were obtained by calculating the slope of the historical EI curve from 1979 - 1988, and using it to extrapolate from the 1988 value to 2020. Future GDP in 1985 US$ was then calculated for the three scenarios, and with the EI forecast was used to predict commercial energy consumption to 2020.

To predict electricity consumption it was assumed that the rate of growth in the share of Electricity in TFC for the period 1971 - 1985 would continue under the influence of

---

i1985 US$ - local currency converted to US$ at prevailing exchange rate and then deflated using US$ deflator.

the positive real GDP growth associated with the three scenarios, and that saturation would not be reached by 2020. For this estimate of commercial energy consumption it was assumed that the ratio of coal to oil consumption would remain constant at the 1988 value until 2020.

Table 5.3 shows the results of the above analysis for the years 2000, 2010 and 2020 as well as data for 1988. A more comprehensive Table of results is contained in Appendix J.

TABLE 5.3: COMMERCIAL ENERGY - TOTAL FINAL CONSUMPTION
1988 AND PREDICTIONS
OTHER (ESA excluding SOUTH AFRICA)
000 's TOE (PERCENT OF TOTAL IN BRACKETS)

YEAR	Scenario	ELECTRICITY	COAL	OIL	TOTAL
1988		2598 (18)	2458 (17)	9252(65)	14308
2000	1	5156 (21)	4061 (17)	15290 (62)	24507
	2	5921 (21)	4664 (17)	17559 (62)	28144
	3	6342 (21)	4996 (17)	18809 (62)	30147
2010	1	9881 (25)	6345 (16)	23887 (59)	40113
	2	12207 (25)	7839 (16)	29511 (59)	49557
	3	15111 (25)	9702 (16)	36529 (59)	61342
2020	1	17926 (28)	9566 (15)	36014 (57)	63506
	2	23251 (28)	12407 (15)	46711 (57)	82369
	3	34060 (28)	18176 (15)	68428 (57)	120664

5.3.2.3 Traditional Energy

Predictions of future traditional energy consumption were made in the same manner as those for RSA. Results for the years 2000, 2010 and 2020, as well as data for 1988 are given in Table 5.4. A more comprehensive Table is presented in Appendix J.

5.3.2.4 Total Energy

The results of the analysis carried out in 5.3.2.2 and 5.3.2.3 above were combined to obtain predictions of TFC of energy to the year 2020 for the three scenarios. Table 5.4 shows these results for 2000, 2010, and 2020 as well as data for 1988. A more comprehensive Table of results is contained in Appendix J.

TABLE 5.4: TOTAL FINAL CONSUMPTION OF ENERGY FOR 1988 AND PREDICTIONS
OTHER (ESA excluding SOUTH AFRICA)
000's TOE

YEAR	scenario	COMMERCIAL	TRADITIONAL	TOTAL	PERCENT TRADIT-IONAL
1988		14308	69617	83925	83
2000	1	24507	95782	120289	80
	2	28144	95782	123926	77
	3	30147	95782	125929	76
2010	1	40113	121768	161881	75
	2	49557	121768	171325	71
	3	61342	121768	183110	67
2020	1	63506	149333	212839	70
	2	82369	149333	231702	65
	3	120664	149333	269997	55

5.3.4 Total Region - ESA (Including RSA)

The results obtained in sections 5.3.2 and 5.3.3 were then combined to obtain a set of predictions for the entire region for the three economic growth scenarios. A comprehensive set of historic and predicted energy consumption data is contained in Appendix J, together with key energy and economic indicators. The results are also presented in graphical form in Appendix M (Commercial energy) and N (Total Energy). A summarized version is shown in Table 5.5.

TABLE 5.5: TOTAL FINAL CONSUMPTION OF ENERGY
FOR 1988 AND PREDICTIONS
<u>ESA TOTAL (including SOUTH AFRICA)</u>
000 'S TOE

YEAR	scenario	COMMERCIAL	TRADITIONAL	TOTAL	PERCENT TRADIT-IONAL
1988		55850	76493	132344	58
2000	1	76034	103517	179551	58
	2	89795	103517	193312	54
	3	97387	103517	200904	52
2010	1	106842	129780	236622	55
	2	136760	129780	266540	49
	3	172554	129780	302335	43
2020	1	149267	157173	306441	51
	2	199374	157173	356458	44
	3	297040	157173	454213	35

Figure 5.10 shows the historic consumption of (commercial) energy by the whole region, and electricity as a percentage of commercial energy, for the period 1971 - 1989, as well as results of predictions to the year 2020. The "kink" in the electricity percentage curve around 2010 is a result of the method used for taking electricity saturation into account as discussed in 5.3.1.1.

Figures 5.11 and 5.12 show TFC of commercial energy per capita and total energy per capita respectively, for RSA and the total ESA region. Even though RSA's consumption of energy per capita is predicted to increase rapidly (102,8 GJ per capita in 2020) under the assumption of high economic growth depicted by scenario 3, total ESA energy per capita increases much more slowly only reaching 26 GJ per capita in 2020 (see Appendix J). These results compare favourably with the figures given by the WEC[79].

Figures 5.13 and 5.14 show commercial and total energy intensity in 1985 US$[i] for RSA, the remainder of the region (other) and total ESA for selected scenarios. In terms

i Local currency converted to US$ at prevailing exchange rates and then deflated using US$ deflator for 1985.

of commercial energy, predicted results indicate that the remainder of the region's energy intensity would continue rising towards RSA levels which in turn would reach a maximum towards the mid 2010's. Conversely in terms of total energy, the remainder of the region's energy intensity would continue increasing for some time before starting to decrease towards RSA levels.

FIGURE 5.10:

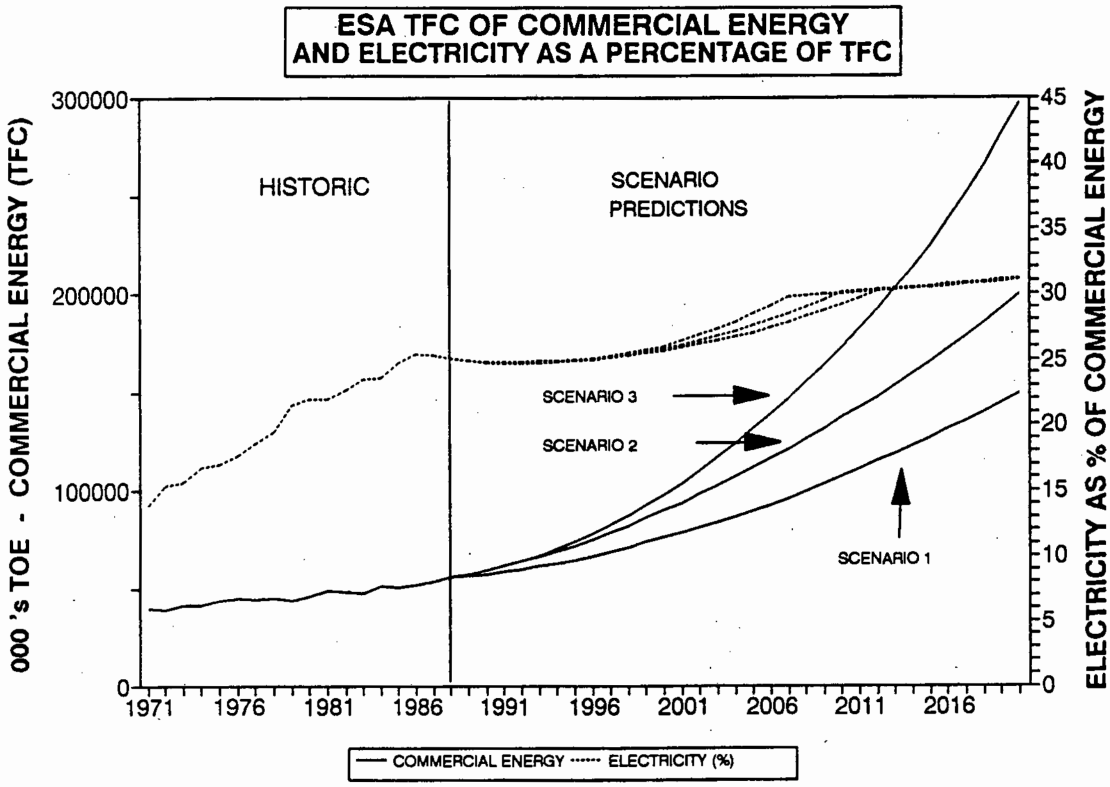


FIGURE 5.11

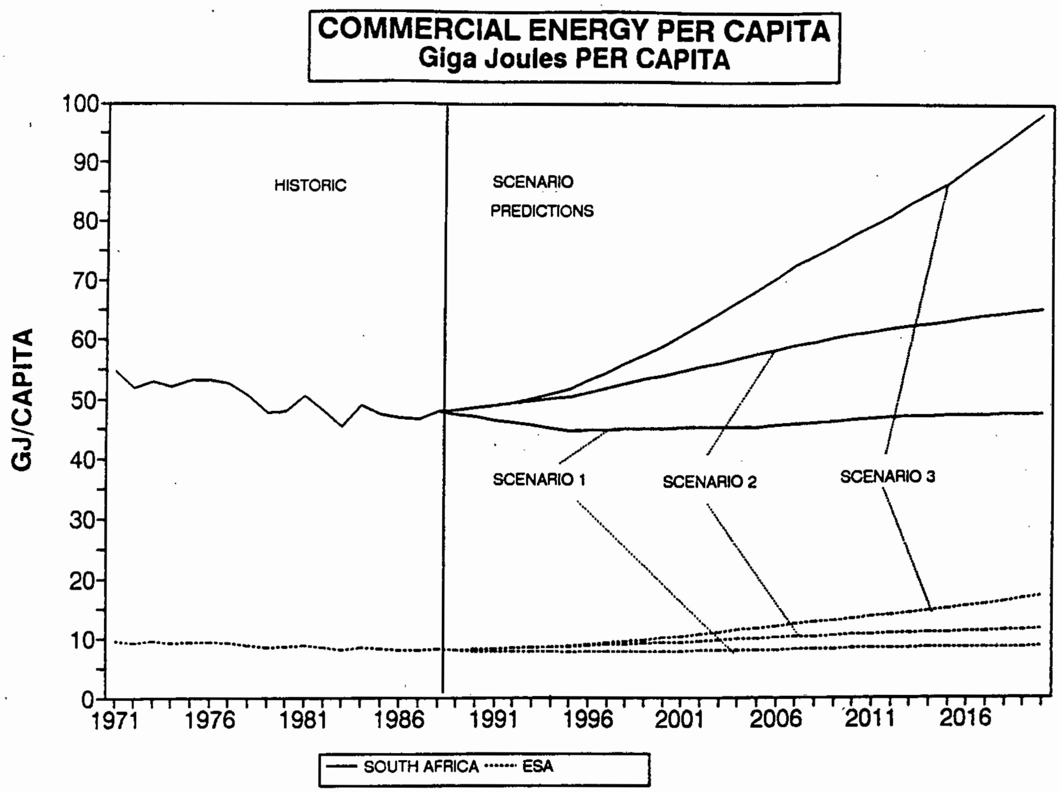


FIGURE 5.12

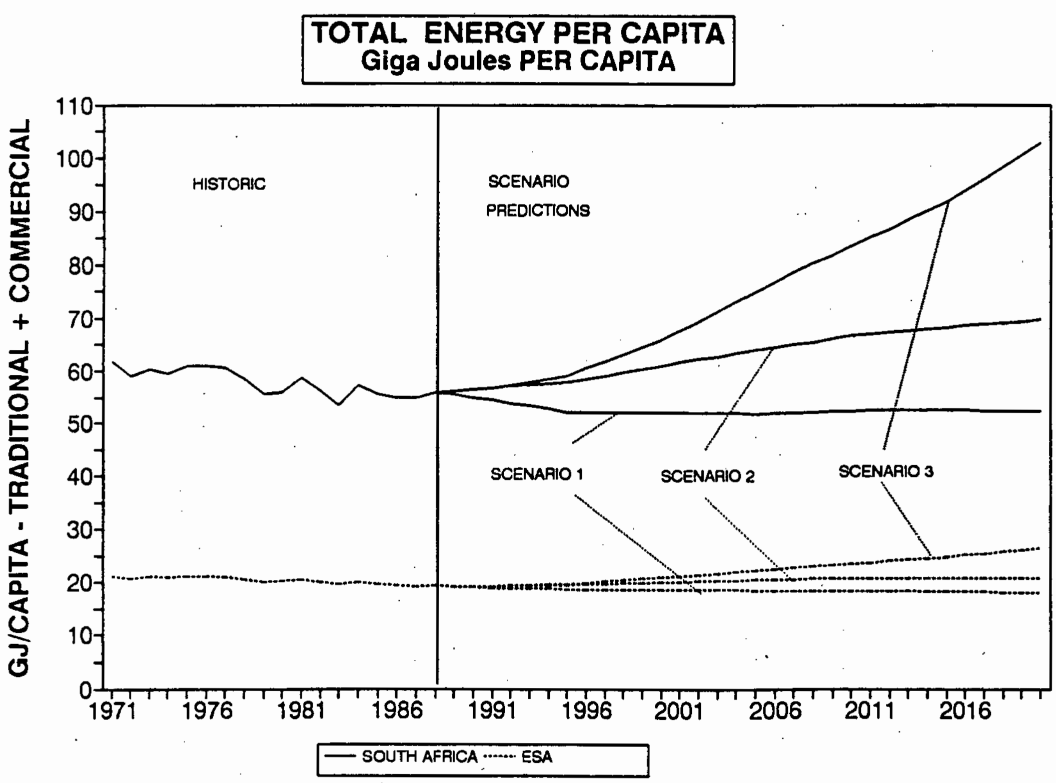


FIGURE 5.13

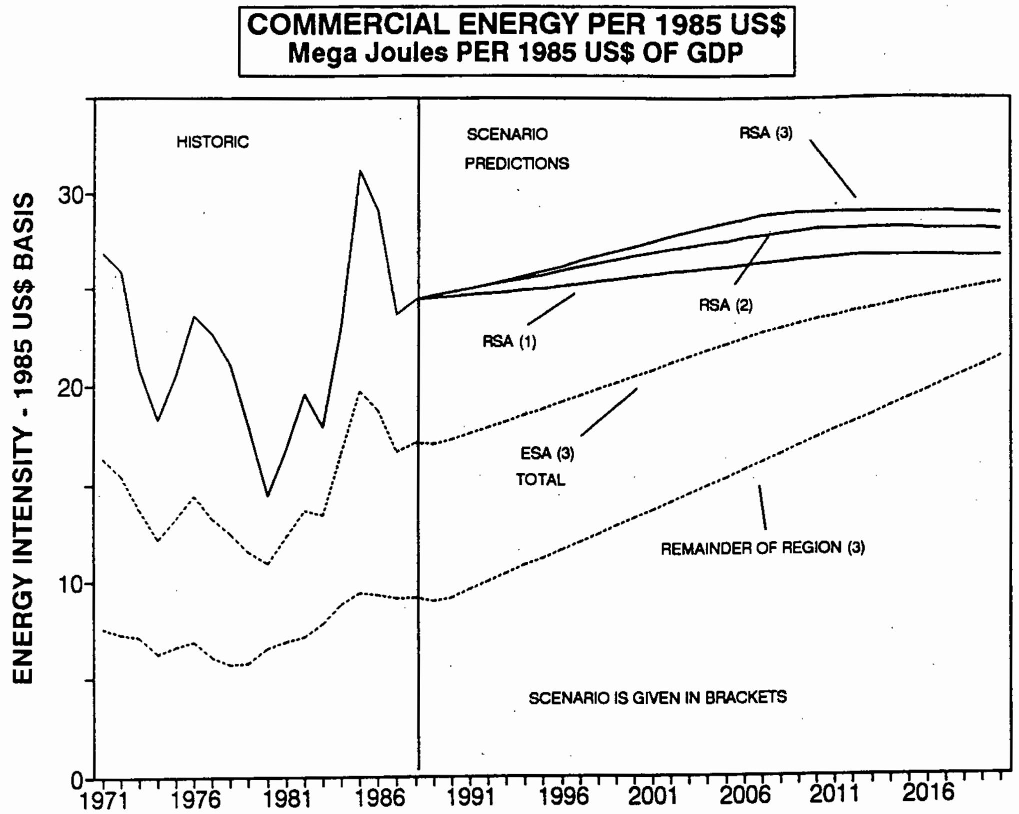
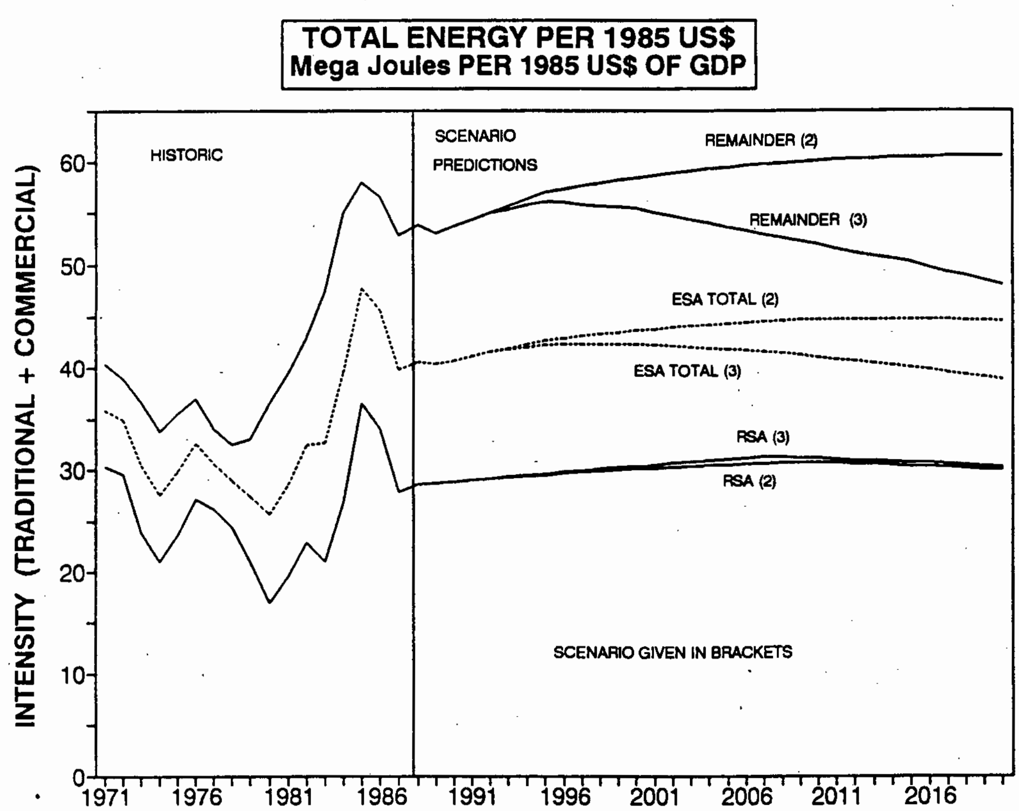


FIGURE 5.14



5.4 Discussion

Although the above analysis is somewhat crude the results follow logical trends and are credible, though sectorial consumption data is not available. The results do give a reasonable indication of the magnitude of, and trends in, TFC of the various energy carriers. It can be argued that a more refined technique would not improve the "accuracy" of these results as forecasting relies more on personal "feel" or informed judgment[80] gained from past experience rather than the degree of refinement of the methodology :

> "In short term forecasting ... a refined technique rarely produces significantly different results from those of a crude technique ... the longer term future is even less predictable than the short term"[80].

However, to obtain detailed results such as the expected future sectorial consumption of individual energy carriers a more refined technique and methodology would be required. A suitable methodology could be based on the analysis of energy intensities within the various sectors and sub-sectors, using a bottom up approach. For example the energy intensity of each category of industry within the industrial sector would be studied in detail, and the energy intensity of each carrier within a particular category obtained. A model for the energy intensity of the total economy could then be constructed from models of the energy intensity of the economy's individual components. Predictions could then be made of future structural changes within and growth of the economy, changes in energy efficiency within the various sectors and the possibility of energy substitution. This would then be applied to the model, and detailed energy consumption predictions obtained. However this would be a difficult process, even for South Africa, as the statistics and data required are not readily available.

5.5. Conclusion

Although the technique used suffices for a first estimate of future overall energy TFC the prediction of sectorial carrier consumption will require a more refined technique based on Energy Intensity. The first priority in attempting to improve on the 'accuracy' of these results should be to obtain data which is more reliable and correct.

Further work needs to be carried out to predict the future consumption of primary energy, as well as an investigation into the effect possible energy interchange and energy trade will have on primary carrier consumption. For example, how will the tapping of the hydro potential of the Zaire river effect primary consumption of coal and oil in the region. This however, is beyond the scope of this thesis.

6. THE FUTURE - Implications for the Region

This chapter discusses the implications for the ESA, of the results of the analysis undertaken in Chapter 5.

6.1 Introduction.

From the predictions made for the traditional energy consumption in Chapter 5, it is obvious that the large increase in demand will create resource depletion on a greater scale than the present trend. Fuelwood resources will not be able to meet the forecast demand without large scale deforestation, domestic energy scarcity, and environmental degradation, which will have a deleterious impact on the lifestyle of a large portion of the population. It is likely therefore, that the traditional component of TFC will increasingly be substituted by commercial energy sources. The shift from traditional to commercial energy forms will be accompanied by an increase in the efficiency of conversion to useful energy. Therefore, the total final energy demand is likely to be less than that indicated in Chapter 5 and will depend on the degree of substitution.

The speed at which substitution takes place will largely depend on the ability of nations to overcome the present institutional and infrastructure constraints discussed in Chapter 3, sections 3.3 and 3.6. Although electrification, based on the vast hydro, coal and gas resources is considered to be the most suitable end-use form of energy to substitute for traditional and transitional energy forms, long lead times, logistical problems and financial constraints exist. These, together with the rural nature of much of the population, and questions surrounding affordability, implies that fuelwood will remain an important source of energy in the rural and peri-urban areas in the short to medium term. Thus it is imperative that reforestation programmes are carried out in conjunction with the development of commercial energy. This calls for integrated energy sector planning and is reliant on the restructuring of the relevant institutions.

Scope exists for regional energy interchange once the necessary infrastructure has been established. This would ease supply constraints and make gas, coal and hydro electricity readily available to those countries which do not have indigenous resources, which in turn would have an effect on the energy mix as discussed below.

6.2 The Future - the potential for regional energy interchange.

The mix of energy carriers in the final demand for energy, as indicated by the results of the analysis in Chapter 5, would be significantly effected by the increased availability resulting from the realization of the potential for regional trade in energy. The following gives an indication how this would effect the results given in Chapter 5.

6.2.1 Coal

Coal has a large share in the final energy demand of South Africa, Botswana, Swaziland, and Zimbabwe but is of minor importance elsewhere. It may be expected that the other countries of the region would move in the direction of greater coal utilization if coal were more readily. It has been calculated[44] using the above analysis as a basis, that the realization of the potential for coal trade would increase demand by between 3 and 6 million tons per annum, in the medium to long term. The main importers would be Angola, Kenya, Namibia and Uganda. The shift to coal would be at the expense of oil imports and traditional fuels, such as fuelwood and charcoal. The source of this coal would be South Africa, Botswana and Zimbabwe and to a lesser extent Mozambique, Swaziland and Tanzania.

6.2.2 Gas

At present little gas is used in the region. Gas as a percentage of commercial energy is less than 0,8%, most of which is consumed in South Africa where it is made from coal. However, the region has large resources of gas. In OECD Countries the percentage of gas in final demand averages 19,4%, while the average for the world is 16,5% (see Chapter 2 - Table 2.2). It is therefore likely that gas will play an increasing role in the energy supply in the region, if the infrastructure necessary for trade was established. At present the importation of gas into South Africa from Mozambique and Namibia is being discussed. With gas being available in Angola, Tanzania and South Africa, it is to be expected that gas will play an increasing role in the energy economy, taking over some of the supply from oil and to a smaller extent coal. It is expected that opportunities arising from the realization of the various gas trade options would result in gas consumption showing the greatest growth rate, contributing more than 10% of commercial energy final demand by 2020[44]..

6.2.3 Oil

Trade in gas and coal will further decrease the contribution of oil to final demand in percentage terms, but growth will still be substantial due to its continuing dominance of the transport sector[44].

6.2.4 Electricity

The trade in electricity within the region via a "Southern African Grid" would not only create alternative sources of supply for existing large markets, but the installation of transmission lines would also make electricity available to countries and areas through which the lines would pass. This would increase the demand for electricity, to some extent, in the medium to long term.

6.2.5 Traditional Energy

The increased availability of commercial energy as a result of the trade in energy would alleviate the pressure on the demand for fuelwood in the long term. However fuelwood will remain an important source of energy in the short to medium term.

6.3 Conclusion

Fuelwood resources will not be able to meet the demand forecast. It is therefore imperative that reforestation programmes are carried out in conjunction with the development of commercial energy. This calls for integrated energy sector planning and is reliant on the restructuring of the relevant institutions.

Much scope exists in the region for regional energy interchange once the necessary infrastructure has been established. This would ease supply constraints and make gas, coal and hydro electricity more readily available to those countries which do not have indigenous resources.

7. THE POTENTIAL FUTURE ROLE OF SOUTH AFRICA IN THE REGION

This chapter discusses South Africa's possible future role in the energy sector of the region, in light of the political reform taking place in South Africa, and the state of the region's energy sector as highlighted in chapter 3. Attention is given to measures needed, in order to prevent polarization, and to enable equitable development of the region's energy sector.

7.1 Introduction

Recent developments in the region give rise to expectations that major political and economic reform will materialize. South Africa is presently negotiating a new democratic constitution; many countries are implementing structural adjustment programmes; in some former one party states multiple parties are being permitted; in Angola and Mozambique negotiations for a settlement are taking place; Namibia has gained independence; and it is generally accepted by the population of the region that pluralism is desirable[82]. These aspects increase the prospect of the resumption of growth and development in the region. The need for an increased supply of energy to support development and economic growth will therefore arise, as forecast in chapter 5. The inevitable end to South Africa's isolation by the remainder of region, coupled with her sophisticated energy sector, make her ideally placed to play a major role in ensuring the availability of infrastructure and resources required, to supply the necessary energy.

Although South Africa has a lot to offer the regional energy industry, the region also has a lot to offer South Africa. The region's large hydro-potential could be used, in place of the development of new coal fired power stations to supply low cost energy and to alleviate pollution. Gas could be sourced from Mozambique and Namibia, reducing South Africa's dependence on imported oil. South Africa is desperately short of water which could be supplied by the region via the development of innovative energy schemes such as the Lesotho Highlands Water Scheme. The region imports between $US 10 and $US 15 billion of goods and services, much of which could be sourced from South Africa[82]. This potential, together with the injection of funds into the region via the import of the above resources into South Africa, and the resultant stimulation of trade, would provide a much needed boost to the South African manufacturing sector. As most of South Africa's arable land is already intensively cultivated, she faces a food production shortage in the long term. Conversely the remainder of the region has vast areas of undeveloped well watered arable land which could be used to supply South Africa with additional agricultural products.

Thus, the integration of the energy sector of the region would form a key element in the economic integration of sub-regional and regional economies, in whatever form this might take place. Fears exist that South Africa might dominate the region and that due to South Africa's larger, more efficient, industrial sector, economic integration would lead to de-industrialization of the remainder of the region, with the PWV area becoming the new industrial hub. Measures need to be taken which will allay fears and ensure an equitable development path for the region as a whole[82].

This is also the case for the energy sector. South Africa will need to ensure that her admission to the various regional energy institutions, and her increased negotiations and dealings with the energy utilities of the region, are not hampered by the fears of her attempting to dominate their energy sector. At the same time, these energy institutions need to redefine their role in the light of South Africa's imminent acceptance to ensure that polarization does not take place. It is important that South Africa is seen to play an active role in the development of the energy sector of the region, in conjunction with her possible use of the region's natural resources for her own benefit, as monetary payment in itself will not prevent polarization. The transfer of technology, skills and 'know-how' to the region will ensure an equitable development of the energy sector, and will assist in building trusting relationships between South African and other energy utilities and institutions of the region. In this respect, the training of local personnel will play a large role. ESKOM has already begun assisting with developing the electrical sub-sector through its regional initiatives[38].

Areas in which potential exists for South Africa to play a key role in the energy sector are highlighted below.

7.2 Energy Interchange

The exploitation of much of the hydro and gas potential of the region is only economically possible within the context of energy interchange with South Africa. This would be mutually beneficial to South Africa and the exporting country. South Africa would gain access to alternative, less costly, and less environmentally damaging energy resources. The exporting country, as well as the country through which the transport infrastructure passes, would gain access to these previously "uneconomical[i]" energy resources, which would reduce there dependance on imported energy and save valuable foreign exchange. These countries would also

---

i Uneconomical in terms of indigenous market.

earn much needed revenue from sales of energy to South Africa. Much scope also exists for South Africa to export coal to countries without exploitable coal resources. This would reduce their energy imports from counties with less favorable terms of trade and provide a substitution, especially in the populated areas, for fuelwood. However a substantial investment would be needed in order to provide the necessary transport infrastructure.

The interchange of energy would give the region an economic boost, ensure an adequate supply of energy to the region as a whole, stimulate trade between countries of the region and South Africa and make more efficient and rational use of regional resources and capacity.

7.3 Energy Technology

The South African energy industry has maintained a high-level technology base and is continually monitoring, developing and adapting all appropriate technology to guarantee the provision of adequate energy at an affordable price. This technology has been modified, developed and proven under similar conditions as experienced in many areas of the region. Examples include cooling towers, lightning resistant transmission lines and long distance DC transmission lines. Much scope thus exists to export this technology to the region in a more cost effective manner than employing technology directly from Western Industrialized countries. To increase the capacity of the regional energy industry, it is important that the export of technology is not limited to the hardware alone. Personnel from the client country should be involved in projects from the start, and adequate training should be given so that the plant, or infrastructure, can be properly operated, maintained and repaired by local personnel, with the bare minimum of support from South Africa. Thus turn-key projects should be avoided at all costs and the effective transfer of technology encouraged.

Where it is necessary to import technology from Western Industrialized countries (WIC), South African energy experts can ensure that the interests of the client country are protected, as these experts are familiar with local conditions and requirements. They can also ensure that the equipment is not over or under specified for local conditions and that any modifications required are undertaken. South African energy practitioners could also be employed as project managers to ensure that the more sophisticated WIC do not take advantage of the inexperience of the region's countries.

7.4 Maintenance and Operating

There is a lack of an adequate technical skills resource base to adequately operate and maintain the energy infrastructure in many countries of the region. The result is that much of the energy plant is operating at below name plate rating, or is inoperative. On the other hand South Africa has a relatively large skills resource base, and plant is well maintained and operated. She also has large training facilities. ESKOM for instance has dedicated a fully operational power station exclusively for training purposes. South Africa has the skills and resources necessary to assist with the development of the energy sector of the region by means of the training of operating and maintenance personnel. This can be accomplished firstly by making South African training facilities, infrastructure and courses accessible to energy utilities of the region. Secondly, South African operating and maintenance personnel could be seconded to power stations, refineries, etc. in the region, where they would improve the existing operating and maintenance procedures and train the local personnel, to increase their self sufficiency in critical skills. For example, ESKOM is training personnel from Maputo power station at its training facilities in South Africa, and at the same time has sent members of its own personnel to Maputo power station to assist with training on site. Scope also exists for the South African energy industry to assist with the training of energy sector management to ensure the energy industry is run in an efficient, reliable and responsible manner. This would improve the confidence in the energy sector and would also help create an environment conducive to investment.

The lack of heavy engineering facilities will continue to prevent many countries carrying out major maintenance and overhaul of energy plant themselves, in the foreseeable future. The heavy engineering facilities in South Africa (Such as Rosherville Engineering, Dorbyl Heavy Engineering etc.) have the capacity to do this work, and provide a more cost effective alternative as opposed to returning the equipment to the original manufacturers. Rosherville engineering maintains a number of steam turbine and generator rotors for the electricity utilities of Namibia (SWAVEK) and Zimbabwe (ZESA). Scope also exists for such businesses to carry out the more technically exacting on site maintenance and repair of plant, which is and will be beyond the capacity of many energy utilities for the foreseeable future. This would also prove more cost effective than hiring the original equipment manufacturer to carry it out, as is the practice at present.

7.5 Exploration and mining

With regard to energy resources, South Africa is well surveyed, relative to the region. South Africa also has the faculty for large scale exploration projects. However, the remainder of the region has not been effectively explored and surveyed, and there is an enormous potential for the discovery of further lucrative energy resources. For instance, Angola has only had 20% of its surface geologically mapped at 1:250 000 scale[82]. Thus, the potential exists for South African companies to undertake large exploration projects in a number of countries of the region.

South Africa also has a sophisticated coal mining sector that is able to undertake anything from exploration through to the development and commissioning of a mine. South African industry is also capable of supplying all requisites for an existing, or new, mine. If this expertise and these requisites were freely available to the Forex-strapped and ailing mining sector of the remainder of the region, there would be an immediate surge in coal production in the short term, and new resources and mines would become viable in the medium to long term.

7.6 Summary

There is great potential for South Africa to play an increasing role in the energy sector of the region. This would be of mutual benefit to South Africa and the remainder of the region, as long as measures are taken to ensure equitable development and prevent excessive industrial polarization, and would lead to a more rational and efficient use of limited resources. To ensure the regional energy industry and infrastructure is developed in an integrated, coordinated and equitable manner it may be necessary to have regional energy companies and agencies. The companies would take the form of a regional electricity transmission company, a regional railways company, a regional petroleum products distribution company, a regional energy exploration company, a regional gas distribution company etc. These would find their roots in bilateral agreements between countries trading in energy and would grow as the need arose. To adequately regulate, coordinate and protect the interests of less developed countries, Sub-regional and regional energy Institutions will be required. SADDC and the OAU could potentially fulfill this function once they have redefined their role vis-a-vis South Africa's inclusion.

8. CONCLUSION

The immediate priority in the region is for economic growth to support the urgent need for human development, alleviate the widespread poverty and increase access to essential services and goods. To facilitate economic growth it is necessary to assure an adequate supply of energy in the appropriate form and in the most efficient and cost effective manner possible. The region has an abundance of commercial energy resources but they are not uniformly distributed with regard to form or locality, and a number of supply constraints exist. The realization of the potential for trade in energy within the region is of key importance in guaranteeing the supply of sufficient commercial energy in a sustainable manner and ensuring the efficient utilization of the region's resources.

Economic growth, development and the supply of adequate energy are reliant on the initiation of institutional reform, both politically and within the energy sector, the cessation of civil war and the achievement of political and associated social stability. Increased cooperation and trust between nations of the region is also required. The PTA, SADCC and the OAU have the potential to play a central role in this regard but need to reassess their purpose in light of recent developments in the region.

South Africa has the potential to play a leading role in the energy sector of the region and is expected to act as the pivotal growth point on which the region's survival depends. The actualization of this potential is dependant on the achievement of acceptable political reform, the implementation of sound macro economic policies by a future government and the cessation of violence. Although South Africa is an economic power in regional terms, it is poor by international standards. This means that for South Africa to play an effective role, as far as economic and in particular energy sector development is concerned, large investments are required in the region. Thus it is necessary for the region to create an environment conducive to international investment. With respect to the energy sector the resolution of issues surrounding pricing and pricing mechanisms, the implementation of policies aimed at rationalizing and deregulating the industry and the restructuring of institutions to increase accountability would go a long way in allaying reservations of potential investors in the sector.

With respect to the domestic sector, it has been determined that traditional energy will remain the dominant source of energy in the short to medium term. To provide an adequate supply of energy for the population of the region reforestation programmes, based on agro-forestry principles, need to be implemented with vigour and the issues surrounding common property institutions and land ownership need to be resolved. In the medium to long term, electrification based on hydro resources, is seen as the preferred option to satisfy domestic demand for energy, although the possibility exists for coal to play a role in the interim period. Therefore, to make use of the region's resources most effectively, governments need to undertake energy planning and policy formulation encompassing both traditional as well as commercial energy forms in an integrated manner.

The increasing use of energy in the region will have a growing impact on the environment. It is necessary to take cognizance of the environmental dilemma faced by the Western Industrialized countries when undertaking development within the energy sector of the region, so as to minimize the measures which will be necessary to combat pollution and environmental damage in the future.

It is necessary to emphasize that as long as the status quo in the region remains unchanged, the prospects for economic growth will never be realized, and problems hounding the energy sector will remain unresolved.

9. REFERENCES:

(1) ODELL, P.R. *Draining the World of Energy*. In Johnson R.J. & Taylor P.J. Editors. A World in Crises. 2end Ed. Basil Blackwell. Cambridge, Mass. (1990)

(2) ADELMAN, M. *The World Petroleum Market*. Johns Hopkins University Press. Baltimore, MD. (1972).

(3) INTERNATIONAL ENERGY AGENCY. *Energy Statistics and Balances of Non-OECD Countries 1988-89*. OECD. Paris. (1991).

(4) EDEN, E, POSNER, M, BENDING, R, CROUCH, E, STANISLAW, J. *Energy Economics Growth, Resources and Policies*. Cambridge University Press. New York. (1981)

(5) DUTKIEWICZ, R.K. *Regional Energy Cooperation: the South African Perspective*. Paper presented at the Regional Conference of the World Energy Council, Harare 1990. Energy Research Institute. Cape Town. (1990).

(6) GIELINK, M.I. *Report and comments on a workshop entitled Energy in the 1990's and Beyond presented by Peter James, 23 June 1991*. Energy Research Institute. Cape Town. (1990).

(7) WORLD ENERGY CONFERENCE. *1989 Survey of Energy Resources*. Holywell press Ltd. Oxford. (1989)

(8) INTERNATIONAL ENERGY AGENCY. *Energy Statistics and balances of OECD Countries 1980-1989*. OECD. Paris. (1990)

(9) INTERNATIONAL ENERGY AGENCY. *Energy Statistics and balances of OECD Countries 1960-1979*. OECD. Paris. (1990)

(10) INTERNATIONAL ENERGY AGENCY. *World Energy Statistics and Balances 1971-1988*. OECD. Paris. (1990).

(11) WORLD ENERGY CONFERENCE. *1986 Survey of Energy Resources*. Holywell Press Ltd. Oxford. (1986).

(12) GIELINK, M.I. and DUTKIEWICZ, R.K. *Country Energy Profile Series*[i]*: East and Southern Africa*. Energy Research Institute. Cape Town. (1991-92).

---

i This is a series of individual reports on the following countries:
Angola, Botswana, Ethiopia, Kenya, Lesotho, Malawi, Mozambique, South Africa (RSA), Swaziland, Tanzania, Zaire, Zambia, Zimbabwe.

International Seminar on " Energy in Africa ". 23-30 November 1990. Abidjan. Cote d' Ivoire. (1990).

(28) GULHATI, R. *The Making of Economic Policy in Africa.* Economic Development Institute of The World Bank. Washington DC. (1990).

(29) PEARCE, D.A.M.and BARBIER, E.B. *Blueprint for a Green Economy.* Earthscan. London. (1989).

(30) CHANDER, R. *Information Systems and Basic Statistics in Sub-Saharan Africa: a Review and Strategy for Improvement.* The World Bank. Washington DC. (1990).

(31) 'T SAS ROLFES, M., GIELINK, M. I., and DUTKIEWICZ, R. K. *Unpublished report for the South African Committee of the World Energy Council.* Johannesburg. (1991).

(32) SADCC. *1989-1990 How the Sectors Went.* SADCC ENERGY, Vol 8, No 22, 1990, pp 14-30. (1990).

(33) WORLD RESOURCES INSTITUTE. *World Resources 1990-91.* World Resources Institute. (1991).

(34) KAALE, B.J. *The Role of Wood Fuel in the Tanzanian Energy Supply.* SADCC ENERGY, Vol 3, No 9, 1985, pp 12-15. (1985).

(35) GATA DR, Z.S. *A Review of Contrasting Markets - Sub-Saharan Africa.* Paper Presented at the Financial Times Conference: World Electricity. London. 14-15 November 1991. (1991).

(36) DUTKIEWICZ, R. K. and GIELINK, M.I. *Traditional Energy and Electricity in South and Eastern Regions of Sub-Saharan Africa.* Energy Research Institute - UNIVERSITY OF CAPE TOWN; REPORT NO INT 161. Cape Town. (1991)

(37) SCHNEIDER, M. *Powerhouse.* Interview with Dr. I McRae of ESKOM. Leadership, Volume 10 August/September, pp. 10-12. (1991).

(38) ESKOM. *ESKOM Annual Report and Statistical Yearbook 1990.* Johannesburg. (1991).

(39) HAMMOND, J.R. *Privatization and Private Sector Participation in the Power Sector.* Paper presented at the International Seminar on " Energy in Africa". 23-30 November 1990. Abidjan. Cote d' Ivoire. (1990).

(40) THE WORLD BANK. *Summary data sheets of 1987 Power and Commercial Energy Statistics for 100 Developing Countries.* The World Bank. Washington DC. (1990).

(41) SCHLOSS, M. *Sub-Saharan Energy Financing: The Need for a New Game Plan.* Paper presented at a Regional Energy Forum for East and Southern African Countries: Energy Perspectives for the 1990's. 12-14 November 1990. Harare, Zimbabwe. (1990).

(42) CUNEO E ASSOCIATI. *Petroleum Products Supply and Distribution in Southern Africa.* Reports on East Africa meeting with Government Experts and Project Planning Phase Meeting with Government Representatives as part of a Regional Study on the Rationalization of Petroleum Supply and Distribution in Sub-Saharan Africa. 20-25 January 1992. Nairobi. (1992).

(43) OPENSHAW, K. *Energy in the Environment in Africa.* Paper presented at the International Seminar on " Energy in Africa ". 23-30 November 1990. Abidjan. Cote d' Ivoire. (1990).

(44) DUTKIEWICZ, R. K. *Energy Supply and Demand in Southern Africa.* Energy Research Institute, University of Cape Town. Cape Town. (1992).

(45) WORLD BANK. *Fuelwood Supply and Environmental Management.* World Bank. Washington, DC. (1987).

(46) INTERNATIONAL ENERGY AGENCY. *Energy in non-OECD countries.* OECD. Paris. (1991).

(47) VINJAR, A. *Development of Regional Energy Markets in Africa.* Paper presented at the International Seminar on " Energy in Africa ". 23-30 November 1990. Abidjan. Cote d' Ivoire. (1990).

(48) WEREKO BROBBY, C. J. *Energy, Environment and Development in Africa.* Paper presented at the International Seminar on " Energy in Africa ". 23-30 November 1990. Abidjan. Cote d' Ivoire. (1990).

(49) GATA DR, Z S. *Ethical Choices in Energy Technology for Developing Countries.* Paper Presented at the conference on : Ethical Choices in the Age of Pervasive Technology. University of Guelph, Ontario, Canada. 25-29 October 1989. (1989).

(50) TIMBERLAKE, L. *Africa in Crises: The Causes, the Cures of Environmental Bankruptcy.* Earthscan. London. (1985).

(51) MARKET RESEARCH AFRICA. *Project Ecos: Adult All Races Quantative Survey Charts.* MRA. Johannesburg. (1990).

(52) GATA, Z.S. *Factors Affecting the Availability of Thermal Power Plants in Developing Countries.* Paper Presented at CIGRE Southern African Regional Conference on Electrical Power for Developing Communities. Mbabane, Swaziland. 12-13 March 1990. (1990).

(53) MOORE, E.A. *Review of Electricity Tariffs in Developing Countries During the 1980's*. World Bank. Washington DC. (1990).

(54) CHURCHILL, A.A. and SAUNDERS, R.J. *Financing of the Energy Sector in Developing Countries.* World Bank. Washington DC. (1989).

(55) SADCC. *SADCC Energy Sector Year Book 1988.* SADCC, TAU. Luanda. Angola. (1990).

(56) UN. *Energy Statistics Year Book 1985.* UN.

(57) UN. *Energy Balances and Electricity Profiles 1986.* UN.

(58) WORLD ENERGY COUNCIL - COMMISSION, PROJECT MANAGEMENT UNIT. *Executive Summary for Sub-Saharan Africa.* WEC. London. (8 January 1992).

(59) The Economist Intelligence Unit. *South Africa Country Profile 1989-90.* The Economist Intelligence Unit, London.

(60) GROBBELAAR, J.A. *Projections and analysis of the South African population for the period 1980-2015.* Institute for Futures Research, University of Stellenbosch.

(61) UN. *Demographic Year Book 1987.* United Nations.

(62) EBERHARD, A.A. *Energy consumption patterns and supply problems in underdeveloped areas in South Africa.* Energy Research Institute, University of Cape Town, September 1990.

(63) *Africa South of the Sahara 1991*. 20th edition, Europa Publications.

(64) ASTAKHOV, A.S. *Effective coal resources of the world*. Energy Exploration and Exploitation, Vol. 8, No. 6, Multi Science Publishing Co., 1990.

(65) VENTER, G.P.N. *The energy situation in South Africa.* ROC - RSA Energy Conference 1991.

(66) VAN DEVENTER, J.R. *Development and implementation of an electricity strategy for a developing region: Sub-Saharan Africa.* Paper presented at ROC-RSA Energy Conference in Taipei, Taiwan, 11-12 March 1991.

(67) Water Power and Dam Construction. *National Profiles.* Water Power and Dam Construction, March 1991.

(68) National Energy Council. *Annual Report 1989-90.*

(69) EBERHARD, A.A. *A Solar Radiation Data Handbook for Southern Africa.* Energy Research Institute, University of Cape Town.

(70) *Sonenergie en Suid Africa.* Departement van Beplanning en die Omgewing.

(71) ROBERTS, L.W. *The potential of small commercial wind-energy devices for use in rural areas of South Africa.* 1985.

(72) *Wind Direction and Speed: Table X.* South African Weather Bureau.

(73) DUTKIEWICZ, R.K. *Wind energy potential in South Africa.* Energy Research Institute, University of Cape Town.

(74) BASSON, J.A. *The state of energy conservation and the efficient production and use of electricity in South Africa.* Paper presented at the ROC-RSA Energy Conference in Taipei, Taiwan, 11-12 March 1991.

(75) EBERHARD, A.A. *Energy consumption patterns in underdeveloped areas in South Africa.* Energy Research Institute, University of Cape Town, 1986.

(76) BREYTENBACH, W.J. *South Africa in Africa: The Challenge of a Changing World.* Institute for Futures Research, University of Stellenbosch.

(77) DOPPEGIETER, J.J., DU TOIT, J., VAN VUUREN, E. and WESSELS, A. *Energy Futures 1991.* Institute for Futures Research, University of Stellenbosch. (1991).

(78) DUTKIEWICZ, R. K., STOFFBERG, T.C. *Electricity Saturation in South Africa.* Energy Research Institute, UNIVERSITY OF CAPE TOWN, November 1991.

(79) WORLD ENERGY COUNCIL - COMMISSION, PROJECT MANAGEMENT UNIT. *Executive Summary for Sub-Saharan Africa.* WEC. London. (8 January 1992).

(80) SCHUMACHER, E.F. *Small is Beautiful - A Study of Economics as if People Mattered.* Pg 208 -224. Blond & Briggs, London. (1978).

(81) WILDLIFE SOCIETY. *Enviro-Facts 40.* Wildlife Society. Howick. (1991).

(82) KISA, J.K. *Non-Economic Barriers to Development.* Southern Africa Political & Economic Monthly Vol 5 No.2 (November 1991). SAPES Trust. Harare.

APPENDICES

APPENDIX A:

LIST OF COUNTRIES AND SELECTED STATISTICS

DATA FOR 1988 OR LATEST YEAR AVAILABLE

COUNTRY	POPULATION	ENERGY TFC** 000'S toe	GDP US$ MILLION	TFC** PER CAPITA (kgoe)	GDP PER CAPITA US$	TFC** PER GDP kgoe/US$	TRADITIONAL ENERGY AS A PERCENT OF TFC**
ANGOLA	9,41	1678,2	5633,40	178,4	599	0,298	60
BOTSWANA	1,21	840,0	1871,09	694,2	1546	0,449	53
BURUNDI	5,15	1202,6	1093,87	233,6	212	1,099	94
COMORES	0,42	12,0	207,15	28,4	491	0,058	-
DJIBOUTI	0,48	67,0	338,92	138,7	702	0,198	-
ETHIOPIA	46,14	9539,9	5574,40	206,7	121	1,711	92
KENYA	23,02	9272,0	8601,69	402,8	374	1,078	78
LESOTHO	1,68	618,0	410,08	367,9	244	1,507	75
MADAGASCAR	11,26	1649,1	1883,31	146,5	167	0,876	80
MALAWI	7,75	1566,0	1194,32	202,1	154	1,311	87
MAURITIUS	1,05	635,0	1947,54	605,9	1858	0,326	68
MOZAMBIQUE	14,97	3983,8	1101,33	266,1	74	3,617	89
NAMIBIA	NA	NA	NA	NA	NA	NA	-
RSA	36,19	48716,9	88035,00	1346,0	2432	0,553	14
RWANDA	6,66	1677,3	2305,47	252,0	346	0,728	92
SEYCHELLES	0,068	27,0	295,40	397,1	4344	0,091	-
SOMALIA	5,88	1068,3	1009,29	181,6	172	1,058	86
SUDAN	23,78	6399,3	11723,20	269,1	493	0,546	76
SWAZILAND	0,74	632,8	612,21	855,1	827	1,034	19
TANZANIA	24,00	12936,2	3136,99	539,0	131	4,124	96
UGANDA	16,20	5616,3	4259,43	346,8	263	1,319	94
ZAIRE	33,62	8919,5	6468,17	265,3	192	1,379	83
ZAMBIA	7,84	4146,9	3994,00	528,8	509	1,038	60
ZIMBABWE	9,26	4610,6	6323,89	498,1	683	0,799	38

** TOTAL FINAL CONSUMPTION OF ENERGY INCLUDING TRADITIONAL

toe - TONS OIL EQUIVALENT kgoe - KILOGRAMS OIL EQUIVALENT

APPENDIX B:

ENERGY INSTITUTIONS OF 13 SELECTED COUNTRIES[12]

- i ANGOLA
- ii BOTSWANA
- iii ETHIOPIA
- iv KENYA
- v LESOTHO
- vi MALAWI
- vii MOZAMBIQUE
- viii SOUTH AFRICA ... See section 4.3.2 for details.
- ix SWAZILAND
- x TANZANIA
- xi ZAIRE
- xii ZAMBIA
- xiii ZIMBABWE

i ANGOLA

Prior to 1984 there were two Ministries dealing with energy - the Energy Ministry, and the Petroleum Ministry. In 1984 these two Ministries were combined to form the Ministry of Energy and Petroleum (MEP) which now has overall control of the energy sector. The Ministry has three wings dealing with oil, electricity, and biomass fuel. Prior to 1987 the three sectors reported to separate Vice-Ministers. Since this perpetuated the split between petroleum and energy which the creation of the MEP was supposed to eliminate, this division was replaced by a horizontal division into four sections - planning, technical, legal, and human resources.

In addition to the control by the MEP, the Ministries of Finance and Planning and the Central Bank have the final say in investment decisions. However, investment planning seems to take place in a haphazard fashion and no institution seems to have total control. The Minister of Finance imposes taxes on the energy sector and oversees the operation of the foreign oil companies. The Minister of Finance also subsidizes the operation of the power utilities.

The oil company SONANGOL is the administrative arm of MEP, controlling petroleum development. Whilst SONANGOL's brief is to control all activities such as exploration, production, transport, refining, and distribution, its main role covers two main areas: the encouragement of foreign investment in oil exploration, and the control of foreign companies in exploration and the development of the country's oil resources. The Government and SONANGOL have shown a practical and businesslike attitude towards the petroleum market and they have been able to attract significant foreign participation in the development of its oil industry.

The electricity sector is divided into three utilities: the ENE (Empresa Nacional de Electricidade), SONEFE (Sociedade Nacional de Estudo e Financiamento de Empredimentos Ultamarinos), and EDEL (Empresa de Electricidade de Luanda). These utilities are separated geographically and are not electrically interconnected. Each utility works independently and there is little overall co-ordination. A separate organization, "GAMEK", has been created by MEP to supervise the construction of the Capanda power station on the Kwanza River.

The MEP wing responsible for biomass and renewable energy is the DNFRE (Department of New and Renewable Sources of Energy). The DNFRE has a small but

Several institutions are involved in the renewable energy field, namely, the Botswana Technology Centre, the Rural Development Unit of the Ministry of Finance, the Department of Water Affairs, and the Renewable Energy Technology Pilot Project. Between them these bodies are investigating the potential use of wind, solar, human, animal, and biogas power.

Public electricity supply is largely the responsibility of the Botswana Power Corporation, a parastatal organisation established in 1971 and sponsored by MMRWA. It operates a national grid and as an agent of the Government supplies power to the larger villages.

MMRWA's Department of Electrical Engineering is responsible for the supply of energy (not necessarily electrical) to Government institutions. MMRWA is also responsible for drawing up Energy Sector Plans as part of the five yearly National Development Plans of the Ministry of Finance and Development Planning.

This fragmentation in institutional responsibilities has hindered the planning and implementation of some energy programmes, especially where more than one sector are involved. A joint UNDP/World Bank report found that energy sector plans have not been detailed enough, the allocation of responsibilities in the energy sector is not clear, and details of energy supply and demand are scattered and usually unreliable.

iii ETHIOPIA

(The following is based on the situation in 1984.)
The Ministry of Mines and Energy is the lead agency in policy formation and development planning for the energy sector. The Ethiopian National Committee (ENEC) was formed by the government in 1979 in order to address the pressing problems of the energy sector in a co-ordinated manner and to assist in policy-making and the setting of priorities. ENEC operates through the Ministry of Mines and Energy as a planning secretariat reporting to the Minister. The energy parastatals and the agencies established for geothermal and petroleum exploration report to the Permanent Secretary of the Ministry or to the Minister himself. ENEC is technically comprised of the permanent heads of all these agencies plus other energy-related ministries, meeting under the chairmanship of the Minister or the Permanent Secretary.

iii.a Petroleum Sector:

The Ethiopian Petroleum Corporation (EPC) is responsible only for petroleum refining and the regulation of additional supplies through the major oil companies. The 800 000 tpy Assab refinery, owned by the Government, is operated by the EPC.

iii.a Electricity Sector:

Electricity is generated under the authority of the Ethiopian Electric Light and Power Authority (EELPA) which was formed in 1956 as an autonomous parastatal and since 1976 has been placed under the Ministry of Mines and Energy. Although EELPA maintains overall responsibility throughout the country for public electricity generation, transmission and distribution, the supply of power to the northern region is provided by its unconsolidated subsidiary, the Eritrea Region Electricity Supply Agency. Both supply regions are composed of an interconnected system and a series of satellite generation centres.

iv LESOTHO

The Ministry of Water, Energy and Mines was established by the Government in 1978. An Energy Planning Unit (EPU) was established within the Ministry of Water, Energy and Mines and is responsible for preparing and implementing an appropriate energy policy and a programme for the production, storage, distribution and use of all forms of energy including electricity. The EPU is inadequately staffed and lacks technical support.

The Lesotho Electricity Corporation (LEC) was established under the Electricity Act of 1 April, 1969 and is a parastatal body. It has received substantial technical assistance from the Electricity Board of Ireland. The LEC was seen to be performing its transmission and distribution functions efficiently and effectively by the World Bank. The LEC faces large challenges with the development of the Lesotho Highlands Water Project and will require additional expertise and manpower.

A Temporary Provision of the Forest Act of 1978 implemented the Woodlot Project under the direct supervision of the Ministry of Agriculture and Marketing. One of its major objectives was to establish a Forest Service, but by 1984 this had not been realized and the Government of Lesotho continued to rely on the management of the Woodlot Project for general forestry administration.

Five international oil majors handle the supply, storage, domestic distribution, and retailing of petroleum products. An interstate oil committee consisting of representatives from the RSA, Lesotho, Botswana and Swaziland was created in 1979 to monitor the procurement, allocation, pricing and conservation of petroleum.

v KENYA

v.a Ministry of Energy

The Ministry of Energy (MOE) was established by the government in 1979 and was to function according to the structure shown in Appendix A. Official responsibilities include:

Energy policy development
Electric power development
Oil and other fossil fuels
Exploration and exploitation of non-conventional energy sources.

v.b Electricity power supply companies

Four companies are involved with electricity supply in Kenya:

East Africa Power and Lighting Company Ltd (EAPL) is the sole distributor of electricity in the country. It is a mixed (government and private) company in which the government owns 57%. EAPL co-ordinates all sources of electricity, staffs and manages the generating companies (KPC & TRDC), and is responsible for the Upper Reservoir generating station owned by TRDA.

Kenya Power Company (KPC) is 100% government owned and operates the Uganda interconnection. It is also in charge of the development of the Olkaria geothermal field.

Tana River Development Company (TRDC) is 100% government owned and has been responsible for the development of the hydro potential of the Tana River.

Tana River Development Association (TRDA) is mainly concerned with the irrigation potential of the Tana River. It also owns the Upper Reservoir power station.

EAPL suggested that the two generating companies, KPC and TRDC, be merged to reduce costs.

vi MALAWI

Various government departments are responsible for a number of aspects of energy planning and management. The Ministry of Trade and Energy receives and analyses submissions for price increases from the oil companies and from the Electricity Supply Commission of Malawi (ESCOM), as well as acting as the main link with the oil companies over financial matters. From 1982 ESCOM, which was created under the Electricity Act of 1963 and is Malawi's sole electricity distribution company, reported to the newly formed Department of Statutory Bodies (DSB) in the Office of the President and Cabinet (OPC) for administrative, personnel, and financial affairs. The DSB hopes to extend its role to all the parastatal agencies. The Economic Planning Division (EPD) is the government's national planning, monitoring and advisory unit. The energy unit in EPD has been charged with the responsibility of forming energy policy. The monitoring of petroleum imports and organizing their distribution during periods of scarcity is carried out and supervised by the Contingency Planning Unit in OPC.

Wood and charcoal energy planning falls under the Ministry of Forestry and Natural Resources. The Forestry Department is responsible for forestry development, conservation and fuelwood pricing policy. The Ministry of Forestry and Natural Resources also has a Energy Studies Unit and Wood Energy Division located under it.

The following four oil companies organize petroleum product supply with little direct government involvement: the Oil Company of Malawi Ltd (OILCOM), Mobil, Caltex, and Total/Lonrho. OILCOM, having a 61,5% share of the market, acts as an informal industry spokesman for all four companies.

The Coal Users Committee (CUC), an association of all coal users, except for Portland Cement, organizes the importation, distribution and allocation of coal supplies.

The Energy Subcommittee of the National Research Council is involved with research and development efforts in the field of non-conventional energy.

vii MOZAMBIQUE

The economy of Mozambique has been managed through a central planning procedure. Central agencies are assigned the exclusive responsibility for the definition of policy, setting norms, and for the control of the implementation of policy. Within the framework of the Central State Plan the responsibility for the energy sector rests with the Ministry of Industry and Energy (MIE). The Ministry has two groups responsible for the main sub-sectors, petroleum and electricity. The Empresa Nacional de Petroleos de Mozambique (PETROMAC) is responsible for the petroleum sub-sector, and Electricidade de Mozambique (EDM) is responsible for the electricity sub-sector. EDM was formed in 1977 and is responsible for the generation and distribution of electricity with the exception of Cahora Bassa. Since its formation it has experienced difficulties in integrating its various components inherited from a number of small producers.

The Ministry of Mineral Resources (MMR) is also involved in the energy sector through its responsibility for oil and coal exploration. The principal operating bodies reporting to the MMR are ENH for petroleum and gas, and CARBOMOC for coal.

The Ministry of Agriculture is responsible for fuelwood matters through its Directorate of Forestry, and the Ministry of Construction and Water is responsible for the construction of capital items such as dams. Many decisions affecting the energy sector are made through the Bank of Mozambique which controls all foreign exchange and domestic credit.

The present organization as described is very fragmented and difficult to co-ordinate. In addition, there is a serious lack of trained manpower to plan or oversee decision implementation. This also results in a serious lack of adequate statistics being collected.

The Government has realized that high-level co-ordination is required and is considering the formation of a National Energy Council who would be required to formulate an energy policy for the National Council of Ministers. It is proposed that the National Energy Council should consist of the Ministers and heads of the organizations in the energy sector and of sectors which have a strong link with energy.

The MIE set up a Department of Energy in 1985 to provide technical assistance to the Minister. However, staff shortages may limit the usefulness of this body.

In addition to the Governmental agencies identified above, the Cahora Bassa Power Station is owned and operated by the Hidroelectrica de Cahora Bassa (HCB), a company owned and controlled by Portuguese interests (82%). The remaining 18% minority shareholding is held by Mozambique interests. There are also a number of small private producers of electricity, the largest being linked to a sugar mill.

viii SOUTH AFRICA - See section 4.3.2

ix SWAZILAND

The Government plays only a limited role in the energy sector, and planning is carried out in the various public institutions and private companies. Of the public agencies the ones concerned with energy are the Swaziland Electricity Board (SEB), the Geological Survey and Mines Department (GSMD), and the Forestry Department. These agencies are divided between a number of Government Departments, making co-ordination difficult and resulting in these agencies working with considerable independence. The only energy plan to have been carried out was the Energy Master Plan study which was carried out with financial support from the German Government and was completed in 1982. Arising out of this study, the Government brought most of the energy-related agencies under the control of one Ministry, that of Natural Resources, Land Utilization, and Energy. This Ministry also looks after national oil matters. It is the intention of the Government to form an Energy Branch in this Ministry.

The exploitation of coal resources is vested in the Head of State in trust for the Swazi nation. Decisions in this regard are based on the advice of a Minerals Committee which is appointed by the Head of State, but it is independent of the Government and its members usually consist of traditional leaders. Prospecting licenses issued by the State are typically for a 3-5 year period, whilst production leases are issued for 15 years. Whilst foreign investment is permitted, provision has to be made for the Swazi nation to acquire equity in the venture. The Government agency which deals with mining operations on a day-to-day basis is the GSMD.

The Swaziland Electricity Board (SEB) operates within an Electricity Act which stipulates that the SEB has authority to set tariffs subject to the condition that revenue must exceed expenditure. The SEB is also charged with the responsibility of developing and extending its area of supply, and of reducing the cost of power.

Moreover it must make available electricity to any customer within 100 yards, though customers beyond that line may be required to pay for the link to them.

The SEB is run by a Board appointed by the Minister for Natural Resources, Land Utilisation, and Energy, though most of the dealings of the Board are with the Ministry of Finance. The Minister for Natural Resources, Land Utilisation, and Energy is entitled to give general direction to the Board, though in practice the absence of a national energy plan and the lack of technical expertise in the Ministry has led to the Government being mainly concerned with the adequacy of supplies. However, recent financial problems in the SEB have led to the Government taking a more active part in the financial affairs of the SEB.

Control of the oil industry in Swaziland is concerned purely with the collection of taxes from the various oil companies. Liaison between the oil industry and the Government is handled on a rotational basis by each of the six oil companies operating in the country. Most of the imports for the country come from South Africa and the Government is associated only in the marketing exercise through its membership, together with the other countries in the South African Customs Union, of a committee which was set up after the 1970's oil crisis to co-ordinate the supply arrangements in the event of a shortage of petroleum products.

x TANZANIA

Several Ministries are responsible for energy supplies. The Ministry of Water, Energy and Minerals (MWEM) is entrusted with hydrocarbons, electricity, coal and uranium. The Ministry of Natural Resources and Tourism (MNRT) handles fuelwood, via its Forestry Directorate, and the Prime Minister's Office is involved in the development of village woodlots and village electrification.

These Ministries are responsible for overall policy formation in their sub-sectors. They present options to the Cabinet and arrange financing for large projects. They also supervise the various parastatals under their authority.

The Tanzania Electricity Supply Company (TANESCO) was founded as a private company in 1931 and procured by the Government in 1964. It is a State-owned enterprise supervised by MWEM.

The Rufiji Basin Development Authority (RUBADA) was created by the Rufiji Basin Development Authority Act of 1975 to develop the catchment area covered by the Rufiji River. Much of its activities have been concentrated on the development of hydro-electricity. The relationship between RUBADA and TANESCO has been tense and inefficient duplication of scarce technical and managerial resources has taken place.

The Tanzania Petroleum Development Corporation, supervised by MWEM, was established in 1969 under the Public Corporations Act. Its objectives are:

(a) To develop an adequate industrial base for the oil industry
(b) To explore for and develop petroleum resources
(c) To carry out the normal activities of an oil company
(d) To acquire interests in projects associated with the exploration and production of petroleum energy
(e) To hold exploration and production rights
(f) To contract for, hold equity in or participate in oil concessions, franchises and licenses
(g) To manage parastatals or other legal entities transferred to the Corporation.

An agreement between the Italian company AGIP and the Tanzania Government in 1961 to construct an oil refinery in Dar-es-Salaam resulted in the Tanzanian-Italian Petroleum Refining Company (TIPER) being incorporated in 1963. The Government acquired 50% of the shares from AGIP in 1967.

The State Mining Corporation (STAMICO) was created in 1972 to take over the mining companies which had been nationalized. STAMICO is responsible for the development and exploration of the country's mineral resources and it trades in the mineral markets on behalf of its six operating subsidiaries.

The Forestry Directorate within MNRT is responsible for the development, protection and conservation of forests. Five divisions report to the Director of Forestry who is in charge of the Forestry Directorate:

(a) Forest Industries
(b) Village Afforestation
(c) Management and Development
(d) Research and Training
(e) Survey and Inventory

The World Bank identified a lack of central co-ordination in the energy sector as well as a lack of co-ordination between the various energy agencies. The need for an institutional framework to rapidly and effectively develop Tanzanian natural gas resources was also highlighted by the World Bank. The major difficulty in solving these problems is the lack of adequately qualified and experienced staff.

xi ZAIRE

There are a number of public and semi-public agencies which affect the distribution and sale of energy. The main organization overseeing the energy programme for Zaire is the Ministry of Mines and Energy which, through its Energy Department, controls the public and parastatal bodies, and private companies in the petroleum and power industries.

The Ministry of the Environment, Nature Conservation, and Tourism controls one of the main sources of Zaire's energy namely wood.

The Ministry of Finance and Budget, and the Ministry of Economy and Industry is responsible for the pricing of petroleum and electricity prices.

Other agencies involved, or potentially involved in the energy scene are :- the Atomic Energy Commission, Ministry of Agriculture and Rural Development, Ministry of Public Works and Land Management, Ministry of Transport and Communications, Ministry of Education and Scientific Research, and the Prime Ministers Office. These agencies, together with the Executive Council, make the final decisions concerning major energy issues such as pricing and capital expenditure.

One of the problems which has been recognized in the energy scene is the lack of adequate consultation and co-operation between the various ministries. For this reason a National Energy Council was formed in 1981. However, for various reasons, the NEC has not got off the ground and one of the recommendations made by the World Bank in 1986 was that this body should be given power to carry out policy planning and to correct the many problems in the energy field.

In the Petroleum sector the main government agency is the Enterprise Petroliere du Zaire (Petrozaire) which was formed in 1978. It does not have any policy making responsibilities nor does it carry out exploration, which is the duty of the "Petroleum Technical Unit" within the ministry of Mines and Energy.

Also in the Ministry of Mines and Energy is the "Societe Nationale d'Electricite (SNEL)" which is responsible for the generation, transmission, and distribution of electricity.

The other important body in the energy sector is the National Reforestation Service (NRS) which is responsible, through the Ministry of Environment, Nature Conservation, and Tourism, for initiating reforestation programmes in those areas threatened by deforestation. Also, in the same ministry are "Service Permanent d"Inventaire et Amengement Forestier (SPIAF) which carries out an inventory of forest resources and is responsible for forest management, and the "Centre for Adaptation of Wood-Energy Techniques (CATEB) which develops techniques and equipment for wood exploitation and carbonization. These latter two organizations are joint Zaire-Canadian organizations.

xii ZAMBIA

Recognizing the need for a body which would be ultimately responsible for the co-ordination of energy supply, conservation, and pricing, the Government has created a National Energy Council (NEC). The role of the NEC is to advise the Government on the formation of appropriate energy policy by identifying energy issues which need attention, and by advising how to implement such policies.

The NEC consists of 12 part-time representatives from Government, parastatal bodies, and private and university bodies, appointed by the Minister of Power, Transport, and Communications. The NEC meets every three months and reports directly to the Minister, with the individual members also reporting to their respective agencies.

The World Bank has suggested that the NEC needs technical and economic expertise and that they should be responsible for the collation, analysis, and dissemination of statistical information, and also for liaison with the National Commission for Development Planning (NCDP) which is currently responsible for manpower planning in the country.

The Bank also recommends that the NEC should provide a five-to-ten year plan for energy, especially in the area of energy financing.

There are three organizations covering the Zambian electricity sector: the Zambian Electricity Supply Corporation (ZESCO) owned by the Government, the Copperbelt Power Company (CPC), a subsidiary of the copper mining company, and the independent Broken Hill Development Company (BHDC). A fourth organization, the Central African Power Company (CAPC), which controlled the supply of electricity from the Kariba Dam power stations has been disbanded by joint Acts of Parliament in Zimbabwe and Zambia, and now acts purely in a caretaker capacity, supervising the operation of the power stations, and with a planning function for the Zambezi River hydro-potential.

ZESCO was formed by an Act of Parliament in 1969 and was given responsibility for all electrical supply in Zambia, excluding that from Kariba. On its formation it took over the electricity supply and distribution from the various municipalities and from three utilities. On the recent disbanding of CAPC, ZESCO took over the role of distributing power from Kariba Dam, though the actual operation of the two power stations at Kariba are still under the control of what has remained of CAPC. The Copperbelt company (CPC) remained as a separate entity with its own, limited, generating capacity and now acts as a distributor of electricity to the copper mines, buying in bulk from ZESCO.

The BHDC is isolated from the ZESCO system and operates as an independent utility.

The Forestry Department of the Government (FD), situated at Ndola, has overall responsibility for managing Zambia's planted woodlots. The FD administers nine field organizations to manage the forestry provinces. Fuelwood operations, including the allocation and management of charcoal production and the licensing of operators, are managed via Provincial Forest Offices. The staff allocated to the FD is inadequate to police this activity satisfactorily and wide-scale illegal tree-felling occurs. The Forest Product Research Division is responsible for testing and demonstrating kilns.

The Ministry of Power, Trade and Commerce also has a Technical Development and Advisory Unit (TDAU) which is responsible for renewable energy development.

xiii ZIMBABWE

xiii.a General

In 1980 the Ministry of Mines was broadened to become the Ministry of Mines and Energy Resources. This however, did not work since the responsibility for energy remained fragmented. In order to be able to implement measures, which the government felt needed urgent attention, a number of energy activities were consolidated into a new Ministry of Industry and Energy Development (MIED). The energy component of the Ministry is divided into four main areas, namely, electric power, coal policies, liquid fuels, and energy research and development. The MIED suffers from a shortage of staff and technical expertise.

xiii.b Electricity

The electricity sector has suffered in the past from fragmentation of the generation and transmission sub-sectors. Thus individual municipalities, the Central African Power Corporation (CAPC) and the Electricity Supply Commission (ESC) all supplied electricity and the CAPC sold electricity to ESC who in turn sold it to individual consumers or in bulk to a municipality. In 1986 the ESC became the Zimbabwe Electricity Supply Authority (ZESA) and took over the generation of electricity both from the Kariba Dam plant previously operated by CAPC, and the power plants in Harare and Bulawayo which were previously operated by the municipalities. ZESA sells electricity directly to individual consumers.

The role of the Central African Power Corporation, formed to operate the Kariba Dam and to distribute electricity within Zimbabwe and Zambia, changed with the dissolution of the Federation and in 1987 it was reconstituted as the Zambezi River Authority by Acts of parliament in Zimbabwe and Zambia. The main function of this new Authority is to operate, monitor, and maintain the Kariba Dam complex, and to investigate the construction of new dams on the Zambezi River.

With the formation of ZESA, electricity planning has become more co-ordinated, though detailed control by the MIED means that communication channels are possibly longer and slower than they should be for best management.

xiii.c Coal

The mining of coal is controlled by the Ministry of Mines and the MIED, with the Ministry of Mines administering the Mines Act and issuing exclusive prospecting rights and special prospecting grants. The MIED is responsible for formulating and implementing policies on coal development and with integrating them with overall energy and industry policies.

Coal exploration is being carried out by private companies such as Shell, Rio Tinto, Goldfields, and Anglo-American.

The parastatal Industrial Development Corporation (IDC) is involved with some of the financial aspects of the coal industry and they are expected to play a greater role in the future.

xiii.d Petroleum

The MIED controls and formulates policy for the petroleum sector, though the Ministry for Trade and Commerce (MTC) is responsible for pricing policy. Distribution is in the hands of private enterprise consisting of Mobil, Shell, BP, Total and Caltex. An oil importing company, the National Oil Company (NOCZIM) has been formed to be responsible for oil procurement. NOCZIM arranged long term contracts with the Kuwait Petroleum Corporation for part of its demand but allowed the contract to lapse in 1988. It is rumoured that half of Zimbabwe's supply was obtained on the spot-market through a consortium led by Mobil Oil. This consortium was completely privately owned but was responsible to MIED.

xiii.e Fuelwood

Whilst there are various bodies responsible for the control of forestry, there was no institution responsible for the supply of fuelwood or charcoal. Following recommendations from the World Bank in 1982, the Government has assigned principal responsibility for reforestation and fuelwood programmes to the Forestry Commission and to the Department of Agriculture. No information is available on the effect of this delegation of responsibility.

APPENDIX C

SUMMARY OF THE ECONOMIES OF 13 SELECTED COUNTRIES[12]

i ANGOLA
ii BOTSWANA
iii ETHIOPIA
iv KENYA
v LESOTHO
vi MALAWI
vii MOZAMBIQUE
viii SOUTH AFRICA ... See section 4.2 for details.
ix SWAZILAND
x TANZANIA
xi ZAIRE
xii ZAMBIA
xiii ZIMBABWE

i ANGOLA

Angola is potentially one of the richest countries in Africa. It has large reserves of oil and hydro-electricity, is thought to possess substantial geological reserves, including diamonds and iron ore, and has plentiful agricultural land. The economy grew rapidly in the late 1960's. By the time of independence Angola was the fourth largest exporter of coffee in the world, the fourth largest producer of diamonds, a substantial exporter of iron ore, and a net exporter of agricultural products. At that time it had a large fishing fleet, a growing manufacturing sector, and was an exporter of oil. The infrastructure was adequate, with railway lines from Luanda to Malanje, from Namibe on the coast to Menonque in the south of the country, and the Benguela railway from Lobito through to Shaba Province in Zaire and on into Zambia.

Since 1975, however, the economy has suffered severe setbacks. The first setback was the exodus of the skilled expatriates ahead of independence, leaving industrial and commercial activities paralyzed. In addition, the constant war for 15 years has disrupted agricultural activities and the transport sector. For example, the Benguela railway has completely stopped. In addition, the government has had to divert money and skills to the war effort.

The one economic area which has done very well over the last 15 years is the oil industry which has continued to expand. In 1987 oil exports accounted for 93% of export earnings and for approximately 52% of GDP. Oil revenue was however severely cut from late in 1985 because of the dramatic fall in oil prices on the world market. A partial recovery in the oil price since then, together with an increased production volume, is helping to ease the economic crisis.

Manufacturing capacity has been seriously depleted since the colonial days, but even the available production capacity is not being utilized. Thus food processing plant is running at around 40% capacity, the chemical industry is running at 10% of capacity, and tobacco and textile plant is running below 25% capacity. The construction industry is also running below capacity mainly due to the acute shortage of building material with the shortage of cement being at one time the most serious. However, the recent refurbishing of the Cimangola cement works in Luanda has allowed exports of cement to be resumed.

Table C.1 shows GDP at market prices over the period 1982 - 1988. The Gross Domestic Product has continued to grow in current terms. The GDP grew rapidly towards the end of the colonial period, with the real GDP growing by 7,8% during the period 1960-1974. However, with the production decline described above, the real GDP has fallen to pre-1975 levels.

Table C.1 GDP at market prices (National Currency)

	Kwanza - billion		Growth
	Current	Real(1985)	% p.a.
1982	110,1	127,3	
1983	125,6	139,3	9,4
1984	140,5	150,8	8,2
1985	143,0	143,0	-5,1
1986	130,1	122,5	-14,4
1987	148,2	-	
1988	161,8	-	

With the decline in the export of coffee and diamonds, and the cessation of iron ore production, Angola is overwhelmingly dependent on oil exports to raise foreign exchange. For instance, during 1989 90,2% of foreign exchange was earned by oil.

The abandonment of hundreds of commercial and industrial organizations during the expatriate exodus led the government to bring them under State control. A nationalization act in 1976 brought all the abandoned businesses, and those businesses which were deemed to be of national importance, or those whose management was deemed to be practicing "economic sabotage", under the direct control of the government. Banks and the shareholdings of Portuguese nationals were also nationalized. Non-Portuguese foreign investment was excluded from this nationalization and in 1979 a law was enacted to encourage foreign investment. This has attracted capital to the oil industry where investment is controlled by a separate Petroleum Act.

A law enacted in 1982 envisaged a centralized planning system under which each sector and each State corporation would receive precise production targets. In addition, a strict import control system was introduced in order to conserve foreign exchange, a measure which was to result in serious supply problems. A series of emergency plans have been adopted since then on a yearly basis, in which the production targets have been steadily reduced. In December 1985 the government committed itself to a more liberalized economy, including a shift away from State farms, the privatisation of much of the retail and wholesale trade sectors, increased autonomy for state enterprises, and decentralization.

The implementation of these measures has however been slow and in 1987 President dos Santos announced the SEF (Saneamento Economico e Financeiro). This was a plan for economic and financial restructuring. So far the steps to implement this have been slow. The reason for this has been preoccupation with the war effort and the shortage of economists able to translate the principles of the SEF into working details. The ending of the war would permit more time and funding for the restructuring of the economy, but with the serious shortage of skilled personnel and professional people, the recovery will be slow.

ii BOTSWANA

Two-thirds of Botswana's land is unsuitable for arable farming. Droughts occur frequently, often in successive years. At the time of independence (1966) Botswana was one of the twenty poorest countries in the world, with minimal infrastructure development and a predominantly subsistent economy.

However, by the 1980's Botswana's economy was performing better than most of the non-petroleum producing African countries. This can be partially attributed to the rapid expansion of the beef sector, but mainly due to the discovery and exploitation of valuable mineral resources, especially diamonds. This has not only transformed Botswana's export base, but has also funded and stimulated the development of its infrastructure and the manufacturing sector, as well as social services.

Agriculture's contribution to GDP dropped from 40% in 1966 to 3% in 1988/89. This decline was accelerated by the period of drought from 1981 to 1987. The contribution by mining increased from 0% to 51% over the same period. A temporary drop in sales and the subsequent stockpiling of diamonds in 1981/82 caused a temporary decrease in the contribution of mining to GDP. The manufacturing sector, although having grown in absolute terms, has remained relatively small, contributing only 4,2% to GDP in 1988/89.

Current GDP has displayed an exponential growth since independence. There was a reduction in GDP growth in 1981/82 as a result of the temporary depression in the mining sector. This emphasizes the fact that the economic growth has been based on the narrow foundation of mineral mining, especially diamonds.

Real GDP has shown overall a steady growth with an average yearly growth rate of 7% from 1960/61 to 1969/1970, 16% from 1970/71 to 1979/80 and 11% from 1980/81 to 1988/89. The negative growth in GDP in 1974/75 and 1981/82 was due to the post oil-crises slump and reduced world demand for diamonds respectively.

Real GDP has been keeping ahead of population growth in general terms. Real GDP per capita in 1985 prices has increased from 443 Pula in 1970/71 to 1779 Pula in 1987/88. The GDP per capita in US dollars is high by African standards. In 1987/88 the GDP per capita was US$ 1546.

However, more than 80 percent of the population remain dependent on the traditional agricultural based economy, largely outside the cash economy, in contrast to the emerging modern sector which is based on the capital intensive mining sector. The ever existing possibility of drought poses a major problem to the Government and is the underlying cause of the growing rural exodus and the associated rising urban unemployment.

Concern has been expressed that the growth in GDP in the late 1980's was greatly assisted by a rapid increase in Government expenditure which cannot be sustained indefinitely. However the Government endeavours to encourage the development of the manufacturing and tourism sectors to stimulate future growth.

The economy of Botswana is linked closely to that of South Africa. Almost all modern sector investment capital has been supplied from companies based in the RSA. Botswana is a member of the South African Customs Union, together with Lesotho and Swaziland. Eighty percent of imports are routed through the RSA and all commodity exports are made through the RSA. Botswana is also a member of SADCC which is forming strategies to reduce Botswana's dependence on the RSA.

iii ETHIOPIA

In 1988 Ethiopia had a GDP of 11 539 million Birr or 5 574 million US$. This equates to a per capita GDP of 120 US$ which makes Ethiopia one of the poorest countries in the world. Agriculture is the main occupation and source of income of the majority of the population. Agriculture provides some 80% of exports and engages 75% of the working population. Ethiopia's predominantly agricultural economy has felt the impact of land reforms, nationalization, a series of secessionist wars, as well as renewed drought and the external strains of world recession and declining terms of trade.

The droughts which began in 1972/73 and 1984 had a detrimental effecton the economy. The ongoing drought in the country, coupled with a high population growth rate, has also resulted in a high mortality rate both of humans and of livestock and the vegetation cover has suffered a long-term setback.

Ethiopia has a relatively small industrial sector with over 90% by value under public ownership. Its relative contribution to GDP was 14,3% in 1968, rising to 15,4% in 1988. This increase in share of contribution to GDP was mainly due to the poor performance of the agricultural sector during the drought. The industrial sector continues to encounter major problems as a result of the lack of new investments, raw materials, spare parts, and problems with staffing and management.

There was negative growth in real and current GDP in 1984 and 1985 which can be directly attributed to the impact of the worsening drought. Improved rains in 1985/86 resulted in a recovery in GDP growth. During the period 1974-1988 yearly real GDP growth rates averaged 2,3% which is below the population growth rate for the same period. This has resulted in a general decline in real GDP per capita since 1973.

iv KENYA

In 1988 Kenya had a GDP of 152 680 million Kenya shillings or 8 602 million US$. This equates to a per capita GDP of 370 US dollars.

Agriculture is the main occupation and source of income of the majority of the population, although the service and manufacturing sectors are more important than would be expected of a country with Kenya's income levels, due mainly to the early presence in Kenya of a large number of non-African settlers.

Kenya's growth of output in the 15 years after independence placed it amongst the most successful of African developing countries. Although GDP in current terms has been increasing exponentially, in real terms the growth has been slower. Over the period 1972-1983 real GDP grew at an average annual rate of 5%. In the early 1980's indications of a weakening in the once booming economy became increasingly apparent. This was exacerbated by a severe drought in 1984 and real GDP growth averaged 2,4% over the period 1980-1984. However, improved rainfalls and favourable coffee prices saw real GDP growth rates exceeding 5% in the following 4 years.

Although real GDP growth has been positive over the past two decades, it has not been able to keep pace with population growth. A weakening of the Kenya shilling against the US dollar has resulted in an average yearly growth in GDP per capita in US dollars of -1,4% over the period 1980-1988. Since 1986 GDP per capita in US$ has been increasing by an average of 5% per year but is still below the value for 1979. The overall trend is a very slow movement of the economy away from agriculture towards industry.

v LESOTHO

Lesotho, one of the smallest countries in Africa, is located entirely within the borders of the RSA. Most of the 30 350 km^2 of land is mountainous, and only 13% of the land is capable of cultivation. It has few natural resources other than diamonds and the hydro-electric potential of its rivers, and it is a member of Africa's 27 least developed countries (LDC's). The economic predicament of Lesotho is aggravated by its landlocked geographical situation and its excessive economic dependence on the RSA. Lesotho is a member of the Southern African Customs Union (SACU).

The main sources of national income are remittances by migrants working in the RSA mines, revenue from SACU, and the construction and services sectors which have been encouraged by injections of foreign aid. The economy is being transformed by the Lesotho Highlands Water Project, the construction of the necessary infrastructure having begun in 1988.

In 1989 Lesotho had an estimated GDP of 1099,7 million Lesotho Maloti (LSM), or 420,4 million US$, and a GNP of LSM 2027,4 million. GDP's contribution to GNP has decreased from 81% in 1967 to just 54% in 1989. The difference between GDP and GNP is largely made up of remittances from migrant workers in the RSA. Remittances of mine wages from workers in the RSA have increased from 20% of GNP in 1970 to 54% of GNP in 1984.

Current GDP has shown an exponential growth over the period 1960 to 1989. Real GDP has shown an overall upward trend over the same period, although it declined significantly in 1975. There was also a lack of growth of real GDP from 1980 to 1983, due to a period of drought and the closure of the Letseng diamond mine. The average annual growth rate for this period was -1%. The emergence from the drought in 1984 saw GDP increase by 8,2% over the previous year. The average yearly real GDP growth rate over the period 1984 to 1987 was 4,1%, although the GDP for 1987 was only 1% higher than that of 1986.

GDP per capita in real terms displayed an upward trend until 1980, after which the effect of the drought and closure of the diamond mine caused a decline. This decline was halted after the end of the drought in 1984 and subsequently GDP has barely managed to keep pace with population growth.

Agriculture has declined as a percentage of GDP from 32,9% in 1967 to 15% in 1989. Conversely, the manufacturing sector's share has increased from 3,2% to 11,2%. The rise in the share of construction in total GDP from 8,9% in 1986 to 13,9% in 1989 can be attributed to the construction of the infrastructure required for the Lesotho Highlands Water Project. There was a sharp decline in the mining sector in 1983 followed the closing of the Letseng diamond mine.

vi MALAWI

Malawi is still, in terms of average income, among the poorest countries in the world. In 1988 it had a GDP of US$ 1 387 million (3552 million Kwacha), which translates to US$ 179 per capita. However, since independence Malawi has been one of Africa's more notable development successes despite its landlocked position, lack of mineral resources, shortage of skilled labour, a population which is almost entirely rural, subsistence agriculture, and relatively inefficient and unstable access routes.

The period from independence to 1969 was initially one of strong growth due to independence euphoria followed by limited growth with low levels of public and private investment. The period 1970-1978 saw a healthy growth in the GDP with a sharp rise in investments supported by favourable government policy and an influx of foreign aid and capital. On a per capita basis real GDP also grew during this period. However, this internal growth was paralleled by a poor external performance of the economy and growing foreign exchange problems. A worsening in the political and security situation in the region also began to have an effect. The above, together with increasing problems in using Mozambique ports, the drought of 1979/81, and the sharp decline in foreign aid and resources from 1979 to 1981, resulted in a real GDP decrease in 1981 which only regained 1980 levels in 1983. Meanwhile real GDP per capita declined rapidly from 1979 to 1981 and has since remained virtually constant.

In 1981 the Government together with the International Monetary Fund and the World Bank initiated a programme of reform. This together with the good rains of 1982 resulted in a growth in real GDP. However, this growth barely kept up with the population growth, and real GDP per capita has remained almost constant since 1982. There has been a rapid decline in GDP per capita (US$) since 1980 ass a result of the rapid slide in the exchange rate due to the poor performance of the economy externally.

The breakdown in the contribution of the various sectors to the national economy is shown in Table C.1.

Table C.1. Sectorial contribution to GDP (%)

	1981	1988
Agriculture,	36,1	36,5
of which smallholding	29,2	28,3
estate	6,9	8,3
Manufacture	12,7	12,2
Electricity & Water	2,0	2,1
Construction	5,0	3,7
Distribution	13,4	11,7
Transport & Communication	6,7	5,7
Financial & Professional Services	6,6	6,2
Ownership of Dwellings	4,4	4,2
Social & Community Services	4,2	4,4
Government Services	11,5	15,6
Unallocatable Financial Charges	-2,6	-2,5

vii MOZAMBIQUE

The gross domestic product (GDP) in real terms has been falling since 1980. Real GDP/capita decreased rapidly in the same period indicating that there has been a substantial decrease in personal wealth. The largest contribution to GDP has been agriculture which provides over 40% of GDP. The manufacturing sector has been declining in terms of GDP contribution.

Though Mozambique has good resources of minerals and agriculture and has more development potential than many other African countries, the almost continuous war has so severely damaged the economy that by 1985 the country was on the verge of economic collapse. A contributory factor to the poor economy has been the lack of trained technical and managerial staff, a factor exacerbated by the exodus of many Portuguese nationals following independence. There is some sign of recovery, with a positive growth rate in 1987.

The exchange rate was kept low for a long time in order to make the economy look better than it was. However following pressure from various external organizations, the Metical was devalued from 40 to the US dollar in 1986 to 286 to the dollar in 1987.

viii SOUTH AFRICA

See section 4.2 for details.

ix SWAZILAND

Although Swaziland is the second smallest State in mainland Africa, it has one of the highest per capita incomes and has a well developed economy. Exports of goods and services are equivelent to 75% of GDP, whilst imports are equivelent to around 80% of GDP. Its Gross Domestic Product (GDP) has been increasing, in real terms, although the GDP per capita has been approximately constant over the last 12 years. The economic downturn during the 1980's resulted in a decrease of real GDP growth from 6% in 1978-1980 to 2,4% in 1980-1983, but recovered to 5,7% in the period 1985-1987.

Agriculture is the main component of the economy, contributing 20% to GDP and employing three-quarters of the working population. Sugar is the dominant agricultural export crop providing, in 1988, 30% of export earnings. Other crops include maize, citrus, pineapples, and forestry products.

The contribution of mining and quarrying to the GDP has been declining from around 10% in the 1960's to 2,6% in 1986. However, it is the third largest source of export earnings, and exports of coal, gold, and asbestos provided about 6% of export earnings in 1987.

The contribution of then various sectors to GDP at market cost is shown in Table C.2 for 1984.

Table C.2: Sectorial contribution to GDP in 1984

Sector	Percent Contribution
Agriculture	20,0
Mining & quarrying	2,1
Manufacturing	16,6
Electricity, water	1,6
Construction	4,1
Services	55,6

The manufacturing sector is the second most important contributor to the GDP. The majority of Swaziland's manufacturing activity is based at the Matsapa industrial estate.

x TANZANIA

The Tanzanian leadership officially put the country on a course of 'socialism and self-reliance' in 1967. The Government then proceeded to extend the State's role to all spheres of the economy and proceeded to nationalize the banking and insurance systems and large trading companies were appropriated. The industrial sector became dominated by mixed companies in which the Government had a majority shareholding. Some companies are owned outright and controlled by the National Development Corporation. Importing was confined to State trading companies.

However, several years of severe economic decline since the late 1970's brought the country to a condition of economic collapse and, in order to secure extended aid specifically from the IMF, in the mid-1980's the Government adopted measures to redress the economy.

The poor performance of Tanzania's economy in the 1980's is largely the result of the second oil price shock of the 1970's, the subsequent world recession, and the consequent deterioration of the prices of major export commodities. This was compounded by the financial burden of the Ugandan war, repeated droughts, the breakup of the East African Community in 1977, and the disruptive effects of the Ujamaa Villagisation Programme.

This led to an acute shortage of foreign exchange and by 1982 the balance of payments problem was so desperate that President Nyerere suspended all development projects. In June 1982 a Structural Adjustment Programme (SAP) prepared jointly by the Ministry of Planning and Economic Affairs and the World Bank was announced. The World Bank loan in support of the SAP was conditional on agreement being reached with the IMF. After the Government's economic reform programme was implemented, agreement was finally reached with the IMF in 1986.

The subsequent economic recovery has been constrained by the inability of the export base to generate sufficient foreign exchange. However, the export base is highly import-dependent and this has resulted in a vicious circle of low production and industrial capacity, and insufficient foreign exchange generation.

In 1988 the gross domestic product (GDP) was estimated at 311 478 million Tanzania Shillings (TS) or US$ 3 137 million. This equates to US$ 130 in per capita terms. GDP in real terms showed a steady growth until the mid 1970's, after which growth tapered off. From 1977 to 1985/6 the economy stagnated and was revived only in 1986/87 with the injection of aid from the World Bank and the IMF as well as by Government economic reform. This growth was also helped by improved coffee prices and favourable weather. From 1967 to 1976 the average yearly real GDP growth rate was 4,5%. The growth rate decreased to 1% from 1978 to 1984 and averaged 2,5% over the period 1985-1988.

GDP per capita reached a peak of TS 6 712 in 1975, after which it declined steadily until 1985. Subsequently GDP growth has just kept pace with population growth. In 1988 GDP per capita was TS 5 453. GDP per capita in $US has decreased rapidly from $US 317 in 1985 to $US 130 in 1988 mainly due to the devaluation of the Tanzania Shilling by the Government as part of its economic reforms.

Agriculture's contribution to GDP reached a low of 34% in 1974 at the height of the drought and has since increased to 53,7% in 1987 and 57,2% in 1988. Conversely, industry's contribution has declined from 16,9 % in 1977 to 6,9% in 1987 and 6,5% in 1988. This can mostly be attributed to the lack of foreign exchange and the related low productivity and industrial capacity. The economy is swinging increasingly towards agriculture as a result of the lack of foreign exchange as well as successive increases in producer prices since 1983 as a result of the economic reform programme.

xi ZAIRE

During the colonial days Zaire was considered a provider of minerals for industry in Belgium. The mining sector was dominated by Union Miniere du Haut Katanga. With independence came the nationalization of Union Miniere and the creation of the State owned Gecamines to replace it. All foreign owned businesses were also nationalized. At this time a number of large prestigious projects were started by the state, such as the Inga hydroelectric plant, the Maluku metallurgical plant, and the Sozar oil refinery. These projects were an attempt to transform the economy from an agricultural, and single mineral (copper) economy into a modern industrial economy.

Loans to pay for the governments projects were obtained from the developed countries who saw the tremendous mineral wealth of Zaire as sufficient collateral. However, the catastrophic drop in the price of copper, compounded by the lack of fiscal discipline has led to a serious deterioration in the economy, and Zaire is now the ninth poorest country in the world.

Since 1980 there has been a general liberalization of the economy and a return of the nationalized smaller industries to private hands. A further liberalization move was instituted for the 1987-1990 period aimed at the encouragement of private industry, and to decentralize economic activity. World Bank loans have been obtained aimed mainly at the stimulation of the private sector. Public investment during this period is aimed mainly at the transport (39%), mining (35%), electricity (18%), and agricultural (14%) sectors.

Agriculture in Zaire has tremendous potential but has performed badly in the past because of lack of adequate infrastructure, and because of inadequate planning and pricing policies. Crop exports are mainly concentrated on sugar and coffee though various vegetable oils are also produced. Timber is an increasingly important export commodity.

The main export commodity is minerals which account for some 65% of export earnings. The principal minerals are cobalt, copper, diamonds, and zinc. The mining giant is Gecamines which produces all the cobalt, zinc, and coal. In 1990 Gecamines will, with the take-over of Sodzima, become the only producer of copper.

The contribution of the various sectors to GDP in Zaire is given in Table C.3.

The current GNP of the country has been increasing rapidly during the last twenty years, but this has been associated with a very high inflation rate especially in the mid 1980's. The result has been a steady decline in real GDP per capita until 1985 after which there appears to be the beginning of a reversal in the trend.

The major turning point in the economy came in 1983 when the Government introduced a series of stabilization and reform measures including the devaluation of the Zaire currency by 78%, the decontrol of prices, the liberalization of exchange rates and trade systems, and tighter control of expenditure.

In 1988 the Government realized that its economic policies were still not having the desired effect and introduced a series of austerity measures. Real growth in GDP is expected to be 3,3% in 1989 compared to 2,7% in 1987 and 2,5% in 1988.

Table C.3: Sectorial contribution to GDP in Zaire (1982). (Reference 9)

Sector	US $ Million	Percent
Agriculture	1943	35,7
Mining & Metal Processing	624	11,5
Manufacturing	124	2,3
Construction	328	6,0
Electricity, gas, water	2	0,0
Government services	504	9,3
Non-government services	1740	32,0
GDP at factor cost	5265	96,8
Indirect taxes	175	3,2
GDP at market price	5440	100,0

xii ZAMBIA

In the immediate post-independence period, the economy of Zambia was buoyant with high, and rising levels of the world copper price, providing a sound base for government revenue and expenditure. Large investments were made in physical and social infrastructure. During this time much of the foreign-dominated private sector, including mining, was nationalized and import-replacement enterprises were instituted.

However, in 1975 the long period of high copper prices came to an end due to excess world capacity. The price of copper fell from 45 US cents per kilogram in 1974 to around 35 US cents in 1975. This led to a deficit on balance of payments. At that time it was thought that this fall was only of a temporary nature and the Government financed the deficit out of additional foreign borrowings. The contribution of copper exports to the Gross Domestic Product (GDP) fell from 33% to 15%. At the same time agricultural exports declined to zero.

The rising cost of oil in the 1970's added to the financial problems of the country. Extreme shortages of many goods occurred, leading to high inflation rates and a "black market" in foreign currency. The Government reacted by imposing price control and subsidies on basic commodities.

Conditions continued to deteriorate until negotiations with the World Bank in 1984 led to a range of measures including the exchange rate devaluation of the Kwacha by 60%, reductions in government spending, a cut in subsidies, and the rescheduling of foreign debts.

Whilst the GDP has been rising rapidly in current terms, the GDP in real terms has been largely stagnant over the last 15 years. However, with an increasing population, the per capita GDP has been decreasing steadily.

The wealth of the country until around 1975 was based largely on the mining industry. The dramatic decrease in the price of copper in the mid-1970's and the poor response of the agricultural sector to possible export potential has led to the steadily worsening economic situation. To add to the country's economic problems, current estimates suggest that copper reserves will be largely exhausted by the end of the century.

The breakdown of the contribution of the various sectors to the national economy is shown in Table C.4.

Table C.4. Contribution to the GDP by various sectors - 1988

Sector	Percent of GDP
Agriculture, forestry & fishing	18,0
Mining & quarrying	8,7
Manufacturing	22,0
Electricity, gas & water	3,0
Construction	3,4
Trade, hotels & restaurants	10,5
Transport & communications	5,1
Financial institutions & insurance	2,6
Real estate & business services	8,8
Community, social & personal services	17,3
GDP at producer values	100,0

xiii ZIMBABWE

Zimbabwe has a diversified economy which is rapidly changing from an agricultural economy to an industrial one. The industrial sector's contribution to GDP has increased from 34% of the total GDP in 1967 to approximately 43% in 1987, whilst the agricultural sector has decreased from 20% to 11%. During this period the economy in terms of GDP per capita, has remained fairly constant in real terms.

During the Post-Unilateral Declaration of Independence (UDI) days, after 1965, the economy grew rapidly as the government was forced to diversify the economy and the pressure was to manufacture locally. In the period 1967 to 1974 growth in real GDP was positive and running at over 5% per annum. In fact in 1970 growth was an exceptional 22% per annum. However, by 1975 the cost of the internal war coupled with international sanctions had resulted in a deterioration of the economy and growth became negative. The result of independence following the Lancaster House agreement, coupled with good rains and the lifting of sanctions, resulted in an increase in the economy with growth becoming positive and running at 10% p.a. However, this improvement was short-lived and two years later the economy again exhibited a negative growth rate and has been running at around 2% p.a since then. The national economic development plan formulated in 1981 expected an annual real growth of 8% from 1982 to 1985, with a large investment and private capital inflow of Z$176 million annually. However, the world economic situation, years of drought and the conflicts in Matabeleland and Mozambique, together with inadequate planning, resulted in the growth rate being much lower than planned, with real growth only just above zero. The next planning period from 1986 to 1990 called for a more realistic growth of 5,1%. In 1985 the growth was 5,3% and it is estimated that growth was 4% in 1989.

Over the 1984-1988 period the main growth in the economy has been in the area of electricity & water (16,0% p.a), agriculture (7,6% p.a), and manufacturing (3,1% p.a).

The sectorial contribution to GDP in 1988 is shown in Table C.5.

Zimbabwe is generally self-sufficient in food and during average rainfall years is able to export. Agricultural exports include meat, maize, tobacco, cotton, and sugar. In drought years maize has to be imported; 200 000 tons had to be imported in 1984 for instance. Tobacco was the most significant crop before UDI amounting to 73% of agricultural sales. This has dropped and in 1988 accounted for only 34%. However, Zimbabwe is still the third largest exporter with about 15% of the world market.

Table C.5: Sectorial contribution to GDP - 1988

Sector	Z$ Million	%
Agriculture & forestry	1283	15,5
Mining & quarrying	529	6,4
Manufacturing	1441	26,5
Construction	168	2,0
Electricity & water	374	4,5
Transport & communications	423	5,1
Distribution, hotels, etc.	1032	12,4
Finance & real estate	537	6,5
Public administration	616	7,4
Services & other	1136	13,7
GDP at factor cost	8295	100

Mining was the reason for the development of the country's economy and is still the largest foreign currency earner. Over 90% of production is exported and in 1988 export earnings rose by 20,9%. The main earners are gold, coal, asbestos, and nickel.

Although President Mugabe called for a Marxist-Leninist single party state at a congress at the end of 1989, this has not materialized. Consultations with the World Bank have resulted in an approach to a liberalization of trade. It is likely therefore that the de facto capitalist economic system will remain, even though land reforms may lead to land redistribution.

A decreased GDP growth rate and increased inflation are seen for the near term, but the prospects for improved economic growth in the future are good.

APPENDIX D:

ECONOMIC DATA FOR 13 SELECTED COUNTRIES[12]

- i ANGOLA
- ii BOTSWANA
- iii ETHIOPIA
- iv KENYA
- v LESOTHO
- vi MALAWI
- vii MOZAMBIQUE
- viii SOUTH AFRICA
- ix SWAZILAND
- x TANZANIA
- xi ZAIRE
- xii ZAMBIA
- xiii ZIMBABWE

Table D.1: ANGOLA

GDP at market prices (National Currency)

	Kwanza - billion Current	Kwanza - billion Real(1985)	Growth % p.a.
1982	110,1	127,3	
1983	125,6	139,3	9,4
1984	140,5	150,8	8,2
1985	143,0	143,0	-5,1
1986	130,1	122,5	-14,4
1987	148,2	-	
1988	161,8	-	

Table D.2: BOTSWANA

ECONOMIC DATA (MILLIONS OF NATIONAL CURRENCY UNLESS INDICATED)

YEAR	POPULATION MILLIONS	GROSS DOMESTIC PRODUCT AT MARKET PRICES LESOTHO MALOTI: AGRICULTURE	INDUSTRY: TOTAL INDUSTRY	INDUSTRY: MINING QUARRY	INDUSTRY: MANUFACTURE	INDUSTRY: ELEC, WTR GAS	INDUSTRY: CONSTRUC	OTHER SERVICES	TOTAL	GDP DEFLATOR	GDP AT 1985 MARKET PRICES	GDP/CAPITA CURRENT	GDP/CAPITA REAL 1985	EXCHANGE RATE MALOTI PER US$ DOLLAR	GDP IN US$(MILL) CURRENT MARKET PRICES	GDP IN US$(MILL) AT 1985 MARKET PRICES	GDP PER CAPITA US$/CAPITA	GDP PER CAPITA US$(1985)/CAPITA
1960	0,51	NA	NA	NA	NA	NA	NA	NA	23,6	20,2	116,8	46,27	229,08	0,71	33,05	163,6	64,81	320,84
1961	0,51	NA	NA	NA	NA	NA	NA	NA	25,5	20,3	125,6	50,00	246,31	0,71	35,71	175,9	70,03	344,97
1962	0,51	NA	NA	NA	NA	NA	NA	NA	27,5	20,5	134,1	53,92	263,03	0,71	38,52	187,9	75,52	368,39
1963	0,52	NA	NA	NA	NA	NA	NA	NA	29,6	21,0	141,0	56,92	271,06	0,71	41,46	197,4	79,72	379,64
1964	0,52	NA	NA	NA	NA	NA	NA	NA	34,4	21,5	160,0	66,15	307,69	0,71	48,18	224,1	92,65	430,94
1965	0,52	NA	NA	NA	NA	NA	NA	NA	32,8	21,7	151,2	63,08	290,68	0,71	45,94	211,7	88,34	407,11
1966	0,54	NA	NA	NA	NA	NA	NA	NA	36,8	22,8	161,4	68,15	298,90	0,71	51,54	226,1	95,45	418,62
1967	0,55	16,4	6,0	NA	NA	NA	NA	17,9	40,3	24,5	164,5	73,27	299,07	0,71	56,44	230,4	102,62	418,87
1968	0,57	18,3	6,6	NA	NA	NA	NA	18,9	43,8	24,9	175,9	77,52	311,33	0,71	61,34	246,4	108,57	436,04
1969	0,58	23,2	5,2	NA	NA	NA	NA	22,8	51,2	25,3	202,4	88,28	348,92	0,71	71,71	283,4	123,64	488,68
1970	0,59	19,8	16,5	NA	NA	NA	NA	23,6	59,9	26,4	226,9	100,84	381,98	0,71	83,89	317,8	141,23	534,98
1971	0,61	25,7	21,5	NA	NA	NA	NA	30,8	78,0	28,8	270,8	127,87	443,99	0,72	109,09	378,8	178,84	620,96
1972	0,66	34,2	28,6	13,0	5,7	1,4	8,5	40,8	103,6	29,1	356,0	157,93	542,70	0,77	134,90	463,6	205,63	706,65
1973	0,68	49,7	41,6	18,7	7,2	2,4	13,3	59,3	150,6	30,6	492,2	221,47	723,76	0,69	217,63	711,2	320,04	1045,90
1974	0,70	62,4	49,5	16,0	10,1	3,3	20,1	73,0	184,9	34,4	537,5	264,90	770,06	0,71	258,96	752,8	371,01	1078,51
1975	0,74	61,2	60,5	18,0	15,5	6,9	20,1	86,8	208,5	39,4	529,2	283,67	719,98	0,73	285,23	723,9	388,06	984,93
1976	0,74	65,7	84,4	33,6	20,9	11,1	18,8	119,7	269,8	44,1	611,8	364,10	825,63	0,87	310,11	703,2	418,51	949,00
1977	0,77	74,4	91,8	42,0	25,3	9,2	15,3	144,6	310,8	49,6	626,6	404,69	815,90	0,84	370,00	746,0	481,77	971,31
1978	0,80	71,7	107,4	55,8	24,4	10,1	17,1	175,1	354,2	47,9	739,5	444,97	928,97	0,83	427,78	893,1	537,41	1121,94
1979	0,87	78,1	193,1	117,4	42,8	11,5	21,4	233,0	504,2	61,2	823,9	581,55	950,24	0,82	618,65	1010,9	713,55	1165,94
1980	0,91	83,3	291,3	210,7	29,2	15,0	36,4	334,9	709,5	73,0	971,9	782,25	1071,57	0,78	913,13	1250,9	1006,76	1379,12
1981	0,94	90,5	310,7	203,8	49,3	19,3	38,3	389,0	790,2	74,7	1057,8	840,64	1125,35	0,83	948,62	1269,9	1009,17	1350,96
1982	0,98	87,8	270,7	130,1	71,2	21,8	47,6	434,4	792,9	76,8	1032,4	809,08	1053,49	1,02	776,59	1011,2	792,44	1031,82
1983	1,01	77,2	440,4	287,0	78,7	29,7	45,0	532,1	1049,7	82,0	1280,1	1039,31	1267,45	1,10	957,76	1168,0	948,27	1156,43
1984	1,05	76,1	590,7	405,9	82,0	32,3	70,5	635,3	1302,1	84,8	1535,5	1240,10	1462,38	1,28	1014,10	1195,9	965,81	1138,92
1985	1,09	82,9	814,2	618,5	88,0	42,9	64,8	763,6	1660,7	100,0	1660,7	1523,58	1523,58	1,89	879,61	879,6	806,98	806,98
1986	1,13	94,0	1183,3	938,5	125,9	57,7	61,2	958,0	2235,3	124,7	1792,5	1978,14	1586,32	1,87	1196,82	959,8	1059,13	849,34
1987	1,17	107,0	1405,6	1089,7	161,9	72,2	81,8	1134,9	2647,5	134,0	1975,7	2262,82	1688,67	1,68	1577,77	1177,4	1348,52	1006,36
1988	1,21	136,2	1836,9	1478,5	166,8	81,2	110,4	1424,8	3397,9	157,8	2153,3	2808,18	1779,58	1,82	1871,09	1185,7	1546,36	979,95
1989	1,26	149,1	3010,0	2542,1	209,4	92,9	165,6	1828,8	4987,9	204,1	2443,9	3958,65	1939,56	2,01	2481,54	1215,8	1969,48	964,96
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D.3: ETHIOPIA

ECONOMIC STATISTICS

YEAR	POPULATION MILLIONS	GROSS DOMESTIC PRODUCT AT MARKET COST							GDP AT MARKET COST	GDP DEFLATOR	GDP AT 1985 MARKET PRICES	GDP/CAPITA		EXCHANGE RATE BIRR PER US$	GDP IN US$(MILL) CURRENT MARKET PRICES MILLIONS	GDP PER CAPITA US$ PER CAPITA
		AGRICUL-TURE	INDUSTRY					OTHER SERVICES				CURRENT	REAL 1985			
			TOTAL INDUSTRY	MINING QUARR	MANUFAC-TURE	ELEC,WTR, GAS	CONSTRUCT									
1968	27.47	2011	548	NA	NA	NA	NA	1278	3837	55.84	6871.72	139.69	250.18	2.50	1534.80	55.88
1969	28.19	2120	588	NA	337	NA	NA	1348	4056	57.11	7102.51	143.87	251.92	2.50	1622.40	57.55
1970	28.94	2327	602	NA	372	NA	NA	1532	4461	58.97	7565.14	154.16	261.43	2.50	1784.40	61.66
1972	30.44	2286	707	NA	440	NA	NA	1751	4744	57.36	8270.51	155.83	271.66	2.30	2062.61	67.75
1973	31.25	2331	748	NA	464	NA	NA	1926	5005	58.63	8536.67	160.19	273.22	2.10	2383.33	76.28
1974	32.08	2605	796	NA	508	NA	NA	2150	5551	64.21	8644.64	173.03	269.45	2.07	2681.64	83.59
1975	32.95	2450	855	NA	569	NA	NA	2246	5551	64.04	8667.48	168.45	263.02	2.07	2681.64	81.38
1976	33.87	2768	824	NA	586	NA	NA	2404	5996	67.34	8903.61	177.05	262.90	2.07	2896.62	85.53
1977	34.83	3227	892	NA	636	NA	NA	2766	6885	74.96	9185.18	197.66	263.69	2.07	3326.09	95.49
1978	35.82	3497	894	NA	636	NA	NA	2904	7295	80.71	9038.46	203.64	252.31	2.07	3524.15	98.38
1979	36.79	3656	1046	NA	758	NA	NA	3285	7987	82.99	9623.48	217.09	261.56	2.07	3858.45	104.87
1980	37.72	3872	1189	NA	830	NA	NA	3438	8499	84.60	10045.82	225.34	266.35	2.07	4105.80	108.86
1981	38.79	4072	1258	NA	871	NA	NA	3573	8903	86.80	10256.67	229.55	264.45	2.07	4300.97	110.89
1982	39.88	4062	1297	NA	902	NA	NA	3808	9167	87.99	10418.65	229.85	261.23	2.07	4428.50	111.04
1983	41.01	4389	1402	NA	984	NA	NA	4240	10031	91.62	10947.96	244.60	266.96	2.07	4845.89	118.16
1984	42.17	4070	1476	NA	1009	NA	NA	4455	10001	93.40	10707.59	237.16	253.92	2.07	4831.40	114.57
1985	43.35	3916	1495	NA	1023	NA	NA	4479	9890	100.00	9890.00	228.14	228.14	2.07	4777.78	110.21
1986	44.61	4354	1596	NA	1073	NA	NA	4882	10832	102.60	10557.50	242.84	236.69	2.07	5232.85	117.32
1987	45.94	4318	1737	NA	1167	NA	NA	5141	11196	97.20	11518.52	243.71	250.74	2.07	5408.70	117.74
1988	47.36	4327	1775	NA	1200	NA	NA	5665	11767	98.50	11946.19	248.48	252.26	2.07	5684.54	120.04
1989	48.86	4666.0	1843	NA	1230	NA	NA	5982.0	12491.0	102.10	12234.08	255.64	250.39	2.07	6034.30	123.50
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D.4: KENYA

ECONOMIC INDICATORS (MILLIONS OF KENYA SHILLINGS UNLESS INDICATED)

YEAR	POPULATION	GROSS DOMESTIC PRODUCT AT MARKET COST							GDP AT MARKET COST	GDP DEFLATOR	GDP AT 1985 PRICES MARKET	GDP/CAPITA		EXCHANGE RATE MS PER US$	GDP IN US$(MIL CURRENT PRICES MARKET	GDP PER CAPITA US$/CAPITA
	MILLIONS	AGRICUL-TURE	INDUSTRY					OTHER SERVICES				CURRENT	REAL 1985			
			TOTAL INDUSTRY	MINING QUARRY	MANUFAC-TURE	ELEC,WTR, GAS	CONSTRUCT									
1968	10.75	3460.0	1710.0	NA	NA	NA	NA	4500.0	9670.0	24.3	39852.1	899.70	3707.86	7.140	1354.34	126.01
1969	11.11	3220.0	1880.0	NA	NA	NA	NA	5320.0	10420.0	24.2	43051.7	937.56	3873.65	7.140	1459.38	131.31
1970	11.50	3460.0	2060.0	NA	NA	NA	NA	5930.0	11450.0	27.9	40978.9	995.83	3564.01	7.140	1603.64	139.47
1971	11.90	3580.0	2320.0	NA	NA	NA	NA	6800.0	12700.0	25.4	49943.1	1067.05	4196.20	7.140	1778.71	149.45
1972	12.33	4850.0	2810.0	NA	NA	NA	NA	7390.0	15050.0	25.7	58480.0	1220.90	4744.06	7.140	2107.84	170.99
1973	12.78	5600.0	3280.0	NA	NA	NA	NA	8690.0	17570.0	28.4	61797.9	1375.34	4837.41	7.000	2510.00	196.48
1974	13.25	6640.0	3890.0	NA	NA	NA	NA	10680.0	21210.0	33.1	63982.8	1601.24	4830.35	7.140	2970.59	224.26
1975	13.74	7220.0	4280.0	NA	NA	NA	NA	12430.0	23930.0	36.9	64873.4	1741.50	4721.15	7.340	3260.22	237.26
1976	14.26	9690.0	4760.0	NA	NA	NA	NA	14620.0	29070.0	43.9	66260.1	2038.28	4645.92	8.370	3473.12	243.52
1977	14.81	13770.0	5900.0	NA	NA	NA	NA	17530.0	37200.0	51.3	72533.3	2511.82	4897.59	8.280	4492.75	303.36
1978	15.39	13140.0	7150.0	NA	NA	NA	NA	20700.0	40990.0	52.9	77425.6	2663.94	5031.88	7.730	5302.72	344.62
1979	15.99	13580.0	8420.0	NA	NA	NA	NA	23500.0	45500.0	55.8	81510.4	2844.82	5096.31	7.480	6082.89	380.32
1980	16.63	14510.0	9910.0	NA	NA	NA	NA	28170.0	52590.0	61.3	85826.9	3161.98	5160.35	7.420	7087.60	426.14
1981	17.30	16740.0	11220.0	NA	NA	NA	NA	32540.0	60500.0	67.4	89760.0	3496.50	5187.54	9.050	6685.08	386.35
1982	18.01	20350.0	12230.0	NA	NA	NA	NA	36710.0	69290.0	75.6	91638.0	3847.31	5088.17	10.920	6345.24	352.32
1983	18.75	23790.0	13790.0	NA	NA	NA	NA	40950.0	78530.0	84.9	92535.0	4187.82	4934.67	13.310	5900.08	314.64
1984	19.53	26250.0	15230.0	NA	NA	NA	NA	46300.0	87780.0	93.0	94372.2	4493.93	4831.42	14.410	6091.60	311.86
1985	20.35	28600.0	16790.0	NA	NA	NA	NA	54480.0	99870.0	100.0	99870.0	4906.89	4906.89	16.430	6078.51	298.65
1986	21.21	33600.0	19070.0	NA	NA	NA	NA	64190.0	116860.0	109.6	106664.2	5510.44	5029.67	16.230	7200.25	339.52
1987	22.10	35270.0	21920.0	NA	NA	NA	NA	74030.0	131220.0	116.4	112711.1	5938.63	5100.97	16.450	7976.90	361.01
1988	23.02	40190.0	26280	NA	NA	NA	NA	86210.0	152680.0	127.9	119393.3	6632.21	5186.28	17.750	8601.69	373.65
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	ERR	NA	NA	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	ERR	NA	NA	NA	NA	NA	NA

Table D.5: LESOTHO

ECONOMIC DATA
MILLIONS OF NATIONAL CURRENCY UNLESS INDICATED

YEAR	POPULATION MILLIONS	GROSS DOMESTIC PRODUCT AT MARKET PRICES MALOTI								GNP	GDP/GNP	GDP DEFLATOR	GDP AT 1985 MARKET PRICES	GDP/CAPITA		EXCHANGE RATE MALOTI PER US$ DOLLAR	GDP (US$)		GDP PER CAPITA ($US)
		AGRICUL- TURE	INDUSTRY					OTHER SERVICES	TOTAL					CURRENT	REAL 1985		AT MARKET PRICES	AT 1985 MARKET PRICES	
			TOTAL INDUSTRY	MINING QUARRY	MANUFAC- TURE	ELEC,WTR GAS	CONSTRUCT- ION												
1960	0,87	NA	NA	NA	NA	NA	NA	NA	23,00	NA	NA	NA	NA	26,44	NA	0,71	32,21	NA	37,03
1961	0,89	NA	NA	NA	NA	NA	NA	NA	25,60	NA	NA	NA	NA	28,76	NA	0,71	35,85	NA	40,29
1962	0,90	NA	NA	NA	NA	NA	NA	NA	28,50	NA	NA	NA	NA	31,67	NA	0,71	39,92	NA	44,35
1963	0,92	NA	NA	NA	NA	NA	NA	NA	31,70	NA	NA	NA	NA	34,46	NA	0,71	44,40	NA	48,26
1964	0,94	NA	NA	NA	NA	NA	NA	NA	40,80	NA	NA	NA	NA	43,40	NA	0,71	57,14	NA	60,79
1965	0,95	NA	NA	NA	NA	NA	NA	NA	43,00	NA	NA	NA	NA	45,26	NA	0,71	60,22	NA	63,39
1966	0,97	NA	NA	NA	NA	NA	NA	NA	44,50	NA	NA	NA	NA	45,88	NA	0,71	62,32	NA	64,25
1967	0,99	15,30	4,40	NA	1,50	NA	NA	26,80	46,50	57,20	0,81	20,20	230,20	46,97	232,52	0,71	65,13	322,41	65,78
1968	1,02	16,00	4,00	NA	1,70	NA	NA	27,40	47,40	58,90	0,80	18,60	254,84	46,47	249,84	0,71	66,39	356,92	65,08
1969	1,04	15,60	4,70	NA	1,80	NA	NA	29,40	49,70	61,60	0,81	19,42	255,92	47,79	246,08	0,71	69,61	358,43	66,93
1970	1,06	16,72	4,31	0,65	2,07	0,15	1,44	31,45	52,49	74,80	0,70	20,40	257,28	49,52	242,72	0,71	73,51	360,34	69,35
1971	1,09	12,00	4,90	0,20	2,40	0,30	2,00	33,60	50,50	76,30	0,66	18,60	271,51	46,33	249,09	0,72	70,63	379,73	64,80
1972	1,11	20,98	6,07	0,20	2,82	0,40	2,65	37,22	64,26	95,80	0,67	23,70	271,15	57,89	244,28	0,77	83,67	353,06	75,38
1973	1,14	32,67	8,32	0,26	3,94	0,53	3,60	46,83	87,81	132,40	0,66	25,60	343,02	77,03	300,89	0,69	127,26	497,12	111,63
1974	1,16	31,74	11,32	0,90	4,83	0,79	4,79	54,95	98,00	158,10	0,62	25,80	379,84	84,48	327,45	0,68	144,33	559,41	124,42
1975	1,19	31,70	12,90	0,50	5,60	0,80	6,00	66,00	110,60	199,70	0,55	33,70	328,19	92,94	275,79	0,73	151,30	448,96	127,14
1976	1,21	31,00	21,70	0,46	6,20	1,72	13,32	75,70	128,40	247,40	0,52	35,20	364,77	106,12	301,47	0,87	147,59	419,28	121,97
1977	1,24	49,60	22,40	1,20	7,20	1,60	12,40	96,10	168,10	308,00	0,55	37,80	444,71	135,56	358,64	0,87	193,22	511,16	155,82
1978	1,28	55,20	43,50	15,40	10,10	1,80	16,20	133,10	231,80	385,10	0,60	44,10	525,62	181,09	410,64	0,87	266,44	604,17	208,15
1979	1,31	65,70	54,00	18,60	11,90	2,00	21,50	124,60	244,30	422,50	0,58	45,20	540,49	186,49	412,59	0,84	290,49	642,67	221,75
1980	1,34	70,00	64,80	20,70	13,90	2,20	28,00	162,50	297,30	502,30	0,59	54,60	544,51	221,87	406,35	0,78	382,13	699,88	285,17
1981	1,37	74,10	64,30	16,00	16,80	2,00	29,50	190,00	328,40	583,20	0,56	61,10	537,48	239,71	392,32	0,87	377,47	617,79	275,53
1982	1,41	63,90	82,70	13,50	22,20	2,50	44,50	222,60	369,20	742,10	0,50	68,10	542,14	261,84	384,50	1,08	341,22	501,06	242,00
1983	1,44	75,30	63,90	0,80	29,10	2,10	31,90	255,90	395,10	818,20	0,48	76,20	518,50	274,38	360,07	1,11	355,31	466,28	246,74
1984	1,47	98,00	83,30	0,60	40,50	3,40	38,80	289,40	470,70	957,90	0,49	83,90	561,03	320,20	381,65	1,44	327,33	390,14	222,67
1985	1,53	111,00	102,00	1,60	45,70	4,70	50,00	357,50	570,50	1084,80	0,53	100,00	570,50	372,88	372,88	2,19	260,38	260,38	170,19
1986	1,56	108,60	123,60	1,90	59,20	5,00	57,50	415,00	647,20	1230,60	0,53	107,20	603,73	414,87	387,01	2,27	285,24	266,08	182,84
1987	1,62	117,00	159,00	NA	84,00	NA	NA	473,00	749,00	1300,50	0,58	122,80	609,93	462,35	376,50	2,04	368,06	299,72	227,20
1988	1,68	NA	NA	NA	NA	NA	NA	NA	970,00	1633,80	0,59	NA	NA	577,38	NA	2,26	429,01	NA	255,37
1989	1,70	164,10	301,60	4,40	136,00	8,30	152,90	634,00	1099,70	1832,39	0,60	NA	NA	646,88	NA	2,62	420,37	NA	247,28
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D.6: MALAWI

YEAR	POPULATION	GROSS DOMESTIC PRODUCT, KWACHA				GDP AT	GDP	GDP	EXCHANGE	GDP IN MILL, US$		GDP/CAPITA
	MILLIONS	AGRICUL-TURE	INDUSTRY	OTHER SERVICES	INDIRECT TAXES	MARKET COST	DEFLATOR	AT 1985 MARKET PRICES	RATE KWACHA PER US DOLLAR	CURRENT MARKET PRICES	AT 1985 MARKET PRICES	US$(1985) CAPITA
1955	NA	NA	NA	NA	NA	62,7	17,7	354,8	NA	NA	NA	NA
1956	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1957	3,17	NA	NA	NA	NA	72,2	18,0	401,1	0,714	101,1	561,5	177,1
1958	3,25	NA	NA	NA	NA	76,9	18,5	415,7	0,714	107,7	581,9	179,1
1959	3,33	NA	NA	NA	NA	80,9	18,8	430,4	0,714	113,3	602,6	181,0
1960	3,42	NA	NA	NA	NA	85,5	19,3	443,0	0,714	119,7	620,2	181,3
1961	3,51	NA	NA	NA	NA	89,1	19,1	466,5	0,714	124,7	653,1	186,1
1962	3,60	NA	NA	NA	NA	92,7	19,9	465,8	0,714	129,8	652,1	181,2
1963	3,70	NA	NA	NA	NA	100,5	22,0	456,8	0,714	140,7	639,5	172,8
1964	3,80	NA	NA	NA	NA	139,2	24,8	561,1	0,714	194,8	785,6	206,7
1965	3,91	NA	NA	NA	NA	163,4	24,7	661,5	0,714	228,8	926,1	236,9
1966	4,02	NA	NA	NA	NA	185,4	25,5	727,1	0,714	259,6	1017,9	253,2
1967	4,12	86,0	28,8	70,4	10,2	195,4	24,1	810,8	0,724	269,8	1119,6	271,7
1968	4,23	86,6	32,1	75,2	10,4	204,3	26,7	765,2	0,833	245,2	918,2	217,1
1969	4,33	92,4	34,8	81,5	12,8	221,5	27,2	814,3	0,833	265,8	977,2	225,7
1970	4,44	99,2	39,4	87,0	16,5	242,1	29,3	826,3	0,833	290,6	991,9	223,4
1971	4,55	125,1	44,6	112,5	21,4	303,6	32,1	945,8	0,831	365,4	1138,3	250,2
1972	4,67	138,4	52,9	112,0	22,2	325,5	32,0	1017,2	0,802	406,1	1268,9	271,7
1973	4,79	141,7	57,3	141,8	23,2	364,0	28,9	1259,5	0,819	444,3	1537,3	320,9
1974	5,10	178,4	73,9	181,0	28,2	461,5	34,1	1353,4	0,841	548,6	1608,9	315,5
1975	5,24	193,7	91,3	209,7	35,0	529,7	37,1	1427,8	0,864	613,2	1652,9	315,4
1976	5,37	233,1	103,1	242,1	33,7	612,0	40,3	1518,6	0,913	670,3	1663,3	309,7
1977	5,54	298,0	113,5	272,4	44,1	728,0	45,9	1586,1	0,903	806,3	1756,6	317,1
1978	5,68	294,9	143,5	304,1	58,2	800,7	46,7	1714,6	0,844	949,0	2032,2	357,8
1979	5,86	299,6	142,4	315,8	77,9	835,7	48,7	1716,0	0,817	1023,0	2100,6	358,5
1980	6,05	318,8	162,0	430,7	103,4	1014,9	56,9	1783,7	0,812	1249,7	2196,3	363,0
1981	6,23	345,2	186,1	464,7	107,8	1103,8	66,2	1667,4	0,895	1232,9	1862,4	298,9
1982	6,41	406,6	203,4	517,9	116,1	1244,0	72,3	1720,6	1,056	1178,6	1630,1	254,3
1983	6,62	469,6	235,5	590,2	139,6	1434,9	80,6	1780,3	1,175	1221,4	1515,4	228,9
1984	6,84	581,3	275,3	673,0	178,1	1707,7	91,7	1862,3	1,413	1208,2	1317,6	192,6
1985	7,06	639,0	328,1	760,0	216,0	1943,1	100,0	1943,1	1,719	1130,3	1130,3	160,1
1986	7,28	745,3	402,8	866,2	216,4	2230,7	111,8	1995,3	1,861	1198,6	1072,1	147,3
1987	7,50	907,2	441,3	1103,3	268,3	2720,1	136,1	1998,6	2,209	1231,5	904,9	120,7
1988	7,75	NA	NA	NA	NA	3552,3	171,4	2072,5	2,561	1386,9	809,2	104,4
1989	8,03	NA	NA	NA	NA	4364,0	201,8	2162,5	2,760	1581,4	783,7	97,6

Table D.7: MOZAMBIQUE

ECONOMIC DATA BILLIONS OF NATIONAL CURRENCY (UNLESS INDICATED)

YEAR	POPULATION MILLIONS	GROSS DOMESTIC PRODUCT AT FACTOR: AGRICULTURE	+ MANUFACTURE	OTHER INDUST	= INDUSTRY	GDP AT FACTOR COST	GDP AT 1985 PRICES FACTOR	EXCHANGE RATE MT PER US$	GDP IN US$ CURRENT PRICES	GDP IN US$ AT 1985 PRICES	GDP PER CAPITA US$ 1985
1967	8.79	NA	NA	NA	NA	NA	NA	28.8	NA	NA	NA
1968	8.98	NA	NA	NA	NA	NA	NA	28.8	NA	NA	NA
1969	9.18	NA	NA	NA	NA	NA	NA	28.8	NA	NA	NA
1970	9.39	NA	NA	NA	NA	NA	NA	28.8	NA	NA	NA
1971	9.62	NA	NA	NA	NA	NA	NA	28.3	NA	NA	NA
1972	9.86	NA	NA	NA	NA	NA	NA	27.0	NA	NA	NA
1973	10.10	NA	NA	NA	NA	NA	NA	24.7	NA	NA	NA
1974	10.35	NA	NA	NA	NA	NA	NA	25.4	NA	NA	NA
1975	10.61	NA	NA	NA	NA	NA	NA	25.6	NA	NA	NA
1976	10.89	NA	NA	NA	NA	NA	NA	30.2	NA	NA	NA
1977	11.18	NA	NA	NA	NA	NA	NA	32.9	NA	NA	NA
1978	11.48	NA	NA	NA	NA	NA	NA	33.0	NA	NA	NA
1979	11.79	NA	NA	NA	NA	NA	NA	32.6	NA	NA	NA
1980	12.10	36.6	7.8	2.1	9.9	68.4	164.8	32.4	2.1	5.1	420.25
1981	12.42	37.0	8.6	2.3	10.9	71.6	165.7	35.4	2.0	4.7	377.25
1982	12.75	41.0	8.8	2.8	11.6	81.9	161.9	37.7	2.2	4.3	336.68
1983	13.09	38.8	8.1	3.2	11.3	80.2	140.0	40.2	2.0	3.5	266.14
1984	13.44	41.1	8.8	3.8	12.5	97.7	145.4	42.4	2.3	3.4	254.96
1985	13.79	49.2	11.7	4.2	16.0	138.9	138.9	43.2	3.2	3.2	233.20
1986	14.19	55.4	12.6	5.4	18.0	156.4	140.1	40.0	3.9	3.5	246.90
1987	14.59	213.6	36.8	15.8	52.5	426.2	159.2	286.0	1.5	0.6	38.15
1988	14.93	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D.8: SOUTH AFRICA

ECONOMIC INDICATORS

YEAR	POPULATION MILLIONS (INCLUDES HOMELANDS)	POPULATION GROWTH RATE %	GROSS DOMESTIC PRODUCT AT FACTOR COST, MILLIONS OF NATIONAL CURRENCY UNLESS INDICATED: AGRICUL-TURE	INDUSTRY: TOTAL INDUSTRY	INDUSTRY: MINING QUARRY	INDUSTRY: MANUFAC-TURE	INDUSTRY: ELEC,WTR, GAS	INDUSTRY: CONSTRUCT-ION	OTHER SERVICES	TOTAL	GDP DEFLATOR (1985=100)	GDP AT 1985 PRICES (FACTOR)	GDP/CAPITA CURRENT (RANDS)	GDP/CAPITA REAL 1985 (RANDS)	EXCHANGE RATE RANDS PER US$	GDP US$ CURRENT MILLION	GDP PER CAPITA (US$/ CAPITA)
1925	7.56	2.2	108	146	87	42	7	10	283	537	5.6	9617.5	71.07	1272.82	NA	NA	NA
1926	7.72	2.2	105	156	93	45	8	10	294	555	5.4	10308.9	71.87	1335.01	NA	NA	NA
1927	7.89	2.2	109	166	97	49	9	11	305	580	5.4	10716.1	73.50	1358.01	NA	NA	NA
1928	8.06	2.2	113	168	95	52	10	11	320	601	5.3	11404.1	74.53	1414.19	NA	NA	NA
1929	8.24	2.2	97	177	100	54	11	12	325	599	5.1	11811.2	72.69	1433.40	NA	NA	NA
1930	8.42	2.2	78	160	86	52	12	10	313	551	4.5	12239.4	65.43	1453.44	NA	NA	NA
1931	8.61	2.2	66	143	78	46	12	7	288	497	4.4	11400.5	57.76	1324.87	NA	NA	NA
1932	8.79	2.2	62	140	77	46	12	5	264	466	4.0	11600.6	52.99	1319.15	NA	NA	NA
1933	8.99	2.2	70	187	113	54	13	7	274	531	4.0	13218.7	59.09	1471.04	NA	NA	NA
1934	9.18	2.2	74	211	125	63	13	10	316	601	4.4	13524.1	65.45	1472.73	NA	NA	NA
1935	9.38	2.2	97	239	135	74	15	15	352	688	4.2	16539.2	73.32	1762.49	NA	NA	NA
1936	9.59	2.2	111	262	144	84	17	17	394	767	4.3	17827.4	79.98	1858.96	NA	NA	NA
1937	9.76	1.8	106	282	151	93	18	20	426	814	4.4	18434.6	83.41	1888.99	NA	NA	NA
1938	9.93	1.8	110	294	154	99	20	21	440	844	4.6	18515.4	84.99	1864.40	NA	NA	NA
1939	10.11	1.8	121	313	164	107	22	20	458	892	4.4	20070.3	88.27	1986.17	NA	NA	NA
1940	10.28	1.8	125	350	185	123	23	19	512	987	5.0	19908.8	95.98	1936.09	NA	NA	NA
1941	10.46	1.8	135	389	201	143	25	20	591	1115	5.4	20491.5	106.56	1958.29	NA	NA	NA
1942	10.65	1.8	171	411	201	164	26	20	654	1236	6.1	20273.9	116.08	1904.01	NA	NA	NA
1943	10.84	1.8	197	419	190	183	27	19	706	1322	6.6	19915.9	122.00	1837.93	NA	NA	NA
1944	11.03	1.8	194	442	185	207	28	22	766	1402	6.9	20417.8	127.15	1851.79	NA	NA	NA
1945	11.22	1.8	188	486	198	232	29	27	841	1515	7.0	21706.0	135.01	1934.41	NA	NA	NA
1946	11.42	1.8	212	542	194	280	32	36	883	1637	7.2	22867.8	143.37	2002.78	NA	NA	NA
1947	11.66	2.1	283	587	190	314	34	49	942	1812	7.6	23727.7	155.43	2035.32	NA	NA	NA
1948	11.90	2.1	340	702	239	366	37	59	1016	2058	8.0	25622.6	172.86	2152.44	NA	NA	NA
1949	12.15	2.1	397	817	289	418	41	70	1089	2303	8.5	27081.5	189.51	2228.20	NA	NA	NA
1950	12.41	2.1	454	932	338	470	44	80	1163	2549	9.4	27185.1	205.40	2190.58	NA	NA	NA
1951	12.67	2.1	513	1014	366	511	47	90	1245	2772	9.7	28501.4	218.77	2249.34	0.71	3590.14	289.29
1952	13.00	2.6	483	1110	371	572	51	116	1383	2976	10.1	29533.3	228.85	2271.09	0.71	3904.23	308.12
1953	13.35	2.6	574	1238	365	698	62	113	1561	3373	10.9	30954.9	252.73	2319.41	0.71	4191.55	322.33
1954	13.70	2.6	594	1336	399	760	71	106	1694	3624	10.5	34563.2	264.60	2523.60	0.71	4750.70	355.96
1955	14.06	2.6	578	1442	470	780	83	109	1799	3819	11.1	34408.7	271.70	2447.97	0.71	5104.23	372.68
1956	14.43	2.6	619	1587	531	843	90	123	1917	4123	11.4	36279.6	285.80	2514.87	0.71	5378.87	382.67
1957	14.81	2.6	620	1678	572	875	97	134	2044	4342	11.5	37641.5	293.28	2542.48	0.71	5807.04	402.54
1958	15.19	2.6	561	1742	576	912	105	149	2142	4445	11.6	38438.2	292.55	2529.83	0.71	6115.49	413.07
1959	15.59	2.6	589	1842	630	942	115	155	2263	4694	11.7	40052.8	301.03	2568.64	0.71	6260.56	412.04
1960	16.00	2.6	615	1982	684	1023	123	152	2386	4983	11.9	41979.8	311.38	2623.25	0.71	6611.27	423.99
1961	16.52	3.2	680	2101	709	1111	134	147	2499	5280	12.1	43794.5	319.63	2651.16	0.71	7018.31	438.56
1962	17.05	3.2	696	2233	742	1190	144	157	2702	5631	12.2	46234.0	330.24	2711.51	0.71	7436.62	450.19
1963	17.60	3.2	765	2491	788	1363	157	183	3005	6261	12.6	49758.0	355.74	2827.16	0.71	7930.99	465.13
1964	18.17	3.2	728	2827	879	1542	169	237	3317	6872	12.9	53271.6	378.25	2932.16	0.71	8818.31	501.04
1965	18.75	3.2	770	3169	944	1745	181	299	3601	7540	13.1	57374.8	402.07	3059.50	0.71	9678.87	532.74
1966	19.36	3.2	861	3409	1012	1875	200	322	3936	8206	13.7	59842.3	423.93	3091.51	0.71	10619.72	566.29
1967	19.98	3.2	1051	3639	1036	2028	227	348	4483	9173	14.3	63956.1	459.09	3200.84	0.71	11557.75	597.08
1968	20.63	3.2	965	3918	1092	2197	252	377	5001	9884	14.8	66718.5	479.22	3234.83	0.71	12919.72	646.60
1969	21.29	3.2	1014	4428	1215	2512	277	424	5557	10999	15.5	70790.1	516.63	3325.04	0.71	13921.13	674.96
1970	22.00	3.3	973	4817	1207	2796	307	507	6247	12037	16.2	74468.6	547.16	3385.09	0.71	15491.55	727.64
1971	22.64	2.9	1168	5087	1164	2983	351	589	7010	13265	16.9	78463.0	585.99	3466.14	0.71	16953.52	770.65
1972	23.29	2.9	1320	5949	1513	3268	408	760	7783	15052	18.8	80182.9	646.17	3442.21	0.72	18423.61	813.87
1973	23.96	2.9	1531	7802	2244	4092	478	988	9380	18713	22.6	82945.3	781.08	3462.11	0.77	19548.05	839.19
1974	24.64	2.8	2214	9735	3068	4896	537	1234	11167	23116	26.1	88645.6	938.19	3597.77	0.69	27120.29	1131.99
1975	25.34	2.9	2129	11145	3182	5991	610	1362	12590	25864	28.5	90783.2	1020.56	3582.18	0.68	33994.12	1379.69
1976	26.06	2.8	2237	12517	3471	6841	780	1425	14242	28996	31.4	92304.8	1112.88	3542.69	0.74	34951.35	1379.13
1977	26.17	0.4	2532	13694	4155	6963	1140	1436	15757	31983	33.1	96521.0	1222.12	3688.23	0.87	33328.74	1279.17
1978	27.42	4.8	2830	16424	5496	7886	1570	1472	18040	37294	37.6	99217.0	1360.05	3618.29	0.87	36762.07	1404.74
1979	28.35	3.4	3251	20920	7783	9767	1784	1586	20398	44569	43.4	102617.0	1572.04	3619.52	0.87	42866.67	1563.28
1980	29.62	4.5	4216	29693	12742	12991	1809	2151	25256	59165	54.6	108294.0	1997.60	3656.36	0.84	53058.33	1871.48
1981	30.34	2.4	4924	32085	10490	16620	2191	2784	30899	67908	60.0	113200.0	2238.09	3730.80	0.78	75852.56	2561.03
1982	31.67	4.4	4854	34632	10471	18403	2652	3106	36046	75532	67.3	112253.0	2385.35	3545.02	0.88	77168.18	2543.28
1983	32.64	3.1	4316	40149	12392	20937	3270	3550	41688	86153	78.4	109850.0	2639.90	3366.02	1.08	69937.04	2208.65
1984	33.08	1.4	5261	44420	12952	23801	3883	3784	48713	98394	87.2	112796.0	2974.43	3409.79	1.11	77615.32	2378.28
1985	33.68	1.8	6526	51580	16671	25928	4837	4144	54341	112447	100.0	112447.0	3338.99	3338.99	1.44	68329.17	2065.57
1986	34.49	2.4	7287	60536	20213	30260	5556	4507	61837	129660	115.1	112680.0	3759.90	3267.51	2.19	51345.66	1524.65
1987	35.31	2.4	9216	66457	19194	35689	6661	4913	74240	149913	130.6	114805.0	4245.14	3250.98	2.27	57118.94	1656.34
1988	36.19	2.5	9986	78737	22078	43125	7700	5834	87553	176276	147.9	119179.0	4870.44	3292.87	2.03	73848.77	2091.20
1989	37.09	2.5	11629	91258	24936	50896	8923	6503	104061	206948	169.9	121790.0	5579.02	3283.28	2.27	77654.63	2145.57

Table D.9: SWAZILAND

ECONOMIC DATA (MILLIONS OF NATIONAL CURRENCY UNLESS INDICATED)

YEAR	POPULATION MILLIONS	GDP AT MARKET PRICES (EMALENGENI): AGRICULTURE	MINE & QUARRY	MANUFACTURE	ELEC,WTR GAS	CONSTRUCTION	OTHER SERVICES	GDP AT MARKET PRICES	GDP DEFLATOR	GDP AT 1985 MARKET PRICES	EXCHANGE RATE EMALENGENI PER $	GDP IN MILL, US$: CURRENT PRICES MARKET	GDP IN MILL, US$: AT 1985 PRICES MARKET	GDP PER CAPITA US$
1955	0,25	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,7	NA	NA	NA
1956	0,28	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,7	NA	NA	NA
1957	0,30	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,7	NA	NA	NA
1958	0,31	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,7	NA	NA	NA
1959	0,31	NA	NA	NA	NA	NA	NA	NA	NA	NA	0,7	NA	NA	NA
1960	0,32	NA	NA	NA	NA	NA	NA	21,7	NA	NA	0,7	31,0	NA	96,9
1961	0,33	NA	NA	NA	NA	NA	NA	25,0	NA	NA	0,7	35,0	NA	106,0
1962	0,33	NA	NA	NA	NA	NA	NA	30,7	NA	NA	0,7	42,9	NA	130,1
1963	0,34	NA	NA	NA	NA	NA	NA	32,8	NA	NA	0,7	45,9	NA	134,9
1964	0,35	NA	NA	NA	NA	NA	NA	38,6	NA	NA	0,7	54,0	NA	154,2
1965	0,36	16,6	11,0	4,1	0,7	1,8	12,2	46,4	NA	NA	0,7	64,9	NA	180,3
1966	0,37	NA	NA	NA	NA	NA	NA	50,2	NA	NA	0,7	70,2	NA	189,8
1967	0,39	NA	NA	NA	NA	NA	NA	54,9	18,8	292,3	0,7	76,8	408,9	196,9
1968	0,40	NA	NA	NA	NA	NA	NA	53,4	19,2	277,5	0,7	74,7	388,2	186,7
1969	0,41	NA	NA	NA	NA	NA	NA	57,0	19,8	287,4	0,7	79,7	402,0	194,4
1970	0,42	18,1	8,3	9,1	1,6	1,8	37,2	76,1	20,7	366,9	0,7	106,4	513,2	253,4
1971	0,44	21,3	4,2	11,9	0,8	2,6	40,2	81,0	22,4	361,0	0,7	113,3	504,8	257,5
1972	0,45	23,5	6,5	18,6	1,6	2,8	44,7	97,6	23,5	415,3	0,8	127,1	540,8	282,4
1973	0,46	25,8	7,9	26,4	1,5	3,3	48,0	112,9	26,1	433,4	0,7	162,9	625,4	354,2
1974	0,48	32,1	10,7	33,5	1,7	2,8	71,7	152,5	30,1	506,5	0,7	224,6	745,9	467,9
1975	0,49	39,6	14,5	48,3	2,0	3,5	105,4	213,3	35,2	605,8	0,7	291,8	828,7	595,5
1976	0,50	45,6	14,8	56,8	2,3	5,3	110,5	235,1	39,7	591,9	0,9	270,2	680,3	540,5
1977	0,51	56,8	14,6	62,5	2,8	8,0	118,8	263,5	47,5	554,7	0,9	302,9	637,6	593,9
1978	0,53	67,9	14,4	68,2	3,4	10,8	130,6	295,2	48,5	608,7	0,9	339,3	699,6	640,2
1979	0,53	79,1	14,3	73,9	3,9	13,5	161,6	346,2	50,0	692,4	0,8	411,7	823,3	776,7
1980	0,55	90,2	14,1	79,6	4,4	16,2	217,6	422,1	63,5	664,7	0,8	542,5	854,4	986,4
1981	0,57	104,7	15,1	89,1	7,2	21,4	263,4	500,9	70,4	711,5	0,9	575,7	817,8	1010,1
1982	0,59	102,1	14,4	100,8	10,3	26,9	292,2	546,7	76,5	714,6	1,1	505,7	661,1	857,2
1983	0,61	111,2	15,7	89,7	9,3	25,3	336,5	587,7	82,0	716,7	1,1	528,5	644,5	866,4
1984	0,63	131,0	14,3	108,5	10,3	26,9	364,5	655,5	90,9	721,1	1,4	455,8	501,5	723,6
1985	0,65	NA	NA	NA	NA	NA	NA	743,3	100,0	743,3	2,2	339,3	339,3	521,9
1986	0,67	NA	NA	NA	NA	NA	NA	955,9	118,1	809,2	2,3	421,5	356,8	629,1
1987	0,71	NA	NA	NA	NA	NA	NA	1132,8	132,9	852,3	2,0	556,7	418,8	784,0
1988	0,74	NA	NA	NA	NA	NA	NA	1384,2	NA	NA	2,3	612,2	NA	827,3
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2,6	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D.10: TANZANIA

YEAR	POPULATION MILLIONS	GDP AT MARKET COST: AGRICUL-TURE	GDP AT MARKET COST: INDUSTRY: TOTAL INDUSTRY	INDUSTRY: MINING QUARRY	INDUSTRY: MANUFAC-TURE	INDUSTRY: ELEC,WTR GAS	INDUSTRY: CONSTRUCT-ION	OTHER SERVICES	TOTAL	GDP DEFLATOR	GDP AT 1985 PRICES MARKET	GDP/CAPITA CURRENT	GDP/CAPITA REAL 1985	EXCHANGE RATE SH. PER $US	GDP CURRENT PRICES MARKET $US	GDP PER CAPITA US$/CAPITA
1950	8,31	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,143	NA	NA
1951	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,143	NA	NA
1952	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,143	NA	NA
1953	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,143	NA	NA
1954	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,143	NA	NA
1955	9,21	NA	NA	NA	NA	NA	NA	NA	3098	NA	NA	336,37	NA	7,143	433,71	47,09
1956	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	7,143	NA	NA
1957	9,6	NA	NA	NA	NA	NA	NA	NA	3418	NA	NA	356,04	NA	7,143	478,51	49,84
1958	9,83	NA	NA	NA	NA	NA	NA	NA	3522	NA	NA	358,29	NA	7,143	493,07	50,16
1959	10,08	NA	NA	NA	NA	NA	NA	NA	3752	NA	NA	372,22	NA	7,143	525,27	52,11
1960	10,33	NA	NA	NA	NA	NA	NA	NA	3920	NA	NA	379,48	NA	7,143	548,79	53,13
1961	10,58	NA	NA	NA	NA	NA	NA	NA	4102	NA	NA	387,71	NA	7,143	574,27	54,28
1962	10,85	NA	NA	NA	NA	NA	NA	NA	4454	NA	NA	410,51	NA	7,143	623,55	57,47
1963	11,11	NA	NA	NA	NA	NA	NA	NA	4932	NA	NA	443,92	NA	7,143	690,47	62,15
1964	11,39	NA	NA	NA	NA	NA	NA	NA	6030	NA	NA	529,41	NA	7,143	844,18	74,12
1965	11,67	NA	NA	NA	NA	NA	NA	NA	6140	9,9	62020	526,14	5314,50	7,143	859,58	73,66
1966	11,96	NA	NA	NA	NA	NA	NA	NA	7042	10,0	70420	588,80	5887,96	7,143	985,86	82,43
1967	12,26	2870	1130	NA	570	NA	NA	3343	7343	10,1	72703	598,94	5930,10	7,143	1028,00	83,85
1968	12,59	2990	1170	NA	650	NA	NA	3714	7874	10,3	76447	625,42	6072,01	7,143	1102,34	87,56
1969	12,93	3080	1270	NA	740	NA	NA	3921	8271	10,6	78028	639,68	6034,67	7,143	1157,92	89,55
1970	13,27	3380	1420	NA	830	NA	NA	4373	9173	11,1	82640	691,26	6227,55	7,143	1284,19	96,77
1971	13,63	3490	1560	NA	850	NA	NA	4764	9814	11,4	86088	720,03	6316,05	7,143	1373,93	100,80
1972	14,00	4020	1800	NA	1140	NA	NA	5352	11172	12,1	92331	798,00	6595,04	7,143	1564,05	111,72
1973	14,37	4540	2110	NA	1260	NA	NA	6453	13103	13,8	94949	911,83	6607,47	7,021	1866,26	129,87
1974	14,76	5440	2410	NA	1480	NA	NA	8144	15994	16,5	96933	1083,60	6567,30	7,135	2241,63	151,87
1975	15,31	7010	2760	NA	1770	NA	NA	9241	19011	18,5	102762	1241,74	6712,09	7,367	2580,56	168,55
1976	16,41	9050	4130	NA	2810	NA	NA	11239	24419	22,3	109502	1488,06	6672,90	8,377	2915,01	177,64
1977	16,92	11130	4890	NA	3290	NA	NA	12848	28868	25,6	112766	1706,15	6664,64	8,289	3482,69	205,83
1978	17,44	12510	5400	NA	3860	NA	NA	14259	32169	27,8	115716	1844,55	6635,08	7,712	4171,29	239,18
1979	17,98	14730	5660	NA	3870	NA	NA	15893	36283	30,9	117421	2017,96	6530,63	8,217	4415,60	245,58
1980	18,58	16640	6350	NA	4100	NA	NA	19128	42118	35,6	118309	2266,85	6367,55	8,197	5138,22	276,55
1981	19,17	20340	6840	NA	4500	NA	NA	21922	49102	42,0	116910	2561,40	6098,57	8,284	5927,33	309,20
1982	19,78	26450	6910	NA	4360	NA	NA	24866	58226	49,1	118587	2943,68	5995,28	9,283	6272,33	317,10
1983	20,41	32740	6880	NA	4870	NA	NA	30380	70000	59,8	117057	3429,69	5735,27	11,143	6281,97	307,79
1984	21,06	41290	8480	NA	5930	NA	NA	37330	87100	73,5	118503	4135,80	5626,94	15,292	5695,79	270,46
1985	21,73	61230	10500	NA	6660	NA	NA	48870	120600	100,0	120600	5549,93	5549,93	17,472	6902,47	317,65
1986	22,46	84150	13240	NA	7420	NA	NA	63810	161200	131,9	122214	7177,20	5441,40	32,698	4929,97	219,50
1987	23,22	120940	15520	NA	9040	NA	NA	88640	225100	174,2	129219	9694,23	5565,00	64,260	3502,96	150,86
1988	24,00	178250	20340	NA	11030	NA	NA	112888	311478	238,0	130873	12978,25	5453,05	99,292	3136,99	130,71
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	143,377	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA	NA	NA

Table D.11: ZAIRE

GNP US $/CAP current	GNP Billion Z current	POPUL million	GDP DEFLAT	ZAIRE/US$	GNP/CAP US$ curr	GNP/CAP US$ ('80)	GNP/CAP ZAIR curr	GNP/CAP ZAIR '80	GNP ZAIRE '80 million
170	0.87	18.222	3.6	0.3	170	4722	48	1326	24167
170	1.39	18.608	5.6	0.5	170	3036	75	1334	24821
180	1.77	19.026	6.6	0.5	180	2727	93	1410	26818
180	1.72	19.481	6.5	0.5	180	2769	88	1358	26462
200	1.94	19.976	6.8	0.5	200	2941	97	1428	28529
200	2.14	20.513	7.5	0.5	200	2667	104	1391	28533
240	2.73	21.094	8.9	0.5	240	2697	129	1454	30674
270	3.26	21.723	10.5	0.5	270	2571	150	1429	31048
300	3.44	22.399	11.8	0.5	300	2542	154	1302	29153
300	5.26	23.121	18.6	0.8	300	1613	227	1223	28280
330	7.39	23.885	25.5	0.9	330	1294	309	1213	28980
360	9	24.686	32.7	0.8	360	1101	365	1115	27523
410	18.22	25.519	66.0	1.7	410	621	714	1082	27606
430	28.04	26.377	100.0	2.8	430	430	1063	1063	28040
400	38.9	27.252	134.5	4.4	400	297	1427	1061	28922
340	50.03	28.134	180.6	5.8	340	188	1778	985	27702
290	94.71	29.013	341.4	12.9	290	85	3264	956	27742
200	146.96	29.877	559.8	36.1	200	36	4919	879	26252
160	197.69	30.712	726.6	49.9	160	22	6437	886	27208
150	307.52	31.672	1055.2	59.6	150	14	9710	920	29143
150	590.85	32.655	2009.1	112.4	150	7	18094	901	29409

Table D.12: ZAMBIA

ECONOMIC DATA

YEAR	POPULATION	GROSS DOMESTIC PRODUCT AT MARKET COST MILLIONS OF CURRENCY UNITS						GDP AT 1985 PRICES (MARKET)	EXCHANGE RATE KW per US$	GDP PER CAPITA	
	MILLIONS	AGRICUL-TURE	MINING QUARRYING	MANUFAC-TURE	ELEC, GAS WATER	CONSTRUC-TION	TOTAL			US$ CONSTANT	KWACHA REAL 1985
1945	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1946	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1947	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1948	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1949	NA	NA	NA	NA	NA	NA	NA	NA	0, 7	NA	NA
1950	2, 44	NA	NA	NA	NA	NA	NA	NA	0, 7	NA	NA
1951	2, 50	NA	NA	NA	NA	NA	NA	NA	0, 7	NA	NA
1952	2, 57	NA	NA	NA	NA	NA	NA	NA	0, 7	NA	NA
1953	2, 65	NA	NA	NA	NA	NA	NA	NA	0, 7	NA	NA
1954	2, 72	30, 7	157, 5	9, 0	0, 8	17, 5	273, 0	NA	0, 7	141, 36	NA
1955	2, 79	30, 7	201, 8	11, 6	2, 7	21, 2	345, 0	NA	0, 7	174, 16	NA
1956	2, 87	36, 3	212, 2	13, 5	7, 1	25, 7	378, 0	5040, 0	0, 7	185, 50	1756, 10
1957	2, 96	39, 2	132, 9	15, 5	6, 7	27, 6	313, 0	3294, 7	0, 7	148, 93	1113, 09
1958	3, 04	36, 7	103, 1	15, 3	8, 2	28, 0	285, 0	2805, 1	0, 7	132, 04	922, 74
1959	3, 12	43, 7	181, 2	15, 1	8, 8	22, 9	379, 0	4115, 1	0, 7	171, 09	1318, 94
1960	3, 21	44, 5	210, 4	16, 9	8, 0	20, 0	419, 0	3774, 8	0, 7	183, 84	1175, 94
1961	3, 30	47, 8	190, 8	21, 0	7, 5	17, 3	406, 0	3759, 3	0, 7	173, 28	1139, 17
1962	3, 40	45, 7	184, 3	21, 6	7, 6	15, 5	401, 0	3747, 7	0, 7	166, 11	1102, 25
1963	3, 50	49, 8	189, 0	24, 7	8, 2	16, 3	420, 0	3818, 2	0, 7	169, 01	1090, 91
1964	3, 60	52, 9	203, 0	32, 8	9, 4	24, 7	502, 0	4327, 6	0, 7	196, 40	1202, 11
1965	3, 70	65, 7	255, 3	53, 6	12, 7	42, 7	711, 0	5598, 4	0, 7	270, 65	1513, 09
1966	3, 80	67, 2	266, 1	66, 9	14, 6	60, 0	848, 0	5367, 1	0, 7	314, 31	1412, 39
1967	3, 90	75, 3	289, 3	83, 2	15, 6	63, 5	957, 0	5629, 4	0, 7	345, 61	1443, 44
1968	4, 05	75, 1	310, 4	93, 1	16, 5	79, 8	1062, 0	5771, 7	0, 7	369, 33	1425, 12
1969	4, 12	111, 5	427, 7	124, 0	19, 2	95, 9	1314, 0	5945, 7	0, 7	449, 20	1443, 13
1970	4, 25	126, 3	458, 0	129, 2	17, 7	90, 3	1277, 0	6449, 5	0, 7	423, 20	1517, 53
1971	4, 39	139, 4	273, 5	149, 7	20, 6	96, 1	1188, 0	6187, 5	0, 7	381, 15	1409, 45
1972	4, 53	154, 4	322, 9	181, 2	28, 5	97, 4	1349, 0	6711, 4	0, 7	419, 43	1481, 55
1973	4, 68	161, 2	513, 7	195, 3	30, 4	101, 7	1592, 0	6661, 1	0, 7	523, 34	1423, 31
1974	4, 83	178, 0	614, 0	238, 5	38, 4	125, 3	1893, 0	7116, 5	0, 6	612, 38	1473, 40
1975	4, 98	182, 9	213, 2	250, 3	39, 8	151, 2	1584, 0	6917, 0	0, 6	496, 99	1388, 96
1976	5, 14	244, 0	339, 4	275, 6	44, 0	185, 4	1902, 0	7231, 9	0, 7	513, 94	1406, 99
1977	5, 30	325, 6	233, 7	353, 0	47, 6	113, 7	1986, 4	6873, 4	0, 8	474, 42	1296, 86
1978	5, 47	363, 0	286, 8	430, 1	57, 7	111, 5	2250, 7	6904, 0	0, 8	514, 33	1262, 15
1979	5, 52	397, 2	469, 3	486, 7	59, 9	101, 2	2660, 4	6701, 3	0, 8	610, 07	1214, 00
1980	5, 56	435, 3	501, 7	566, 1	61, 0	136, 5	3063, 6	6900, 0	0, 8	697, 48	1241, 01
1981	5, 87	553, 8	488, 4	684, 1	66, 3	111, 7	3485, 4	7322, 3	0, 9	682, 49	1247, 41
1982	6, 03	492, 2	396, 6	740, 4	72, 2	127, 0	3595, 3	7119, 4	0, 9	641, 11	1180, 66
1983	6, 24	593, 7	641, 6	829, 8	70, 4	133, 1	4181, 2	6980, 3	1, 3	535, 88	1118, 28
1984	6, 44	717, 2	673, 8	1010, 6	69, 7	153, 3	4931, 0	6954, 9	1, 8	427, 76	1079, 95
1985	6, 73	925, 2	1101, 9	1610, 0	71, 1	182, 9	7072, 0	7072, 0	2, 7	387, 76	1050, 82
1986	7, 28	1304, 6	2978, 6	2431, 5	72, 3	304, 0	12963, 0	7110, 8	7, 3	243, 82	976, 36
1987	7, 56	NA	NA	NA	NA	NA	19632, 0	7097, 6	8, 9	291, 95	938, 34
1988	7, 53	NA	NA	NA	NA	NA	22495, 0	NA	NA	NA	NA
1989	7, 80	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table D.13: ZIMBABWE

YEAR	POPULAT Thousands	GROSS DOMESTIC PRODUCT (GDP) at FACTOR COST Million of current national currency					GDP DEFLATOR	CONVERS	GDP PER CAPITA		
		AGRICULTURE	INDUSTRY	Manufacture	SERVICES	TOTAL		National currency per US$	current nat. curr	(at 1980 values)	(at 1980 US$)
1967	4721	152.0	254	142	339	745	41.1	0.71	157.81	383.96	540.78
1968	4906	125.0	271	152	390	786	40.1	0.71	160.21	399.53	562.72
1969	5099	170.0	322	175	441	933	46.5	0.71	182.98	393.50	554.22
1970	5249	153.0	367	209	491	1011	41.2	0.71	192.61	467.50	658.44
1971	5403	200.0	415	251	553	1168	43.6	0.71	216.18	495.82	698.33
1972	5561	234.0	485	297	617	1336	45.9	0.66	240.24	523.41	793.04
1973	5724	215.0	569	343	666	1450	48.8	0.59	253.32	519.10	879.83
1974	5892	315.0	681	421	795	1791	54.9	0.58	303.97	553.68	954.62
1975	6065	323.0	722	447	857	1902	60.2	0.57	313.60	520.93	913.92
1976	6243	350.0	777	480	937	2064	65.1	0.63	330.61	507.85	806.11
1977	6426	334.0	749	460	986	2069	71.1	0.63	321.97	452.85	718.80
1978	6615	289.0	801	515	1169	2259	78.7	0.68	341.50	433.92	638.12
1979	6809	321.0	1014	625	1315	2650	91.4	0.68	389.19	425.81	626.19
1980	7009	451.0	1248	802	1525	3224	100.0	0.64	459.98	459.98	718.72
1981	7268	640.0	1484	1016	1925	4049	114.5	0.69	557.10	486.55	705.14
1982	7538	669.0	1601	1121	2362	4632	129.1	0.76	614.49	475.98	626.29
1983	7817	544.0	2287	1441	2519	5350	153.4	1.01	684.41	446.16	441.74
1984	8106	748.0	2142	1475	2778	5668	161.1	1.24	699.24	434.04	350.03
1985	8406	1039.0	2763	2043	3004	6806	182.2	1.61	809.66	444.38	276.01
1986	8705	1080.0	3297	2405	3532	7909	207.2	1.67	908.56	438.49	262.57
1987	9001	947.0	3773	2720	3981	8701	227.1	1.66	966.67	425.66	256.42
1988		NA	NA	NA	NA	NA			NA	NA	NA
1989		NA	NA	NA	NA	NA			NA	NA	NA
1990		NA	NA	NA	NA	NA			NA	NA	NA

APPENDIX E:

ENERGY SUPPLY AND DEMAND IN SELECTED COUNTRIES[12]

- i ANGOLA
- ii BOTSWANA
- iii ETHIOPIA
- iv KENYA
- v LESOTHO
- vi MALAWI
- vii MOZAMBIQUE
- viii SOUTH AFRICA ... See section 4.5 for details.
- ix SWAZILAND
- x TANZANIA
- xi ZAIRE
- xii ZAMBIA
- xiii ZIMBABWE

i ANGOLA

i.a General

Total commercial energy consumption rose steadily until independence in 1974. Thereafter the consumption pattern was erratic but with a gradual decrease until 1988.

On a per capita basis, commercial energy demand rose steadily until 1972 when it reached a peak of 154 kgOE per capita. From 1972 the per capita consumption has been decreasing in sympathy with the decreasing economy of the country. By 1988 the commercial energy consumption had fallen to 70 kgOE per capita. The energy consumption per Kwanza has also decreased steadily in current terms.

Angola's energy consumption per capita is very low compared with counties with similar, or even lower, GDP's per capita. The low energy use is an indication that the GDP generated by, for instance exports, is being used for non-productive purposes of which the most obvious is the war effort. Once the war stops there will be a significant release of funds for productive purposes.

It is difficult to determine the sectorial usage of energy because of incomplete statistics and the often contradictory information from different sources. Using the IEA statistics the sectorial usage of commercial energy in 1988 is shown in Table E.1.

Table E.1. Sectorial Commercial Energy Consumption in 1988

Sector	Oil	Gas	Elect
Industry	7,5	131,1	10,3
Transport	330,9		
Residential	70,5		
Other			114,4

However, the analysis of commercial energy consumption does not adequately cover the energy scene since a large proportion of the total energy consumption is made up of fuelwood and charcoal. The 1988 energy balance, as shown in Table E.2, indicates that 60% of total consumption is traditional fuel. Traditional energy accounted for about 70% of the total consumption until 1978, after which it fell to 54% in 1979 and has been steadily rising to 60% in 1988.

Table E.2 Summary of Final Energy Consumption in 1988

	'000s TOE	%
Fuelwood	1 001	60
Electricity	125	7
Petroleum	421	25
Gas	131	8
Total	1678	100

i.b Fuelwood

Fuelwood is the largest source of energy in the country. Wood itself is the dominant form of traditional energy in the rural areas, whilst charcoal is consumed mainly in urban areas. In 1987 the aggregate use of fuelwood and charcoal was as shown in Table E.3

Table E.3 Summary of wood fuel consumption in 1986
Thousand tons per year

	Consumption	Wood required
Domestic:		
- Fuelwood	1 920	1 920
- Charcoal	440	3 080
Domestic heating:		
- Fuelwood	360	360
- Charcoal	84	590
Industry:	180	180
Total	----	6 130

The country's present overall fuelwood requirements are therefore likely to be 7,5 million tons per year, of which 6 million are required for cooking, and 1,2 million for heating.

Whilst the overall supply position is satisfactory, there is however a large imbalance between different regions. Three provinces, Luanda/Bengo, Benguela, and Huambo, have a resource capacity of below one ton per capita per year. Since these three provinces have a population of around 3 million, it is obvious that they cannot supply their fuelwood needs from within their own boundaries. Another five provinces, Bie, Huila, Kwanza, Sul, and Malanje, have potentials between 1 and 3 tons per capita per year and are therefore barely able to satisfy their needs. It appears that only one-third of the population lives in areas amply supplied with fuelwood. The result of this survey is given in Appendix A.

In Angola the marketing and pricing mechanism is distorted, official regulations for producing fuelwood are ignored, and retail prices usually exceed the official prices by a factor of 50.

i.c Petroleum

Angola has been producing oil since 1960. Production started slowly and even dipped after independence. However, since 1973 oil has been the main foreign exchange earner and since 1982 production has been growing exponentially at a rate of approximately 25% per annum.

The reserve-to-production ratio has been dropping from 13,7 years in 1986 to 8,8 years in 1990. This indicates that not enough exploration is being carried out to keep up with production. Gross export revenue from oil has increased at an average rate of 7% during the period 1984 to 1989 in current terms, and by 1989 oil exports were earning US$ 2 500 million. With falling oil prices from 1986 the growth in earning has been stultified. Table E.4 summarizes the production and export revenue.

Four foreign companies are now producing oil in Angola:

(1) Chevron is the largest producer with an output of 270 000 barrels per day in 1988. Chevron's fields are all offshore Cabinda. They have started exploring in deep waters (70-200 metres) off Cabinda.

(2) Petrofina is operator of all onshore fields in the Zaire and Kwanza basins. It is involved in joint ventures with SONANGOL and Texaco, producing about 35 600 barrels per day. The Kwanza basin field has been virtually exploited. Petrofina is carrying on with onshore exploration.

(3) Texaco holds minority shares in onshore production and has a production-sharing agreement for Block Two, off the mouth of the Zaire River, where it is pumping around 40 000 barrels per day.

(4) Elf Aquitane's production is offshore in Block Three. A second field and a third field have now begun producing. The production-sharing agreement for Block Three includes Agip, Naftagas, INA, and a group of six Japanese companies.

Table E.4 Crude oil exports and revenue ('000s barrels and million of US$)

	1984	1985	1986	1987	1988	1989
Total bbls	64165	73418	92251	119720	153300	154000
Bbls/day	175	201	253	328	419	422
US$/bbl	27,2	25,8	12,5	15,4	13,4	16,2
Revenue US$m	1748	1896	1149	1850	2054	2500

During 1987, the last year for which a breakdown is available, Angola consumed some 420 000 tons per year of refined products, excluding bunkers, The percentage consumption of the various products is shown in Table E.5.

The consumption of petroleum products on a per capita basis is very low. Angola's consumption is approximately 40% of the average of countries in the same range of economy, such as, Mauritania, Zambia, and Bolivia.

Angola's petroleum products are supplied from the FPA (Fina Petroleos de Luanda) refinery at Luanda. The refinery belongs to the Fina company and is a conventional hydroskimming refinery. It has a throughput of 1,45 million tons per annum following a de-bottlenecking measure. It is operating economically and, with the recent increase in capacity, it is expected to be able to supply Angola's need for some time. At present it is operating with a 40% spare capacity. Some import of specific products takes place from time to meet short-term excess demand.

An agreement was signed between Angola and Namibia in November 1990 for Angola to supply Namibia with refined products from the Luanda refinery.

Table E.5 Oil product consumption (1988) (%age of total)

LPG	2,8
Naptha	1,1
Gasoline	10,8
Avgas	23,2
Kerosene	7,4
Gasoil(diesel)	17,8
H.F.O.	18,6
Other	2,0
Refinery fuel	16,3

i.d Electricity

The electricity sub-sector operates reasonably well, though it has suffered from a decade of neglect. By 1987 the firm capacity had dropped to 275 MW, which is less than 60% of total installed capacity. Transmission and distribution lines require significant maintenance.

The electricity supply system is divided into three non-connected systems operated by ENE, SONEFE, and EDEL. ENE is the State enterprise which was created in 1980 and is intended to become the sole national power utility in charge of generation, transmission, and medium-voltage distribution. ENE currently operates the "Central" and "Southern" systems and several isolated systems. SONEFE is in charge of generation and transmission in the "Northern" system which is the largest system in the country and supplies about 300 clients directly at 60 kV. Distribution in the area of Luanda is under the control of EDEL. Low-voltage distribution in the rest of the country is usually the responsibility of ENE but is often handled by municipalities.

The total installed and available capacity in the three main regions and in other isolated regions is given in Table E.6.

Table E.6 Installed and available generating capacity (1987) (MW)

System	Hydro-Power		Thermal-Power		Total Capacity		
	Instl.	Avail.	Instl.	Avail.	Instl.	Avail.	Demand
Northern	197,6	135,0	56,8	56,8	254,6	191,8	90-100
Central	49,4	7,2	61,8	39,5	112,2	46,7	30
Southern	27,2	13,6	25,3	15,1	52,5	28,7	9-10
Isolated	12,9	2,4	31,7	5,0	44,6	7,4	N/A
	-----	-----	-----	-----	-----	-----	-----
	287,1	158,2	175,6	116,4	463,9	274,6	-----

Whilst the available capacity is much lower than the installed capacity, the peak demands on the different regions are less than the available capacity, thus no significant shortage of supply is experienced However, the lack of maintenance does result in significant brown-outs. hydro-power is the largest source of electrical generation. The "Northern" region is based on the Kwansa River, the "Central" region is based on the Catumbela River, whilst the "Southern" region is based on the Cunene River. No new hydro-plant has been built since 1974. In order to overcome supply difficulties caused by sabotage of hydro-installations, ENE and SONEFE installed gas turbine plant (operating on liquid fuels) at Luanda and Huambo, and diesel units in Lobito and other centres. However, because of lack of adequate maintenance, lack of technical assistance and spare parts, and erratic fuel supplies, these facilities have not resolved supply problems. The main isolated regions are those at Cabinda, Uige, and Bie.

Northern System:

The Northern system generated 606 GWh in 1986, which is 80% of total generation in the country. Generating capacity is based on the Kwanza and Donde Rivers and two gas turbines in Luanda. Peak demand was between 90 and 100 MW. The main plant is at Cambambe, with four sets of 45 MW each. This plant is run-of-river, with a minimum flow equivalent to a firm power of 90 MW. Increased capacity in the region could be achieved by raising the height of the dam at Cambambe by 20 metres, thus increasing the total capacity to 260 MW.

All the units at Cambambe, with the exception of Unit 1, require urgent inspection and overhaul. The other hydro-capacity on the system was the Mabubas plant which was built in 1953 with an installed capacity of 17,8 MW. The plant was derated to half of its capacity in 1974 and was closed down in 1986, requiring extensive rehabilitation at an estimated cost of US$ 7 million.

Central System:

This system is based on two hydro-plants: Lomaum (35 MW) and Biopio (14,4 MW), both on the Catumbela River. In addition, a 22,8 MW gas turbine was installed in Biopio and a 10 MW gas turbine in Huambo. In 1983 the Lomaum plant was sabotaged, resulting in flooding of the station and destruction of the control system. The gas turbine at Huambo had a serious breakdown in 1985 due to lack of adequate maintenance.

Southern System:

The main plant in the Southern System is the 27,2 MW hydro-plant at Matala on the Cunene River. This station has two units and a third unit has been stored for several years in Belgium. It is expected that this unit will shortly be installed. The Gove Dam upstream of Matala provides regulation with a minimum firm power of 10,9 MW. However, Unit 1 has been out of order since 1984 and Unit 2 has been derated to 60% of its name-plate rating.

The Matala and Gove Dams have serious safety problems. The 29 gates of the Matala Dam cannot be operated due to fractures in the dam structure. Gove Dam has similar problems with 3 gates and is showing considerable percolation. Unless at least one gate can be opened at Gove, flooding could endanger both the Gove and Matala Dams.

A diesel plant was installed in Namibe in 1980 with an installed capacity of 11,5 MW from two units.

Capanda:

The government has approved the construction of the Capanda Power Station on the Kwanza River. In 1982 agreements were signed with the USSR for the supply of equipment and with the Brazilian company, Odebrecht, for the construction of civil works. An institution, GAMEK, has been formed to supervise the project.

The project will consist of four 130 MW units, virtually doubling Angola's capacity. It is considered by the World Bank that this project will not adequately strengthen the needs of the Northern System, that the full capacity of Capanda will not be required until well into the next century, and that a cheaper alternative to capacity expansion in the Northern System would be the expansion of the Cambambe power station with the provision of increased dam capacity at Cambambe and the eventual increase of the dam at Capanda and a further expansion of the Cambambe plant. It is considered by the World Bank that the project would be, at best, only of marginal economic interest and at worst it will be a heavy financial burden, making no contribution to the medium-term development of Angola.

Electricity demand:

Inadequate metering facilities have made the assessment of electricity consumption difficult. It has been estimated that transmission and distribution losses amount to 22% of generated energy, giving a final consumption of 590 GWh in 1986, of which 80,4% was in the Northern System, 10,0% was in the Central System, and 7,5% in the Southern System. The total generation in Angola during the period 1970 to 1986 is given in Table E.7.

The amount of diesel generation has been dropping during the period covered by Table E.7 from a high of 18,9% of total generation in 1972 to 3,5% in 1986. Hydro generation has been increasing and reached 98% of total generation in 1979. Since that time it has averaged around 92%.

Between 1967 and 1973 generation and consumption increased at a rate of 16,3%. Most of the load was concentrated in Luanda in the Northern System, at Huambo, Lobito, and Benguela, in the Central System, and at Lubango and Namibe in the Southern System. After independence consumption declined to approximately half the pre-1974 period. Supply side constraints have occurred due to sabotage and poor maintenance.

Table E.7. Total electricity generation (GWh) by type of plant

	Hydro	Gas Turb*	Diesel	Total
1970	543,7	0,0	100,0	643,7
1971	605,0	0,0	137,0	742,0
1972	680,3	0,0	158,5	838,8
1973	814,1	0,0	170,2	984,3
1974	858,1	8,0	162,7	1023,8
1975	705,1	0,0	133,2	838,3
1976	460,7	0,0	71,4	532,1
1977	529,4	0,0	28,8	558,2
1978	568,1	0,1	15,0	588,2
1979	636,4	0,0	13,0	649,4
1980	675,3	9,7	5,3	690,3
1981	688,1	20,4	8,0	716,5
1982	748,4	19,9	10,3	778,6
1983	674,3	85,3	4,2	763,8
1984	634,7	88,1	8,6	726,4
1985	621,0	76,3	7,5	704,8
1986	691,1	35,4	27,0	753,5

* Liquid-fuelled.

i.e Gas

Quantities of gas are used for improving the crude yield from boreholes by re-injecting gas. Increased re-injection is planned and it is forecast that the present 50% utilization will increase to around 70% by the end of the century.

A promising use for gas that is currently being investigated is the production of liquefied petroleum gas (LPG). At present the only place where gas for LPG production is being carried out is on a tanker offshore from Cabinda. The output consists of a 66:34 mixture of propane and butane and in 1986 almost the total output was sold to Brazil. Current production is approximately 170 000 tons per year. LPG could be used for local demand if a fractionating plant were constructed and a bottling plant were built.

Angola also has non-associated gas, but it is considered that the collection of this gas would be uneconomic unless a large market could be identified. Consideration has also been given to the construction of an ammonia plant. However, because of the size of a plant necessary to make it economic, the production would need to be greater than local demand requiring export markets. Because of the present fierce competition to supply ammonia on the world market, it is doubtful whether this option is a viable proposition at present.

ii BOTSWANA

ii.a General

The rapid economic and population growths have lead to a considerable increase in the consumption of all energy forms. Total final consumption of commercial energy was 410 000 TOE in 1989, up 32% from 1982. Electricity consumption increased by 54% over the same period and this sector, which is capital intensive, required large investments. Similarly, the total final consumption of oil increased by 42% and that of coal by 9%. The low increase in total final consumption of coal reflects its conversion into electricity. Traditional energy consumption was estimated to be 53% of total consumption (commercial + traditional) in 1982 at 350 000 TOE.

The energy intensity has been almost halved since 1982, which suggests that energy is being used more efficiently. The commercial energy used per capita appears to have remained fairly constant and was 0,325 TOE per capita in 1989.

ii.b Fuelwood

Wood is the major source of energy for the rural population and is used mainly for heating and cooking. Indications are that lower income households in the urban areas also rely on wood for heating water and cooking. It is estimated that wood caters for approximately 75% of the households' energy requirements. The fuelwood supply/demand situation varies from area to area and there is as yet no reliable method for estimating total fuelwood consumption in Botswana. The Government estimates annual fuelwood consumption to be 1,5 tons wood per capita. It has been estimated that fuelwood consumption was 350 000 TOE in 1982 or 1 million tons.

The majority of fuelwood is collected in the vicinity of settlements. Fuelwood supply deficits are reported in most of the areas surrounding Gabarone, Lobatse and the major villages in eastern Botswana. Fuelwood is generally becoming increasingly scarce and is becoming an expensive commodity in major population centres. People are spending more and more time collecting wood at the sacrifice of other activities. The extent of the wood shortages has not yet been fully quantified.

Afforestation in Botswana faces a number of problems making it expensive and difficult. The Government is thus focusing on methods to reduce and substitute the use of wood fuel and improving efficiency. This includes more efficient earthen and metal stoves, retained heat cookers, solar water heaters and substituting coal for wood where possible.

ii.c Petroleum

Botswana imports all of its petroleum product requirements via the RSA. These are undertaken within the framework of the South African Customs Union agreement. Imports were estimated at 144 000 tons in 1982. Five oil companies market petroleum products in Botswana. BP has a 41% share of the market, Mobil 26%, Caltex 17%, Shell 15% and Total 1%. A number of retail stations and large consumers in western and south-western areas receive road deliveries direct from South Africa. The oil companies import their refined products by rail and store it in tanks at the five main towns. The products are then distributed by road. The companies have a total storage capacity of 13 000 tons.

The Government constructed two strategic storage depots in 1979 at Gabarone and Francistown, with a combined capacity of 37 000 tons. These were built to reduce the impact of disruptions or restrictions of the oil supply to Botswana in general and specifically due to the likelyhood of petroleum sanctions being imposed on the RSA at that time. The Government began filling these tanks in 1982 and the reserve stock has been kept at 54% of capacity which represents approximately a month and a half's requirements for petrol, diesel and kerosene.

Published data on petroleum consumption by sector are generally unreliable and scarce. It has been estimated that the transport sector consumes 52% of all petroleum products used in the country and the mining sector consumes 25%. Diesel consumption by mining represented 36% of the total, whilst road transport represented 28%, water pumping 25% and isolated electricity generation 6%. Kerosene is used for lighting in urban and rural areas and to some degree for cooking, but no reliable data on consumption are available. LPG is widely used in urban areas.

Total final consumption of oil has risen from 96 000 TOE in 1977 to 148 100 TOE in 1982 and further to 210 000 TOE in 1989. There was a decrease in oil consumption in 1981 due to the mining depression, the switch to coal for electricity generation, and the import of electricity from RSA.

The Government is concerned about Botswana's dependence on imported oil. One of the major objectives of its 5th National Development Plan (1975-85) was to minimize dependence on imported oil by substituting domestic coal for oil in electricity generation and industry, by substituting wind or solar power for diesel in water pumping, and by encouraging thrift in oil use. These objectives were reiterated in the 6th National Development Plan (1985-1991).

ii.d Coal

Coal is the only indigenous energy source which exists in quantities large enough to have a major impact on Botswana's energy balance. Its increased use, especially for electricity generation, has been responsible for relative reductions in energy imports.

The Morupule colliery, operated by the Anglo American Corporation of South Africa, is the only operating coal mine in Botswana. The yearly production has risen from 355 000 tons in 1979 to 663 000 tons in 1989. The sharp increase in production since 1984 is due to the commissioning of the Morupule coal fired power station.

There is no domestic supply of graded, washed coal which reduces the potential for extensive use of coal by the industrial and residential sectors. Coal thus has to be imported from both South Africa and Zimbabwe for domestic consumers who require higher grade coal than can presently be supplied from the Morupule colliery. Imports rose from 17 100 tons in 1977 to 39 900 tons in 1981. They have since declined, partially due to the Botswana Power Corporation (BPC) not needing to import coal since 1982, but exact figures are not available.

Total coal consumption was 451 000 tons in 1982 and rose to 665 000 tons in 1989. This rise was largely due to increased consumption by BPC due to the commissioning of new coal-fired power stations. BPC was estimated to have consumed 254 000 tons of coal in 1982 and 466 000 tons in 1989, representing 56% and 70% of total consumption respectively. Botswana Concessions Ltd is the next largest consumer at 34% in 1982. The Botswana Meat Commission and the breweries account for 30% of the imported coal. Total final consumption of coal only rose from 110 000 TOE to 120 000 TOE in the period 1982 to 1989, reflecting the conversion of increasing amounts of coal into electricity.

The commissioning of the Sau Pan soda ash mine, for which the Morupule mine's capacity is being expanded to 1 million tons per year, will significantly affect

xii.e Coal

The demand for coal has been falling steadily in unison with the worsening economic situation and especially the decrease in copper production.

Originally Zambia imported coal from Zimbabwe. From 1965 Zambia started exploiting its own resources with mining at Nkandabwa Colliery which has now been closed. In 1972 the Maamba Colliery started operation with a rated capacity of 1,2 million ton/year, though it has not exceeded 800 000 tons/year. A combination of lack of spares, management problems, and design shortcomings have led to serious shortages in production, reaching a low of 453 000 tons in 1983 (253,000 TOE), though production has now picked up. Some exporting has taken place, athough problems at Maamba required coal to be imported in certain years.

xiii ZIMBABWE

xiii.a General

In common with other African countries, the main energy form used in Zimbabwe is fuelwood and charcoal, the traditional energy forms, which together in 1986 contributed 39% of final energy. With the lack of planning for fuelwood development, there is likely to be a serious shortage of traditional fuel within the next decade.

Of the commercial energy most is used in industry (48% in 1986), followed by transport, agriculture, commerce, and residential respectively.

Whilst the total energy demand has been increasing, the per capita consumption has been decreasing.

xiii.b Fuelwood

Data for the consumption of fuelwood shows that traditional energy amounts to between 26 and 39% of final consumption. An estimate of traditional fuel consumption is always a difficult task because of the lack of reliable data. Whatever the figure is, it is clear that there will be a serious shortage of traditional fuels within a decade.

It is estimated that consumption of fuelwood can be broken down as follows; Rural households 74%, Urban households 16%, and commercial agriculture 10%.

consumption. It has been estimated that it would consume 200 000 tons of coal in 1990. However, it seems to be behind schedule.

The 6th National Development Plan called for a feasibility study on the viability of a coal beneficiation plant to wash and grade local coal and an investigation to determine whether low temperature carbonization is a suitable technology for coal processing in Botswana. The outcome of these studies together with the possible substitution of coal directly or indirectly for LPG, fuelwood and kerosene, and the viability of exports if steam coal prices improve, could decrease coal imports and increase local production in the medium term.

ii.e Electricity

Public electricity supply is largely the responsibility of the Botswana Power Corporation (BPC), a parastatal organisation established in 1971. At this time there were two separate interconnected systems, the southern division centred around Gabarone and the Shashe division centred on Selebi-Phikwe. A rural division was established in 1975 to supply the main villages. The construction of the Morupule power station on the Morupule coalfield enabled the two main divisions to be connected to form one interconnected system.

BPC has approximately 220 MW of installed capacity, of which 7 MW is diesel and the rest coal. The main power stations are Morupule which at present has 90 MW, the Selebi-Phikwe power station with 80 MW, and the Gabarone power station with 26 MW. The Morupule power station will have 160 MW when the second phase is completed in the 1990's. A 31 MW 132-kV transmission line between South Africa and Botswana was commissioned in 1981.

A rural electrification project was commenced in 1975 and completed in 1983. Its aim was to provide electricity supplies primarily to hospitals, clinics, schools and other community institutions in nine major and six smaller villages in order to reduce the dependence of each institution on its own diesel generators. It has been estimated that approximatly 3,6% of the population has access to electricity.

The supply of electricity by industry has decreased rapidly due to the connection of several mines and industries to the grid, namely, the Orapa diamond mine in 1983, which has been made possible mainly by the construction of the Morupule power station, and by the import of electricity from South Africa. This has resulted in a reduction in the use of diesel in these industries. Power began to be imported from the

RSA in 1981 due to the inability of BPC to meet demand prior to the commissioning of the Morupule power station. The drought necessitated the closure of the Gabarone power station in 1983 in order to conserve water, and this required increasing imports of electricity. Since the commissioning of the first phase of Morupule in 1987 imports have declined.

In 1988 the mining sector accounted for 66% (70% in 1985) of total electricity consumption and Botswana Concessions Ltd's Selebi-Phikwe mine alone accounted for 44% of total consumption. Domestic use accounted for 7,7% of consumption.

The commissioning of a number of coal-fired units since 1976, the rural electrification project, the connection of industries formerly generating with diesel to the grid, and the import of electricity from South Africa have reduced the consumption of oil by this sector. This was the objective of the 5th and 6th National Development Plans.

A study has been undertaken as part of the SADCC regional energy development programme on the feasibility of a high voltage interconnection with Zimbabwe. It is thought that this would broaden both countries' supply possibilities, allow them to reduce their reserve ratios, and allow them to face the future more securely. Construction of such a link was scheduled to commence in 1987.

iii ETHIOPIA

iii.a General

As in most Sub-Saharan countries, fuelwood accounts for a large proportion of Ethiopia's primary and total final energy consumption. In 1988 Ethiopia relied on traditional fuels for 91,9% of its total final energy requirements. The household sector is responsible for the majority of total final energy consumption, (92,5% in 1988 including traditional energy).

In 1988 primary commercial energy consumption amounted to 1080,3 thousand TOE, of which 145,2 TTOE were derived from indigenous hydro and 935,1 TTOE from imported oil. In 1971 primary consumption of energy was 598,4 TTOE. The general trend has been an exponential increase in the consumption of commercial energy. In 1975 TFC of commercial energy amounted to 389,8 TTOE, while in 1988 TFC had increased to 774,9 TTOE, almost double the 1975 figure.

In 1988 the transport sector accounted for 60,7% of TFC, followed by industry (17%), residential (7,5%), and agriculture (4,1%). Industry's relative consumption has shown a general decrease, while transport and residential sectors have shown a relative increase in consumption.

TFC of commercial energy in Ethiopia is equivalent to approximately 0,64% of the TFC of the continent. The country has a per capita TFC of commercial energy of 17 kgOE per capita which is low by regional standards, although the per capita TFC of all energy forms is much higher at 207 kgOE per capita, reflecting the large reliance on traditional energy. Its commercial energy intensity of 0,139 kgOE per US$ of GDP is a little below average for the region.

Oil plays a major role in the commercial energy sector, making up 91,2% of TFC in 1988, while electricity catered for 8,8% of TFC.

iii.b Traditional energy

Consumption of traditional fuel has been increasing over the period 1971-1988. In 1988 traditional fuel consumption amounted to 8 765 TTOE. Traditional fuels in the form of fuelwood (37%), cattle dung (32%), cereal straw (23%), charcoal (1,3%) and bagasse (<1%) constitute 92% of total final consumption of energy. Almost all traditional energy is consumed by the household sector, for which cooking constitutes the only significant energy use.

Cooking is highly energy intensive due to the adherence to the traditional practice of open fire baking of thin spongy pancake-like bread on clay discs. There is a strong cultural preference for woodfuels for cooking and this together with the above has led to massive deforestation and the resultant insidious depletion of agricultural resources. This is resulting in an increasing scarcity and cost of household fuels, particularly fuelwood, and the Ethiopian landscape has changed dramatically with closed forest cover declining from 40% at the turn of the century to 3% in 1984. In response to the increasing scarcity of fuelwood, dung and crop residues are being substituted, which is having a detrimental effect on crop yields. It was estimated in 1984 that in order to check these trends and to meet fuelwood demand within the next 30 years, 5% of the Ethiopian landscape would have to be reforested.

iii.c Coal

No bituminous coal reserves have been discovered in Ethiopia. Although reserves of lignite and sub-bituminous coal have been identified, they have not been exploited. Coal does not play a role in Ethiopia's energy sector.

iii.d Oil

All of Ethiopia's crude oil and refined product requirements are imported, mostly from the USSR, and account for approximately 45% of export earnings. Crude oil is refined at the Assab petroleum refinery which has an annual capacity of 900 000 tons. In 1982 production reached 800 000 tons. Furnace oil is re-exported, deriving useful revenue for the government.

In 1975 TFC of oil was 345,4 TTOE, while in 1988 TFC had increased to 706,8 TTOE, double the 1975 figure. The relative importance of oil in the TFC of commercial energy decreased from 89,2% in 1971 to 86,4% in 1986 and then increased to 91,2% in 1988 due to the sudden decrease in the consumption of electricity after 1986. In 1988 transport (66,6%) consumed the largest amount of oil, followed by industry (13.8%), residential (5,2%), and agriculture (4,4%). In 1971, 94,9 TTOE of oil were used in the generation of electricity, which decreased to 51,2 TTOE in 1988 due to the increased exploitation of hydro potential.

iii.e Electricity

Since 1972 production has been increasingly based on hydro at the expense of thermal. Consumption of electricity grew steadily from 1978 to 1986, after which it dropped sharply to 1982/83 levels. In 1988 electricity consumption was 68,1 TTOE. Electricity's relative importance as a final consumption form increased from 10,8% in 1971 to 13,6% in 1986 and then decreased to 8,8% in 1988.

In 1988 the industrial sector accounted for 50,7% of electricity consumption, followed by residential (32,3%), and agriculture (0,6%). Relative consumption by the industrial sector has been steadily decreasing, while that of the residential sector has been steadily increasing.

Electricity is supplied by three independent grids (based on Addis Ababa, Asmara and Assab) and isolated centres powered by diesel generators. An energy development programme for the period 1982-2002 is based on the eventual linking of the three grids and the isolated centres into a unified network.

Installed capacity amounted to 338 MW in 1985, of which 225 MW was based on hydro and 113 MW on thermal. The thermal plants are all based on oil.

Total generation amounted to 815 GWh in 1988. Hydro power plays an important role in the electricity supply of Ethiopia, with more than 79% being generated by hydro stations in 1988 as opposed to 51% in 1971.

iv KENYA

iv.a General

As in most Sub-Saharan countries, fuelwood accounts for a large proportion of Kenya's primary and total final energy consumption. In 1980 it was estimated that the country relied on traditional fuels for betwwen 72 and 81% of its total final energy requirements. The household sector is responsible for the majority of total energy consumption (75% in 1988).

In 1988 primary consumption of commercial energy amounted to 2495,7 thousand TOE compared to 1398,4 TTOE in 1981. In 1988 TFC of commercial energy amounted to 1963,9 TTOE. Total final consumption (TFC) of commercial energy increased fairly steadily from 1971 to 1981. After 1981 TFC dropped rapidly in response to the economic downturn and recovered to 1981 levels only in 1986.

TFC of commercial energy in Kenya is equivalent to approximately 1,6% of the TFC of the continent. The country has a per capita TFC of commercial energy of 85 kgOE per capita which is low by western standards but average for the region. Its commercial energy intensity of 0,23 kgOE per US$ of GDP is average for the region.

Oil plays a major role in the commercial energy sector, making up 86,2% of TFC in 1988, followed by electricity (10,2%), and coal (3,5%).

Consumption of fuelwood has been increasing steadily over the period 1971-1988, mainly due to the high population growth rate. During the period 1971-1978 the consumption of commercial energy increased in relation to traditional energy. Since 1978 the importance of commercial fuel has shown an overall downward trend, mainly due to a downturn in the economy coupled with the large population growth rate and its need for traditional fuels.

iv.b Coal

No coal reserves have been discovered in Kenya. Bamburi Portland Cement Company, the biggest coal consumer, imports all its requirements from Swaziland. The origin of the remaining imports is unknown. Industry accounts for 100% of all coal consumption. In 1988 TFC of coal amounted to 69,5 thousand TOE.

iv.c Oil

All Kenya's oil requirements are imported from the Middle East by the international oil companies operating in the country. The crude oil is refined at the East African Oil Refinery (EAOR) in Mombassa. The refinery yield is not in balance with the consumption patterns of Kenya and its landlocked neighbours. Thus, refined kerosene, diesel and gasoline have to be imported to make up deficits, and excess residual fuel is exported offshore at a loss.

Total final consumption (TFC) of oil increased fairly steadily from 1971 to 1981 . After 1981 TFC dropped rapidly in response to the economic downturn and recovered to 1981 levels only in 1986. Total final consumption of oil amounted to 1534,4 TTOE in 1985 and increased to 1693,6 TTOE in 1988. In Road transport (40%) consumed the largest amount of oil, followed by industry (22%), air transport (16%), residential (8%), and agriculture (2%).

Although Kenya relies heavily on oil for its commercial energy requirements, oil's relative importance to other commercial energy forms has declined from 92% in 1980 to 86% in 1988[5]. This is largely due to substitution by electricity based on hydro.

In 1985 36 TTOE of oil were used in the generation of electricity. This rose to 103,3 TTOE in 1988.

iv.d Electricity

Consumption of electricity has grown steadily since 1971, although the consumption in 1988 was down from the previous year. Imports of electricity from Uganda have decreased steadily. Electricity's relative importance as a final consumption form has increased from 5,7% in 1971 to 10,2% in 1988. The industrial sector accounts for 43% of electricity consumption, followed by residential (31%), and commercial (26%).

The East African Power and Lighting Company Limited (EAPL) is the sole distributor of electricity in the country. Generation is carried out by EAPL, the Kenya Power Company Ltd (KPC), the Tana River Development Company Ltd (TRDC), and the Tana River Development Authority. The interconnected system extends from the Uganda border through Nairobi to Mombassa. Isolated diesel generator sets supply larger towns outside this corridor.

Installed capacity amounted to 559 MW in 1985, of which 354 MW was based on hydro, 160 MW on thermal, and 45 MW on geothermal. The thermal plant consist of oil-fired steam turbines, gas turbines, diesel generators and purchases from the Uganda Electricity Board. This import capacity amounts to some 30 MW, giving a total available capacity of 589 MW (excluding losses).

Total generation amounted to 2772 GWh in 1988. Hydro power plays an important role in the electricity supply of Kenya with more than 70% being generated by hydro stations. It was estimated that in 1988 hydro and geothermal plants together accounted for 95% of electricity generated. Most of the hydro stations are exploiting the potential of the Tana River. In the foreseeable future the power supply in Kenya will continue to depend on hydro-power, with future developments taking into consideration the multi-purpose use of water and with increasing emphasis on the environmental impact of large dam projects.

v LESOTHO

v.a General

Lesotho's total final consumption of commercial energy was 123 100 TOE in 1980, of which coal accounted for 37,2%, oil 56,6% and electricity 6,2%. All of these commodities are imported putting a large strain on the economy. Energy imports accounted for, in economic terms, 7,7% of total imports and 11,7% of total foreign exchange earnings in 1981 and 7,5% of total imports and 10% of GDP in 1986.

Total final consumption of traditional fuel in 1980 amounted to 371 000 TOE. This represents 75% of the total final consumption of energy (494 100 TOE). Woodfuels supply 46,6% of energy consumption and other traditional fuels 28,4%. The urban domestic sector relies on woodfuels for 15,8% of its energy needs and the rural domestic sector for 58,8%. It was estimated that 9 700 TOE of woodfuel was imported from the RSA in 1981 at a cost of LSM 0,5 million (US$ 0,58 million). Commercial energy consumption at 0,091 TOE per capita in 1980 was one of the lowest in the world.

v.b Fuelwood and other traditional energy

Consumption of fuelwood and other traditional energy makes up about 75% of the total energy demand. Traditional fuels for the majority of the rural population are derived from local vegetation and agricultural residues and is mostly collected by women. The country has been almost treeless for a number of decades due to its mountainous terrain and the result of overgrazing and erosion. Thus dry-cut fuelwood has to be imported from the RSA. Lesotho already has fuelwood shortages with full supply not guaranteed. Collection of enough biomass for cooking and heating has become an increasingly difficult and time-consuming activity.

Almost 35 000 tons of fuelwood are imported from the RSA each year for urban requirements. The main importers sell it wholesale to a network of 'merchants' in the urban centres. Rural supplies are obtained from woody shrubs or brushwood known as Patsi.

Dung supplies more than 40% of the energy requirements of the rural population. Dung is obtained from livestock kraals by those who own animals and from the fields by those that do not. Households which have sufficient supplies of, and rely exclusively on dung as fuel consume about 1,35 tons a year.

Crop residues in the form of dried stalks from maize, wheat and other crops are used for a short period after harvesting to supplement Patsi and dung as a fuel.

v.c Petroleum

Lesotho imports all its petroleum requirements in their refined state through the RSA under arrangements covered by the South African Customs Union agreement.

Total final consumption of petroleum products was 69 700 TOE in 1980, 62 300 TOE in 1981 and 100 000 TOE in 1989. As Lesotho has a storage capacity equivalent to only six days' supply of petroleum, it can be assumed that approximately all imports in a year are consumed in that year. Over the period 1979-1982 petroleum imports increased at an average yearly rate of 9,8%, decreasing to 4,6% during the period 1983-1986. The slow-down in imports can be partially attributed to the closure of the diamond mine and the effects of the drought. A large proportion of petroleum imports are in the form of paraffin, with the average for the period 1977-1986 being 27,4%. This is relatively much higher than other SADCC countries and is a result of the lack of indigenous fuelwood and the substitution of paraffin for cooking, lighting and heating. Petrol and diesel accounted for 69,4% of petroleum imports over this period.

Table E.8 shows the sectorial consumption of diesel and petrol. The Lesotho Highlands Water Project is expected to increase diesel consumption of the industrial sector.

Table E.8 Sectorial Consumption of Diesel and Petrol as a Percentage of Total

Sector	1979		1982	
	Petrol	Diesel	Petrol	Diesel
Retail	79,9	24,9	80,4	37,6
Commercial	14,1	42,9	14,6	26,8
Industrial	2,7	25,6	2,2	29,5
Agriculture	3,3	6,6	2,8	6,1
TOTAL	100	100	100	100

v.d Coal

Lesotho imports all its coal requirements from South Africa. Coal imports and prices are shown in Table E.9. Two major importers, Co-op Lesotho Ltd and Kuo M.D. Thomas, supply coal for six months during the winter to Government Departments (15%), hospitals (6%), the commercial sector (76%) and local industries (3%). The Lesotho paramilitary force imports two truck loads a month for its own use. Households get their supplies from commercial traders and some small importers.

Table E.9 Coal Imports

	1975	1978	1980	1981	1989
Quàntity (000's tons)	56,3	58,8	67,4	72,3	73,5
Import cost (LSM/ton)	5,3	7,7	10,1	--	--

v.e Electricity

The Lesotho Energy Commission (LEC) imports more than 95% of Lesotho's electricity needs from ESKOM of South Africa. Purchases are made via four intake points: Maseru, Maputsoe, Hololo, and Peka. More than 90% of imports are made through the Maseru connection.

In 1989 Lesotho had an installed capacity of 2,6 MW, most of which was hydro. In the same year the connections with ESKOM had a capacity of 44,2 MW, with the Maseru connection alone having a capacity of 39,6 MW. Maximum demand increased from 1,2 MW in 1970 to 27,9 MW in 1983.

The total number of LEC customers was 8 856 in 1989, an increase of 3,3% over 1988. Of these, 6 647 were domestic customers. Electricity sales have increased from 7,8 GWh in 1970 to 152,7 GWh in 1989. The 1989 figure represents a 12,7% increase over 1988. Domestic and industrial sales have been increasing on a percentage basis, while general purpose and commercial sales have been decreasing.

vi MALAWI

vi.a General

Similar to most other countries in the region, Malawi is heavily reliant on traditional energy. The ratio of traditional to total energy has remained almost constant over the period 1970 to 1986 at an average of 86%.

Total final consumption of commercial energy increased until 1980 and has since declined. On a per-capita basis commercial energy consumption has undergone a rapid decline since 1980 as a result of the economic depression and the increasing cost of coal and petroleum products, as well as the insecurity of supply.

vi.b Fuelwood

Fuelwood is the most important source of energy in Malawi, accounting for more than 85% of total final consumption. Rural households account for 62% of the fuelwood consumption, while the tobacco estates account for 23% and urban dwellers 11%. Wood is also used in the lime industry as well as for brick-making and tea-curing. Wood is the main domestic fuel for 90% of the population.

The importance of fuelwood can be attributed to the expense of petroleum-based energy forms, the small percentage of households connected to electricity, the lower capital investment needed, and the greater reliability of supply as compared with petroleum and coal.

A growing concern is that nationally demand exceeds sustainable supply by as much as 30%. It is estimated that the forestry area is being reduced by 3,5% per annum and that by the year 2000 the deficit over demand will be 13,9 million tons. To offset this the government is encouraging tree planting through its seedling programme as well as establishing wood energy plantations with funding from foreign countries such as Norway. In addition, more efficient use of wood in charcoal kilns, stoves, and braziers is being encouraged.

The Tobacco Research Authority has carried out research into improving the efficiency of woodfuel use in tobacco production and estimates that a reduction of up to 50% in consumption could be achieved by improved furnace, barn and flue designs.

The rural electrification project and its envisaged extensions, when complete, will play an important role in the above. However, in the foreseeable future alternative solutions need to be relied on.

It has been established that nationally the fuelwood problem is not perceived as being critical. This is undermining the government's seedling and self-help woodlot programme. Institutional weaknesses are also hampering progress. The Energy Studies Unit has concentrated only on household fuel and has failed, together with the Wood Energy Division, to investigate industrial use of wood where potential savings are greater. (These two divisions are located under the Ministry of Forestry and Natural Resources). There is also a lack of co-ordination between various energy and research organizations. The task of disseminating information from these institutions to the respective owners and managers needs to be addressed.

vi.c Petroleum

All Malawi's petroleum products are imported. In the past they were imported via the least-cost route, the Beira-Blantyre rail line. In the late 1970's interruptions in supply occurred and since 1979 this route has been totally disrupted by sabotage attacks. This has resulted in a number of shortages and although alternative supply routes have been used, continuity of supply has become a constant problem for the government. These difficulties have been compounded by institutional weaknesses within the country, which have contributed to the inefficiency of the present supply mechanism. Initially supplies were switched to Zambia, but closure of the Zambian refinery in 1984 again resulted in shortages. Imports are presently made via Tanzania, Zambia and South Africa. The bulk seems to be supplied from South Africa.

Petroleum product consumption increased steadily up to 1974. Between 1974 and 1979 consumption was erratic and grew very slowly due to consumers responding to rising prices and supply uncertainties by shifting to alternative fuels where they were available. Since 1980 imports have declined due to the disruption of Malawi's least-cost route to the sea and the subsequent economic depression, the effect of high prices and the commissioning of an ethanol plant in 1982. A small recovery occurred in 1985 due entirely to a rise in diesel imports. The main consumer of kerosene is the rural population who use it for lighting purposes. There has been a relative decline in its consumption which can be attributed the great increase in its cost. Jet fuel consumption dropped in 1979/80 due to the scaling down of Air Malawi's international operations due to profitability problems resulting from increased fuel costs. The percentage consumption of petrol has remained fairly constant over the period 1971 to 19814; however diesel displayed a positive growth rate over the same period. This growth has been attributed to the strong performance of the construction, industry and transport sectors during this time, as well as the lack of suitable substitute fuels. Thus the ratio of diesel to petrol has been increasing and together their portion of total consumption has grown, accounting for 85% of consumption in 1980.

vi.d Coal

Up to 1985 Malawi imported 100% of its coal requirements, most of it from Mozambique's Maotize mine, as well as from Zimbabwe, Zambia and South Africa. Coal imports have been subject to difficulties similar to those in the petroleum sector, with respect to disruption of traditional supply routes. In 1985 local production began at the Kaziwiziwi deposit in the northern region. In 1986 production was 10 700 tons and by 1988 it had risen to 26 140 tons. However, its potential is limited by its 150 000 ton mineable reserve.

Approximately ninety percent of the coal is consumed as industrial fuel. Portland Cement and David Whitehead Textiles account for over half of the consumption, while about twenty smaller industrial and commercial users account for the rest. Table E.10 gives a breakdown of coal consumption by sector. The greater majority of these consumers are located in the south, which makes the exploitation of the large mineable deposit of lower quality coal at Ngana in the north economically unattractive.

Due to data discrepancies, the small number of users, low volume, stock changes, variations in quality, and disruption in supply, the annual consumption figures vary considerablyn. There was a decline in coal consumption after 1976 which can be partially attributed to the disruptions in supply from Mozambique and the subsequent closure of the main supplier in Tete province in Mozambique in 1977. These problems were alleviated by the Coal Users Committee formed in that year. Coal imports declined from approximately 48,1 thousand tons in 1983 to 16,0 thousand tons in 1988 as a result of the unreliability and high cost of such imports together with increasing domestic production as well as a reduction in demand from the Portland Cement Company. The percentage of coal consumed by the tea industry has dropped from 12,5% of the total in 1978 to 5,4% in 1980 which was due to the switch to fuelwood grown on their own plantations for cost and reliability reasons.

Table E.10 Coal consumption by sector (as a percentage of total)

Year	Textiles	Tea	Tobacco	Cement	Other
1978	21,4	12,5	11,6	37,9	16,6
1979	18,4	6,9	15,5	39,2	19,9
1980	20,0	5,4	15,2	39,5	19,9

vi.e Electricity

Electricity consumption in Malawi has been increasing exponentially athough a lack of growth over the years 1979-1981 was due to the recession the country underwent during this period. There was also a decline in consumption during 1985 which has been described in ESCOM's 1985 yearly report as being due to the reduction in energy use by a "large customer". In 1986 ESCOM sales accounted for 86% of the total consumption. Electricity consumption grew by an average of 18% per annum over the period 1965 to 1975, decreasing to 9% over the period 1976 to 1987.

ESCOM is the sole distributor of electricity in Malawi. The distribution network consists of an interconnected system and an isolated system. Portions of the isolated system have been incorporated into the interconnected system over the years and the contribution to sales by the isolated system declined from 7,3% in 1965 to 0,2% in 1987. Thus ESCOM has expanded from a number of isolated systems to an integrated and interconnected network from Nsanje in the south to Rumphi in the north and from Chiponde in the east to Mchinji in the west. Karonga in the far north is the only isolated system.

The interconnected system is based on 144,6 MW of hydro capacity, 15 MW of gas turbine, and 8,9 MW of diesel. The isolated system which supplies the Karonga area has 0,7 MW of diesel capacity. The hydro plants provided 99,7% of total generation in 1987, with the thermal plants, except those of the isolated system, being kept for standby use. Losses as a percent of sent-out energy have increased from 8,77% in 1980 to 16,75% in 1987. In 1980 it was estimated that there were 24 MW of private generating plant, of which about half were fueled by bagasse.

The major demand for electricity is from the industrial sector which accounted for 48,1% of ESCOM sales in 1987. This sector was followed by agriculture at 20,5% and domestic at 16,6%. The sectorial demand has not changed significantly since 1980. Although per capita consumption has increased from 11,7 kWh per capita per year in 1965 to 62,2 in 1987, it is still one of the lowest in the world. In 1987 ESCOM had 35 321 consumers compared with 21 250 in 1979.

A rural electrification project, financed largely by the African Development Bank and designed to bring a steady expansion of electricity to twelve areas widely distributed throughout the country, was commenced in 1981.

The most important generating capacity on ESCOM's system is the Nkula Falls B power station located on the Shire River. It presently has an installed capacity of 80 MW, consisting of 4 x 20 MW sets, with a fifth planned for commissioning in 1991. The next major project planned by ESCOM is a new power station at the Kapachira Falls on the lower Shire River, the first unit to be commissioned in 1997. It will have an ultimate capacity of 120 MW and the unit cost of electricity from this scheme has been estimated at 5,0 US cents per kWh in 1980.

Thus there is a comfortable balance between supply and demand which should extend into the foreseeable future with the development at Kapachira Falls. However, the reliance on the Shire River for hydro power has led to concerns about the security of supply, which stem from the fact there was no flow in the Shire between 1915 and 1935 due to a drop in the level of lake Malawi. Regulation at the Liwonde barrage has reduced the possibility of a reoccurence. However, it has not been ruled out and diversification of the hydro system is called for, and a systematic and comprehensive study should be carried out to identify all the major potential hydro sites.

ESCOM exported electricity to Mozambique for a number of years, but these were halted in 1987 due to security problems. These exports represented 0,5% of sales in 1981.

vi.f ETHANOL

Ethanol is blended with petrol, thus reducing the demand for petrol by more than 10% per annum. In 1987 the production was 11,8 thousand tons oil equivalent.

vii MOZAMBIQUE

vii.a General

Traditional energy sources supply some 88% of the total final energy demand in Mozambique. This percentage has been rising steadily since 1970. The largest consumer of energy is the household sector. The division of fuel by type and sectorial demand is shown in Table E.11.

Table E.11 Sectorial final energy consumption in 1984 by type, expressed as a percentage of total energy

Sector	Oil	Coal	Wood	Charcoal	Total
Industry	2,0	1,0	15,1		18,1
Agriculture	1,1	0,2	1,3		2,6
Transport	5,1	0,1			5,2
Household	0,9		68,8	1,2	70,9
Other	3,2				3,2
Total	12,3	1,3	85,1	1,2	100,0

The demand for electricity was not given in the data from which Table E.11 was taken, but the amount involved was small in comparison with the traditional fuels and oil.

The demand for coal has been falling steadily and is being replaced by oil. This decrease in coal demand has been due to problems with the supply of coal because of

Renamo activities, and because of problems with coal production at Moatize Colliery. Oil comes by sea and is therefore relatively immune from attack by the Renamo.

The energy intensity of the country has been falling rapidly due to the worsening economic conditions in the country and the decrease in manufacturing activity.

vii.b Fuelwood

Fuelwood is the main source of energy and is important in both the household and industrial sectors. The domestic sector accounts for 81% of the total fuelwood consumption, industry for 18% and agriculture for 1%.

Fuelwood is in very short supply in the main urban areas, with Maputo having a very serious shortage. The country as a whole has no shortage of fuelwood, though there are local imbalances. Surveys of fuelwood imports into Maputo have shown that most of the wood is green, pointing to a deteriorating supply position. Fuelwood for Maputo is brought in from distances as far as 500 km away. There does not appear to be any significant commercial trade in fuelwood due to the problems of operating transport in areas where Renamo disrupt the infrastructure

The pressure on fuelwood has been compounded by the growing scarcity of alternative fuels such as kerosene and LPG. Fuelwood prices have escalated significantly and are now beyond the means of the poorer sector of the economy, whose eating patterns have had to be adapted to the use of more uncooked food or of food which does not require lengthy cooking. The escalation in fuelwood prices has resulted in the situation where virtually any fuel is cheaper than fuelwood.

In the rural areas the fuelwood situation is generally easier and more than 90% of families use fuelwood. As elsewhere in Africa, the responsibility for fuelwood gathering rests with women who spend on average 8-14 hours per week on this task. In areas of shortage families use about 30 kg/week. In other areas the consumption is between 50 and 70 kg/week, with 50% of families using less than 50. Kerosene has been used as a fuel in rural areas but, with the present shortages and restrictions, it is less often used.

Serious consideration will need to be given to afforestation programmes and to resuscitate those programmes which have been started but which have been abandoned.

vii.c Petroleum

Until 1984 Mozambique refined its own products from imported crude oil. However, there were problems with satisfying the product mix because of the imbalance between design yield and local demand. This resulted in the importation of certain products, and at times there were exports of gasoline to inland countries. These exports were sold at international prices but any excess to these quantities had to be sold through trading companies at unfavourable rates. For example, in 1981 the refinery production was 435 thousand tons, imports were 148 thousand tons and exports were 115 thousand tons.

Total oil demand rose steadily from 1965 to 1980 and after a slight decrease has remained constant from 1982. During the period 1971 to 1988 demand has not undergone any significant medium-term change but has shown significant differences in product segmentation. The main growth in demand has been for diesel fuel with a reduction in gasoline demand. The diesel-to-gasoline ratio, which varied between 0,7 and 1,7 up to 1984, suddenly shot up to a value of around 5,5. There have been significant shortages in various sectors and especially of gasoline, diesel, and kerosene. The lack of significant growth in demand is therefore due to limitations in supply, rather than due to internal economic exogenous forces. The gasoline demand has also decreased because of the scarcity of private vehicles. The main reason for the shortages have been the serious lack of foreign exchange, which started in 1984 and led to disruption in the procurement of crude oil. Small quantities of products were then imported at international spot prices, exacerbating the foreign exchange problem.

Due to foreign exchange problems it was not possible to import crude in bulk and the Matola Refinery was closed in 1984. The Refinery is 25 years old and gives a product mix which is inconsistent with the current and expected product demand pattern. The Government is now considering the future of the Refinery. One of the options being considered is to restart the Refinery but at a low throughput, in order to import the components which the Refinery is unable to produce in sufficient quantities. The alternative is to refurbish the plant with the addition of thermal cracking plant, to increase the percentage of gasoline and diesel.

The marketing of products throughout Mozambique is carried out by PETROMAC (69% of market), BP (23%), Mobil (6%), and Mocacor which handles, bottles, and distributes LPG.

There is a 287 km pipeline between Beira and the Feruka Refinery in Zimbabwe. This line is owned and operated by a company which is 50% owned by the Government of Mozambique, 45% by UK and Luxembourg companies, and 5% by private individuals. The only restriction on the operation of the pipeline is that due to the limitations in tanker capacity at the Port of Beira. A limit of tanker capacity to below 20 000 tons is in operation due to silting of the access channel. There would be a significant reduction in freight costs if larger ships could be used.

vii.d Coal

Coal has played a minor role in the Mozambique energy sector. The demand for coal increased steadily up to 1973, but declined rapidly thereafter. Although data concerning the use of coal is difficult to come by, although estimates are given in Table E.12.

Table E.12 Coal sectorial demand in 1982

Use	Demand 000's ton	%
Power generation	62	29
Railways	46	21
Cement factories	67	31
Sugar mills	26	12
Other	14	7
Total	215	100

Of the above demand in 1982 60% was imported, mostly from South Africa, for the coal-fired power plant at Maputo. In 1988 imports amounted to 31% of demand. The only producer of coal in Mozambique is the Moatize Colliery in Tete Province. Up to 1982 significant amounts of coal were exported, mainly to Malawi, though some was exported to other countries by sea. At the same time coal was imported to the southern region since it was cheaper to import from South Africa than to rail coal from Moatize to Maputo. Production at the mine started in 1950 and peaked in 1975 at 575 000 tons. Production declined following underground gas and dust explosions in 1976 and 1977. Since 1981 disruptions of the railway line to Beira by sabotage have led to further declines.

Little coal is used for domestic consumption except in the immediate vicinity of Moatize.

One of the Government's priorities is the development of coal exports to earn foreign exchange. The proposed programme for Moatize is for an ultimate production of 6 Million tons/year. Significant amounts of coking coal could be produced and previous exports to Malawi consisted of 55% of coking coal. Such a programme would require the rehabilitation of the Beira export terminal. An alternate transport route would be via Malawi and on to Nacala, a total distance of 615 km. Nacala has the advantage of a natural deep-water harbour with good loading facilities. It is estimatedhat the cost of shipping via Nacala would be less than that through Beira.

Any export proposal would require cessation of hostilities in the country.

vii.e Electricity

The Mozambique electricity system consists of 350 MW of generating capacity for local use, and the Cahora Bassa Dam 2075 MW plant mainly for the export of power to South Africa. Whilst the local plant has a name-plate rating of 350 MW it is badly in need of repair and the assumed available rating is 250 MW. There are 3000 km of high and medium voltage lines.

The system can be divided into four main components: the Northern, Central, and Southern Regions, and the Cahora Bassa system.

Northern Region

The northern region is supplied with power from Cahora Bassa by a line from Cahora Bassa down to Caia ending up at Nacala on the coast. The line down to Caia is a double line for stability purposes, whilst the line between Caia and Nacala is a 220 kV single line. Stand-by diesel units are installed at Nacala.

The far north of the region is isolated from the grid. There are a number of small diesel units in the region, but these are expensive to operate and the supply of fuel is erratic. The EDM have built a 0,7 MW hydro-plant and are constructing another 1 MW hydro-plant.

Central Region

The central system is served by a line from Tete down to Beira. This system is linked to the Cahora Bassa-Nacala line and is provided with 90 MW of hydropower generation on the Mozambique-Zimbabwe border. There is also an interconnection with Zimbabwe. Stand-by power at Beira is not available, but there is some stand-by capacity from local sugar plants which could meet part of the load. There is some old plant, totaling 11 MW, at a sugar mill near Beira which could be refurbished to provide additional security.

The line to Beira has suffered serious damage due to sabotage and requires a major overhaul.

Southern Region

The southern region is not linked with the other two and serves the area from Maputo to Xai-Xai. There are 50 MW of coal plant and 44 MW of gas-turbine plant in Maputo. The plant is old and has been derated from its name-plate rating of 142 MW down to 94 MW.

There is a link between Maputo and the South African grid for the import of power in line with Mozambique's entitlement of Cahora Bassa power. This line is only 75 kilometers long within Mozambique but it has nevertheless suffered from sabotage. The line was also severely damaged by a hurricane in 1985, which blew down 31 transmission towers.

Cahora Bassa

The Cahora Bassa system was built to transmit power from Cahora Bassa to South Africa. The Power Station consists of 5 turbines, each rated at 415 MW. The Power Station is rated at 2 075 MW, with a firm capacity of 1 660 MW. The transmission system is a +/- 533 kV DC line, with a rated capacity of 1 920 MW and capable of transmitting 80% of the rated capacity with one line out of action, via earth return. There is no draw-off from this line within Mozambique. This system is owned and operated by a company with 82% Portuguese and 18% Mozambique interests.

Supply and demand

The main supplier of electricity is the EDM, though there are some small independent producers of electricity, mainly industry for its own use, e.g. sugar mills. The main supply component is hydropower.

Electricity demand in the country grew steadily until 1984. There has been a reduction in demand since 1984 as a result of the serious decline in the economy of the country.

viii SOUTH AFRICA

See section 4.5.

ix SWAZILAND

ix.a General

Unlike the situation in other African countries, the contribution of traditional energy to the total energy demand is relatively small at around 19%. This does not however include the use of crop residues, and especially bagasse, as a fuel in industrial applications. The breakdown of the contribution of the various energy forms to total final demand is shown in Table E.13.

Table E.13: Energy final demand by energy source (1985)

Energy source	Percent contribution
Coal	18,9
Oil	22,6
Bagasse	31,2
Woodwaste	0,1
Electricity	8,0

Total commercial	80,8
Traditional	19,2

	100,0

The largest user of energy is the sugar industry which in 1985 used 35% of total final energy demand. The next largest user was the domestic sector which relied largely on fuelwood.

All petroleum products are imported, a large proportion of coal is imported from South Africa, and some electricity is imported. In order to become less dependent on imported energy more electricity could be produced either from hydro or from thermal power plant based on coal. In addition, much more indigenous coal could be used. However, most of these steps imply higher costs as the move to produce more hydro-power has already demonstrated.

ix.b Fuelwood

Fuelwood is the main source of energy for households in the rural areas where some 74% of the population live. In urban areas some 10-20% of the population use fuelwood. Fuelwood is becoming scarce in the urban areas and is also expensive. It has been shown that the gathering rate varies from 9 kg/hour in the Middleveld through 14,9 in the Highveld to 19,6 in the Lowveld. Consumption of fuelwood varies with season and region. Typically, consumption is in the range 1 to 4,5 kg per day per person.

Fuelwood is already scarce and the scarcity will increase unless some effort is made to plant fuel crops. In the medium term cutting into the standing stock of trees will be required, which will compound the shortage in future years. This requires a decision by Government on its tree-planting programme and the allocation of funds.

ix.c Petroleum

All Swaziland's petroleum products have to be imported since Swaziland does not have an indigenous oil supply, nor does it have a refinery. Supply is carried out by seven international companies - BP, Caltex, Mobil, Shell, Sonap, Total, and Trek. These companies are based in South Africa and supply Swaziland as part of their Southern Africa operation.

The market is relatively simple, with gasoline and diesel fuel accounting for 87% of total supply. Kerosene and LPG account for around 6% of total consumption and are used mostly in the household sector.

The breakdown in product mix in terms of energy utilization is shown in Table E.14.

Table E.14: Petroleum product mix in 1985 (percent of energy supplied)

Product	Percent Contribution
LPG	2,1
Avgas	0,3
Avtur	1,1
Kerosene	4,3
Fuel oil	5,1
Gasoline	44,3
Diesel	42,7

ix.d Coal

The coal potential of Swaziland has been fairly well explored with sufficient work having been carried out over approximately 40% of the coalfield. Coal properties vary over the field and one-quarter of the coal is semi-anthracitic or low-volatile bituminous, the remainder being anthracitic. Ash content is high and beneficiation would be required for most applications and especially if export coal is required.
With the low volatile content there are problems with burning the coal in the conventional stoker boilers used in South Africa and many users have changed over to South African imported coal because of these problems. Whilst it is easier to use South African coals in the present boilers, in the future it would be of benefit if boilers designed to operate on the specific Swaziland coals were to be developed. One possible method of burning the coal efficiently is to use fluidized bed systems.

Whilst international sources quote Swaziland production of coal as starting in 1959, the only operating mine, located at Mpaka, was opened in 1964. It was originally developed as a subsidiary of Anglo-American to provide coal for the locomotives servicing the iron-ore mine at Ngweya. The mine was operated on a lease system on a ten-year basis until 1985 when it was taken over by a Swaziland based company, Emaswati Holdings Ltd. An important consideration of the new arrangement is the equity participation by the Swazi nation, which gives it a 10% share at the moment but increasing eventually to 50%.

The Mpaka mine is an underground operation using bord-and-pillar extraction techniques. Only the main seam is mined, which varies from 3,5 to 4,2 metres in thickness. The production capacity is 17 500 tons per month (210 000 tons per year). Coal is screened and washed to give four size fractions: washed cobbles (38-75 mm), nuts (25-38 mm), peas (9-25 mm), and duff (less than 9 mm). Production has increased steadily from 30 000 tons in 1965 to 166 000 in 1985. Since 1985 the output has been constant at an average of 167 000 tons per year.

A large percentage of the coal has been exported, with Mozambique and Kenya being the main destinations in the 1970's, and now the main customers are Kenya and Korea, though some sales have been made to France, Italy, Belgium, and the Scandinavian countries. Transport is a problem with the export sales due to the unreliability of the Mozambique link.

Because of combustion problems being experienced with the Swaziland coal, coal is also being imported from South Africa. Serious fluctuations have occurred in the export and domestic markets and the mine has stock-piled coal in order to keep operation on a uniform level.

Swaziland has a potential to export anthracitic coal on a world basis. Much of the world market is however for low-ash coal, normally less than 10%. At present the beneficiation of Mpaka coal reduces ash to 14%, and further beneficiation would be required for the world market. There are however segments of the world trade where ash is not a primary consideration and Swaziland coal might be suitable for this sector. The Far East is the main market for this sector, with Korea being the single largest importer of anthracite. The Swaziland coal has a low sulphur content which will make it attractive for countries with strict pollution legislation.

ix.e Electricity

Electricity in Swaziland is distributed by the Swaziland Electricity Board (SEB) which was formed in 1963 as a government-owned entity. Only the SEB is allowed to generate and distribute electricity, although it may grant licenses to others to generate, especially if it is from by-product material. In Swaziland this group of self-generating utilities is large and accounts for around 34% of total electricity consumption. Before the formation of SEB there was a public utility which had an installed capacity of 0,6 MW in 1954.

The growth rate in sales has followed closely the economic activity in the country. The largest users of electricity are industry and irrigation. Between 1970 and 1980 system should be able to meet the maximum demand with the largest "unit" on the system out of commission. In the case of the SEB the largest unit is one of the ESKOM grid lines from South Africa, which are rated at 31 MW each. Table E.15 shows that this cannot be met in practice.

Table E.15: Swaziland Electricity Board maximum demand and installed capacity (MW)

	Max Demand	ESKOM Link	SEB generation	Total	Reserve
1985	81	60	50	110	-1
1986	84	60	50	110	-4
1987	97	60	50	110	-17
1988	87	60	50	110	-7
1989	92	60	50	110	-12

"Reserve" in the Table refers to the difference between the maximum capacity with the largest unit out of commission and the maximum demand on the system. In this case the maximum capacity is taken to be one of the two ESKOM link lines with a capability of 30 MW. It will therefore be seen that over the last five years the amount of the capacity on the system does not give it the required amount of safety and any improvement in the economic situation, and the resulting growth associated with it, could lead to serious shortages. However, this situation is no different from that which has been going on for the last ten years and therefore no greater problems are expected. But continuing increase in maximum demand will need to be catered for by an increase in capacity.

Customers on the SEB system complain of frequent outages. Most of the outages are of the order of 30 minutes, but several outages can occur in one day. Also a cause for complaint are voltage fluctuations on the system. The SEB therefore needs to increase its security both from the point of additional generating capacity as well as from the point of outages.

ix.f Ethanol

The surplus of molasses and the environmental aspects associated with its storage make the manufacture of ethanol as a transport fuel an attractive proposition. Ethanol blend usage is now an accepted technology and has been used on a small scale in South Africa in Natal since 1945, and more recently in Brazil. Ethanol blends are also used in Malawi and Zimbabwe. South Africa uses a 10% blend of ethanol and higher alcohols in all its gasoline on the Highveld and therefore there would not be any problem in cross-border travel as long as the blend levels were not very different.

Gasoline is imported into Swaziland from South Africa and the Swazi market is so small compared with that of South Africa that it is doubtful whether the refiners would produce a blend stock specifically for the Swazi market. Blending would therefore have to be splash blending with conventional feedstock. A blend level of 10%, or at most 15%, could be achieved leading to production of 8 million litres of ethanol at present, rising to 11 million litres by the turn of the century.

x TANZANIA

x.a General

In 1988 Tanzania's total final energy consumption (TFC) was 12,936 million TOE, of which 95% was in the form of traditional fuel and 4% in the form of oil products. Households accounted for 74% of TFC, followed by agriculture (21%), industry (14%) and transport (4,6%). The overall per capita consumption was 515 kgOE.

Tanzania's total final commercial energy consumption was 581,2 thousand TOE in 1988. From 1983 to 1988 there has been a slow decline in consumption. In 1988 oil accounted for 88,5 % of commercial energy consumption, followed by electricity (11,2%) and coal (0,3%). In 1988 the transport sector accounted for 40,4% of commercial energy consumption, followed by industry (33,5%), households (14,3%), and agriculture (6,5%).

The contribution of traditional energy appears to be increasing. This can be partially attributed to the shifting of the economic mix towards agriculture. This is supported by the fact that the commercial energy intensity is declining.

Per capita consumption of commercial energy has declined from a high of 48 kgOE in 1980 to 24 kgOE in 1988.

x.b Fuelwood

Total final consumption of fuelwood in 1988 was estimated to be 12,4 million TOE. This equates to 476 kgOE per capita. The household sector accounts for 90% of fuelwood consumption.

In 1981 the estimated annual demand was 23 million m^3 per year and the estimated sustainable supply only 16 million m^3 per year. This resulted in 26 million m^3 of forest being lost by overcutting. Further, this exploitation reduced the productivity of the forests by 1,8%. The problem is further complicated by competing claims on the land for agriculture and livestock.

x.c Petroleum products

Total final consumption of oil products amounted to 514 100 TOE in 1988, which was down from the high of 829 600 TOE in 1980. The sudden decline in consumption since 1980 has been ascribed to a lack of foreign exchange, oil price increases, reduced economic activity, and the under-utilization of available capacity in the transport and industrial sectors.

In 1988 the transport sector accounted for 46% of final consumption, followed by industry (29%), residential (13%) and agriculture (7%).

In 1988 diesel accounted for 39% of consumption, followed by residual fuel (23%) and petrol (15%). The relatively high consumption of residual fuel (fuel oil) can be attributed to its use for the generation of electricity. (All Tanzania's thermal stations are oil-powered.)

Tanzania has no indigenous supply of petroleum and imports all of its requirements. In 1981 petroleum imports accounted for 50% of 'free' foreign exchange (not tied to a particular project) which puts a large strain on an economy already short of foreign exchange and this has resulted in a depressed supply of petroleum products. In 1990 petroleum imports accounted for 60% of all foreign exchange earnings.

The Tanzanian-Italian Petroleum Refinery is the country's only refinery and is located near Dar-es-Salaam. It was designed to produce 700 000 t/y of refined products using Iranian or Iraqi crude. The yield pattern of the plant is not in balance with the demand profile, and resulted in deficits in the lighter products and an excess of residual fuel. This has resulted in the need to import large quantities of light refined product and export excess residual fuel at depressed prices. In the late 1970's the refinery switched to lighter crudes in order to reduce the surpluses of residual fuel which had to be exported at reduced prices. Although the surpluses have decreased the imbalances have persisted. This has also reduced the plant capacity to 670 000 t/y. The output of the refinery was 485 000 tons in 1987.

This inefficiency is complicated by the fact that the refinery was designed to minimise capital costs at the expense of high energy consumption. These inherent inefficiencies are being added to by the lack of spare parts and maintenance materials due to foreign exchange constraints. This has resulted in high consumption of oil by the refinery compared to refineries of similar configuration. The consumption of oil by the refinery as a percentage of total final consumption of oil has been increasing steadily since 1985, although total final consumption has been decreasing.

A lubricating oil blending plant was added in 1987 and a bitumen plant was due to be completed in 1990. The refinery is to be rehabilitated during 1990-1993 at a cost of $ 18 million.

x.d Electricity

Electricity consumption in Tanzania was 65 300 TOE in 1988. Production totaled 879 GWh (75 700 TOE) in the same year. There has been a reduction in consumption since 1980 as a result of the deepening economic crises. Prior to 1980 electricity consumption displayed an exponential growth except for the effects of the drought which ended in 1975.

In 1988 the industrial sector's consumption amounted to 64,17% of total consumption, while the residential sector accounted for 26% and the agricultural sector 2%. In 1983 it was estimated that only 7% of the population had access to electricity and that rural electrification was progressing slowly. This is reflected in the low per capita consumption of 32 kwh per capita per year in 1988. By 1990 only 45 of the 75 mainland districts had been electrified.

The power supply system of the Tanzania Electricity Supply Corporation (TANESCO) consists of an interconnected system and an isolated system. The connected system is extensive and is situated mainly in the east and north-east of the country. Almost 95% of the grid production is based on hydro sources and the hydro installed capacity is 333 MW. The Kidata Dam project which has an installed capacity of 280 MW makes up 84% of this installed capacity. It supplies Dar-es-Salaam via a single circuit 220 kV transmission line passing through difficult terrain and its vulnerability is a cause of concern. Maximum demand on the grid was 250 MW in 1990, up from 118 MW in 1982. Dar-es-Salaam had a maximum demand of 150 MW in 1990. The isolated system depends mostly on diesel-powered generators, many of which are in poor condition due to lack of spare parts and operate at limited load factors due to lack of fuel.

Total installed capacity was 370 MW in 1981 and increased to 401 MW in 1986. In 1990 the total installed capacity was 519 MW, of which 333 MW was based on hydro and 186 MW on fuel oil. Hydro production accounted for 70% of production in 1988 and thermal stations the remaining 30%. There was a peak in thermal production in the mid 1970's which was due to the drought of that period and the related inability of hydro plant to meet the increasing demand.

Electricity losses in the past have been high (19,2% in 1982) and the failure of many institutions to pay for consumed electricity, together with other economic and political problems, has meant that TANESCO has been unable to invest in the expansion of generating equipment or the grid until recently.

Tanzania has recently launched a major project to generate more electricity, extend its grid, and improve reliability of supplies through an electrification masterplan. This plan aims to develop additional energy sources, namely, gas (Songo-Songo), coal, geothermal and other renewables, as well as the significant further development of hydro power resources. It also aims to provide every region with electricity by 2001, and a rural electrification programme has been set up which aims to use mini-hydro generators to replace diesel generators. Only 10% of townships are presently supplied with hydro-electric power. The plan includes the rehabilitation of the Dar-es-Salaam distribution system, as well as the extension of the grid.

Funds have come from the Japanese International Co-operation Agency, the World Bank, and Finland's FINNIDA.

x.e Coal

Coal plays a relatively minor role in Tanzania, with a total final consumption of 1 800 TOE in 1988, although there are vast reserves. The industrial sector is the only consumer of coal, and consumption is confined to the Mbeya region where the coal deposits are situated, due to supply constraints and limited distribution facilities. The start of production at the 100 000 t/y Songwe-Kiwira mine in early 1989 should change the consumption pattern.

A potential use for coal is in pithead electricity generation. However, the abundance of hydro potential and gas makes coal a less attractive option. The potential for exporting coal is limited.

xi ZAIRE

xi.a General

The main energy form in Zaire is fuelwood. The estimated contribution of the various energy forms in 1983 is shown in Table E.15.

Table E.15: Energy supply in 1983

Source	Fuelwood	Agr waste	Oil	Elec	Coal	Total
TOE '000	6478	600	662	344	141	8224
%	78,8	7,3	8,0	4,2	1,7	100,0

ix.b Fuelwood

Fuelwood is used mainly in the domestic sector though small amounts are used for metalworking, brick-making, laundries, drying agricultural products, and for the smoking of food products. Whilst most of the wood is used in its normal form, some is also converted into charcoal.

No long term statistics are available for fuelwood consumption but an estimate has been carried out for 1983. Table E.16 shows the quantities of fuelwood used in various sectors and also the form in which it is used.

The reason for the heavy reliance on fuelwood is the expense of alternate energy forms and the fact that only 3,5% of households are connected to electricity. The use of fuelwood needs a lower capital investment than electricity, or petroleum products.

Fuelwood is used almost exclusively in the rural areas and is almost always gathered rather than purchased. It is also gathered when required rather than stored. Charcoal is also used for cooking and is more prevalent in dense urban areas such as in Kinshasa. In cities the ratio of charcoal use to fuelwood use is typically 6:4 though in Kinshasa the ratio is 17:3. The ratio of charcoal to fuelwood is a function of the distance from the centre of a city i.e those on the periphery use less charcoal than those in the centre. The average charcoal consumption is 875 kg per household per year, with an estimated 1 kg required to cook a meal.

Table E.16: Consumption of fuelwood - 1983 (Cubic metres wood equivelent)

Consumer	Form	Quantity '000 m^3	TOE '000
Household			
Rural	Firewood	19 840	5 105
Urban	Firewood	5 224	1 344
	Charcoal	7 836	2 016
Metalwork	Charcoal	100	26
Bricks	Firewood	93	24
Laundries	Firewood	6	1
Smoked food	Firewood	2	1
Agriculture	Firewood	9	2
		-------	------
		33 110	8 520
Subtotals			
Domestic		32 900	8 466
Other		210	54

1 m^3 = 0,75 ton: 1 ton = 0,3431 TOE

There will be no shortage of fuelwood in the country for the foreseeable future. However, there is already an in-balance between supply and demand in certain parts of the country. Kinshasa which is the most densely populated region in Zaire also has the highest demand for fuelwood. The forests around the city have been largely felled within a radius of 25 km and charcoal and fuelwood are being imported from regions 50 to 100 km from the city. In other parts of the country the same situation is beginning and the World Bank has recommended that a programme of reforestation should be started. The World Bank also recommends that the government should promote the use of more efficient charcoal stoves which would reduce the consumption of fuelwood. They have also advocated the use of more efficient charcoal kilns.

Cost analyses have been carried out on the provision of fuelwood and charcoal from sawmill wastes near Kinshasa. Plans are also being considered for the supply of charcoal to Kinshasa from a fuelwood plantation on the Bateke Plateau, some 150 km from Kinshasa.

It is also evident that unless a large-scale electrification programme can be started there will need to be a programme of using the forest resources of the Central Basin for satisfying the needs of Kinshasa. Consideration is being given to providing electricity to certain industries which use wood but as shown in Table E.16 this can only produce a small saving in fuelwood demand.

xi.c Petroleum products

Zaire is an oil producer mainly from its off-shore wells in the Coastal Basin. These off-shore wells have been exploited since 1975 and by 1983 approximately half of the proven recoverable reserves had been used. The on-shore reserves in the Coastal Basin have only been utilized since 1979. Production has been low relative to the recoverable proven reserves and only 1,5% of the reserves have been used. However, the off-shore reserves are considered to be under-estimated and exploration is still being carried out.

The whole of the oil production is exported since it would yield more heavy fuel oil than required for local consumption if it was refined locally . Zaire therefore imports finished products or crude which is lighter than its own, for refining in the SOZIR refinery situated near Moanda. Because of the lack of a deep-water port in Zaire, the imported crude is transshipped to barges at the mouth of the Zaire river. The refinery was commissioned in 1969 and is jointly owned by the Government and AGIP of Italy. It was originally designed for Iranian Light crude but has recently been switched to Nigerian Light crude.

Imported crude comes mainly from Nigeria whilst imported products are imported mainly (96%) from Brazil. Additional finished products come from Kenya by road-tanker for use in the eastern parts of the country, or from Zambia to supply the southern part of the country. Because of the high transport costs by land the products imported by road are some two to three times the price of products in the west of the country.

There has been a decline in consumption from 1975 which is in line with the decline in the economy. In spite of the general reduction in consumption there is a gradual increase in the use of diesel fuel (gasoil). There is also a significant change in the ratio between diesel and gasoline with the former increasing whilst gasoline use was decreasing.

The distribution of petroleum products is in the hands of 5 oil companies - Fina, Mobil, Texaco, Shell, and the state owned Petrozaire. The largest of these is Fina with Mobil and Texaco of approximately the same size and Shell the smallest of the four private operators. Petrozaire only has some 5% of the total market.

However, there has been a lack of competition in the market since the oil suppliers worked on the basis of a fixed market quota, stipulated for each product. This quota system was abolished in 1985.

xi.d Electricity

Significant electric power generation started in Zaire in 1930 when a 32 MW hydro-plant was commissioned in Shaba Province. Electricity use grew rapidly thereafter until 1958, after which consumption was static until 1964 after which it again began to grow although at a lower rate. The consumption rose by 16,6% per annum in the early period and from 1964 it has been growing by 3,2% per annum.

Whilst most of Zaire's present electricity generation, and the most significant part of the future potential electricity generation, is based on the Zaire River there are areas which are remote from the river and where alternate electricity generation forms have to be used. At present some 4% of the electricity generation is based on thermal power plant using coal.

Electrical power is supplied by the state-owned Societe Nationale d'Electricite (SNEL) and by various small local producers. The relative amounts supplied by the various producers and from the two resources, hydro and thermal are shown in Table E.17.

Table E.17: Installed capacity in 1986 by producer and form (MW)

	SNEL	OTHERS
Hydro	2402 MW	80 MW
Thermal	60 MW	55 MW

There are three main distribution areas :-

a) Bas-Zaire system at the western end of the country supplying Kinshasa, Matadi, and other surrounding urban areas. There is also some supply to the Congo.

b) Shaba network in the south-eastern part of the country supplying Lubumbashi and other urban areas and with an interconnection with Zambia.

c) Kivu system located in the eastern part supplying local urban areas and inter-connected to Rwanda and Burundi.

The Bas-Zaire and Shaba systems are connected by a 1 700 km Direct-Current link operating at 500 kV between the Inga Power Station and Kolwesi in Shaba Province. This line is currently operated and maintained on SNEL's behalf by Constructeurs Inga-Shaba, a local subsidiary of the international Morrison-Knudsen Company.

The Inga-Kolwesi line was constructed in anticipation of a continuing boom in copper prices on the world market and was rated at 1 120 MW. With the decline in copper prices and the reduced economic activity the terminal equipment was downgraded and the line can only cope with a maximum of 560 MW. During the first years of operation of the line the maximum demand was in the 60-140 MW range.

Because of these factors, and especially because of the high capital cost of the transmission line, the delivered cost of electricity to the Gecamines mines from Inga is

US (1984)cents 1,66/kWh, excluding the capital cost of the Inga Power Station. Increased utilization of this line would reduce this cost significantly.

The most important generation capacity on the Zaire electrical system is the Inga II Power Station which consists of eight generating sets, each with a 178 MW capacity giving a total installed capacity of 1 424 MW. Construction started in the early 1970's and was completed in 1982. The cost of the plant was US$ 590/kW in 1984 prices. Because the economic conditions forecast for Zaire did not materialize Inga has always been under-utilized with, for instance, a load factor of 30% in 1984 and an actual output of 1 942 GWh compared with a possible 6 500 GWh.

The operation of Inga II has been badly affected by design and maintenance problems. Because of these it has not been possible to synchronize Inga I and Inga II onto the same system. As a result Kinshasa is fed from the Inga I Power Station whilst Inga II feeds the Inga-Kolwesi D.C. line only. In addition, Inga II Power Station has been forced to operate at conditions of severe cavitation which results in deterioration of the turbine runners.

The down-turn in economy did not only affect Inga's output but had repercussions on all of the installed capacity. Thus SNEL's annual output was 4 700 GWh in 1984 which is approximately 43% of the potential production. As a result of this the load factor on the assumed integrated system has dropped from a high of 64% in 1971 to 21% in 1983. However, this figure hides an imbalance between the various regions. Thus the ratio of peak demand to installed capacity is 0,92 in Shaba province but is 0,27 for Bas-Zaire and Kinshasa. The latter region has 75% of SNEL's installed capacity but produces only 33,8% of electricity.

The sectorial demand picture for Zaire is not available but in 1983 72% was supplied at high voltage, ie to large industry, 12% at medium voltage, ie mainly to small industry though it may include some residential, and 16% was at low voltage.

The domestic consumption of electricity is low due to the small number of consumers connected to the grid. Even in the urban areas the number of customers is small. For the country as a whole the electricity penetration into the domestic market is only 3,5% with most people relying on fuelwood and charcoal. One of the objectives of SNEL has been to increase this penetration, especially in the more densely populated regions such as in Kinshasa. It has set itself the goal of increasing the domestic connection in Kinshasa from 18,5% in 1983 to 70% by 1991. However, it is unlikely that this target will be reached.

One of the problems of increased penetration into the domestic market will remain the inability of the people to pay for their electricity or even for SNEL to be able to collect the amounts owing. In view of the cost of meters and of the difficulty of reading them one of the plans is to install circuit breakers of a given size, eg 4 amps, and to charge the consumer a fixed charge depending on the circuit breaker setting.

xi.e Energy substitution

By far the largest proportion of energy demand is in the domestic sector and the main source is fuelwood and charcoal. At present the marginal cost of charcoal is half that of electricity and even with high subsidization of electricity in the domestic sector it is not competitive with charcoal. It is only in the middle and higher income groups where convenience is considered above cost that there is likely to be a significant substitution of charcoal by electricity.

In the transport sector there is little scope for fuel substitution in road vehicles with the introduction of ethanol being one of the options being considered. One of the largest users of petroleum fuels is Gecamines and they are considering the replacement of diesel vehicles in open pit mining by electric traction.

There is also some scope for the replacement of coke in metallurgical furnaces by electricity, and to reduce the use of fossil fuels in industrial boilers by changing over to electric boilers, and to replace the use of heavy fuel oil in cement works by coal.

xii ZAMBIA

xii.a General

It has been estimated by the Ministry of Energy and Water Affairs that traditional energy amounts 60% of total final energy demand. However the International Energy Agency Statistics give a figure of 18%.

Total final energy consumption increased until 1976, after which it has shown a steady decline. On a per capita basis, the energy consumption has undergone a rapid decrease. This mirrors the decline in economic activity per capita.

The main commercial energy forms have been oil and electricity which accounted for 40% each of final consumption in 1987. Whilst the GDP has remained approximately constant over the period 1976 to 1987, the total final energy use has decreased. This decrease is a direct result of the decrease in mining activity which fell from a 36% contribution to GDP in 1970 to a low of 14% in 1984 before starting a slow recovery to 23% in 1986. The main reason for the decline in mining activity was the decline in the copper demand.

Because of the high cost of imported fuel, the Government is investigating the role of fuel substitution as a means of conserving foreign exchange. The main area where substitution could be possible is in the copper mines. Some mines favour the replacement of oil-based furnaces by electricity, whilst the Rokana Mine is investigating the replacement of oil by coal. The electrification of mine trolley trucks has already started.

The fertilizer industry is also looking at the possibility of replacing oil-fired furnaces by coal-fired ones.

.xii.b Fuelwood

Whilst there is an overall sufficiency of fuelwood, there are local shortages due to excessive tree-cutting for the production of charcoal in the more densely populated areas. The main charcoal production areas are in Lusaka, Central, and Copperbelt provinces. Demand for charcoal has increased over the last two decades, with over 7500 charcoal plant operators. Licensed charcoal burners pay approximately 0,35 Kwacha per cord for charcoal produced. On average, 1 ton of charcoal is produced from 6-8 tons of wood A locally fabricated portable steel kiln is being introduced, which can produce 1 ton of charcoal from 4 tons of wood.

It is estimated that 95% of households in Zambia use fuelwood or charcoal for cooking and heating. In the rural areas virtually 100% of households use fuelwood or charcoal, whilst the figure is 86% in the urban areas. Charcoal is preferred to fuelwood in urban areas because it is smokeless, less bulky, and easier to handle. Charcoal is also used in industry, in agriculture for tobacco-curing and fish-drying, and is also used as a fuel for boilers.

xii.c Petroleum

Zambia has no exploitable reserves of petroleum and therefore has to import all its needs. Until 1973 all oil products had to be imported. In 1973 the Indeni Refinery, situated at Ndola in the north-west of the country, came on stream. This refinery obtains its feedstock through a 1 704 km pipeline from Tanzania. The refinery design throughput of 1 million tons of useful product is far in excess of demand which was 615 000 tons in 1988. The design production is also out of equilibrium with the country's requirements. For instance, the ratio of diesel fuel to gasoline in 1988 was 2,3, whilst the refinery ratio is 1,6. The diesel-to-gasoline ratio has been rising steadily. Not only is the balance incorrect, but the refinery was built to handle Iranian Light, whilst it now runs on Arabian Light Crude. Changes have had to be made to the method of operating the refinery to accommodate the crude and product mix, which makes it expensive to operate.

xii.d Electricity

The main generating capacity in Zambia is the Kariba Dam power plant, the Victoria Falls plant, and Kafue Gorge. The Kariba Dam complex consists of the Kariba South plant of 666 MW commissioned in 1960, and the Kariba North plant of 600 MW commissioned in 1976. In terms of the agreement between Zimbabwe and Zambia the two countries share the available capacity equally, thus Zambia is entitled to 633 MW.

The Kafue Gorge plant was commissioned in two phases. Phase One was completed in 1972 and contains four 150 MW sets, whilst Phase Two consisted of two 150 MW sets completed in 1977. The total plant capacity is therefore 900 MW. With the completion of Kafue, the country became a net exporter of electricity.

At Victoria Falls there are three power stations with two 1 MW sets, two 3 MW sets, and ten 10 MW sets. Station A was completed in 1950 and Station C in 1972. The total plant capacity is 108 MW.

In addition to the hydro-plant, there are a number of thermal units operated by the mining companies. These consist of 50 MW of waste-heat plant, most of it over 40 years old, and 80 MW of gas-turbine providing emergency and synchronous compensation capacity.

In addition to its own generating plant, Zambia has interconnection to Shaba Province in Zaire and to Zimbabwe via the Kariba Dam power plant.

By the beginning of 1989 Zambia's installed capacity was 2235 MW. Exports of electricity were mainly to Zimbabwe. However, the capacity situation changed dramatically in March 1989 when fire put the whole Kafue Gorge power station out of action. Repairs were carried out in 1989 and 1990 with the first 300 MW of the 900 MW station being recommissioned in December 1989, and the remaining plant by mid-1990. The repairs were carried out under funding from Sweden. The shutdown of Kafue had a significant effect on the economy of the country since it required significant load-shedding and the imposition of a 30-50% surcharge on electricity accounts to cover the cost of imported power from Zimbabwe and Zaire. Power exports to Zimbabwe worth US$ 1 million per month had to be suspended.

A rapid rise in demand for electricity during the period 1971 to 1976 was followed by a stagnant situation until the late 1970's. In that year Zambia started exporting power to Zimbabwe following the commissioning of the Kafue Gorge station. The decrease in demand after 1982 is a result of the decline in copper production. The importance of copper production in the energy scene is illustrated by the fact that in 1980, with copper production at its peak in the last 15 years, the Copperbelt used 74% of total electricity demand.

In the domestic sector the degree of electrification varies from area to area. In Lusaka Urban 67% of homes are electrified, but this drops to 13% in the Kallushi area. By comparison, charcoal provides between 76% and 92% of household needs.

ZESCO has been expanding its rural electrification system to replace rural diesel sets and to bring electricity to a larger proportion of the inhabitants. It was the intention that the Government should provide the capital cost for this rural electrification, whilst ZESCO would bear operating and maintenance costs. There is therefore no attempt to recover the cost of providing the service from consumers since this would make it prohibitively expensive. Over the six-year period 1982 to 1988 the Government spent ZK 32,3 million on ten rural schemes. However, this expansion has been aimed specifically at large agricultural schemes. The low population density in the rural areas has made the provision of electricity very expensive, the operating and maintenance costs alone are proving prohibitive. Rural electrification was being pushed by the Government as a means of arresting the drift from rural to urban areas. However, the programme has stalled and large areas remain without electricity.

For many people in the rural areas fuelwood meets 100% of their energy needs. Of the household usage it has been calculated that cooking accounts for 60% of total usage, heating accounts for 25%, and brewing, baking, etc. account for the remainder.

Fuelwood gathering is normally carried out by women, in bundles of between 24 and 36 kg. Collecting firewood exhibits a seasonal pattern with most of the collecting being made in the dry winter months and decreasing as farming activities pick up in summer.

Commercial farming estates supply farm-workers with fuelwood. For instance, the Triangle Sugar Estate supplies, free of charge, 0,6 tons of firewood per month per family. Urban users of fuelwood normally purchase from retail stalls, and fuelwood supply is becoming a lucrative business.

In agriculture fuelwood is used mainly for tobacco and tea drying. An estimated 16% of the tobacco crop is dried using fuelwood at a rate of 12 kg of wood per kg of cured tobacco.

In addition to fuelwood consumption, commercial plantations and wattle and pine plantations produce waste wood which is used locally for heat generation. Information on the use of milling residues for domestic consumption is scarce. However, one company in Harare produces sawdust briquettes for sale as fuelwood in the local market.

Whilst there is an apparent overall excess supply of fuelwood, distance and transport costs make it uneconomic to transport fuelwood from areas of surplus to areas of scarcity.

xiii.c Petroleum products

Zimbabwe's liquid fuel consumption has been growing steadily by 1,7% per annum over the last 15 years. The largest growth has been in diesel fuel, at the expense of gasoline. The ratio of diesel to petrol has grown from 1,26 in 1971 to 2,53 in 1987. This growth has been caused by the growth in industrial activity and also by the decline in economic growth which amongst other effects has caused a worsening in the supply situation for motor vehicles. The main use for oil products is in the transport sector.

All of Zimbabwe's oil products are currently being imported. The Feruka Oil Refinery with a capacity of 20 000 barrels per day was constructed in 1964 but was closed in

1966 following the imposition of sanctions after UDI. In 1980 an assessment was made of the cost of rehabilitating the refinery. It was however, decided that the refinery was unsuitable for present conditions since it was designed to process Iranian Light and may now not be able to get a suitable crude for processing. The refinery was also designed for a diesel fuel yield of 58% and 42% gasoline, whilst the current demand was for 72% diesel fuel and 28% gasoline.

As part of the Feruka Refinery, a pipeline was built from Beira in Mozambique to Mutare. Commercial pumping began in 1965 but ceased in 1965 because of the blockade on Rhodesia. It was re-opened as a refined product pipeline in 1982. The pipeline is 288 km long with a diameter of 0,27 metre pipeline, has a pumping station at Beira, and a metering station on the Mozambique/Zimbabwe border. The pipeline was extended to Harare in 1989. It has been subject of sabotage in Mozambique, causing serious shortages. It is however, able to supply all Zimbabwe's needs if it is operated for ten days per month.

xiii.d Coal

Coal has been the mainstay of the energy generation industry since the beginning of the century, with an exponential rise in production until 1960. There was a general decline during the sanctions period from 1965 to 1980. After 1980 coal production has increased rapidly. The largest single market for coal is that for coking coal which represents around 34% of the market. The coal utilization by economic sector has changed significantly in the last 18 years. The largest user of coal in 1971 was industry with 41,9% whilst in 1987, the last year for which a breakdown is available, electricity generation took 53,1%.

Zimbabwe has been a significant exporter of coal and especially of coking coal which is in short supply in the surrounding countries. However, exports have been decreasing steadily over the last 20 to 30 years, whilst imports of coal have been rising steadily and have increased substantially since 1986. Most of the export coal has been coking coal to South Africa. For instance in 1980 South Africa took 79% of the export coal in the form of coking coal, with Zaire taking 19% for coking purposes. The other importers were Mozambique and Botswana.

In terms of resource availability Zimbabwe could export more coal. However, the cost of transport by rail to the border of Zimbabwe is high and there are bottlenecks in terms of transport in neighbouring countries and at the ports of Beira and Maputo.

Political problems have so far ruled out South Africa as an export port, but with the political developments taking place this may be possible in the future.

The usage of coal for electricity generation has also been increasing since 1985 when more reliance was placed on the Hwange Power Station and problems were being experienced with electricity supply from hydro-stations.

Coke is produced by the Wankie colliery, mainly as a feedstock for the Zimbabwe Iron and Steel Corporation (ZISCO), though some is also exported, mainly to Zaire and Zambia for use on the copper mines. With increasing demand for coke in Zimbabwe, export coal will decline unless the production capacity is increased.

xiii.e Electricity

Electricity consumption in Zimbabwe has been increasing steadily since 1935. The rate of increase has declined since 1975 but appears to be fairly steady at a reduced rate. Prior to 1986 supply was from the ESC, from individual municipalities, and from the Central African Power Corporation. Since 1986 the Zimbabwe Electricity Supply Authority (ZESA) - the successor to ESC - has been responsible for all supply in the country and has taken over the operation of the municipal power stations of Harare, Bulawayo, and Umniati, and the power station at Wankie.

The main generation plant until 1960 was thermal, but during Federation days it was agreed to build a joint power station at Kariba under the control of the Central African Power Corporation. This power station consisted of two components - the North Bank Power Station with four 150 MW sets, and the South Bank Power Station with six generating sets of 111 MW each. Thus the total output of the station was 1266 MW. On the breakup of the Federation Zimbabwe became entitled to half of the output of Kariba which amounted to 633 MW. The remaining 633 MW was the property of Zambia. However Zambia did not need its available capacity and some of it was imported into Zimbabwe.

During the 1970's Zimbabwe was concerned about the over-reliance on imported power and plans were made to provide more indigenous power based on coal. However sanctions prevented their construction. After independence the feeling remained that less reliance should be placed on imports and in view of an increasing demand a thermal power station was started. This plant is situated at Hwange at the coal pit-head and consists of Hwange I commissioned in 1984/85 and Hwange II commissioned in 1986/87. Hwange I consists of four 120 MW sets and Hwange II consists of two 220 MW sets with an overall sent-out capacity of 876 MW.

The sent-out capacity of all power plant is now 1827 MW, of which 633 MW is hydro and 1194 is thermal. In addition there is 51 MW of plant owned and operated by private companies, some of which is available to ZESA.

The maximum demand on the ZESA system in 1989 was 1429 MW against an installed available capacity of 1827 MW. However, additional capacity was available from Zambia and from the private companies. No information is available about the imported capacity to supply the maximum demand. Besides imports from Zambia there is also a small import component from South Africa which is supplied to the Beit Bridge area.

Further expansion can take place based on both coal and hydro capacity. The Zimbabwe share of possible hydro developments in the Zambezi Basin is 2515 MW which would more than double its installed capacity.

Until 1985 most of the electricity supply was based on hydro plant. Since the construction of the Hwange plant there has been a swing to thermal electricity. This swing to thermal has been hastened by limits on imports from the Zambia due to a fire at Zambia's 900 MW Kafue power station. The Kafue power station is being repaired and at the end of 1990 was producing some two-thirds of its design capacity. However, Zambia has also signed an agreement to supply electricity to Namibia, which will make less capacity available to Zimbabwe.

Zimbabwe and Zambia also agreed in 1990 to undertake a joint feasibility study of the Batoka hydro-electric project. An agreement has also been reached for Zimbabwe to import power from Mozambique from the Cahora Bassa Dam.

xiii.f Ethanol

In 1979 the Government decided to substitute 15% of gasoline with locally produced ethanol. The Triangle Sugar Estate built a plant with an annual capacity of 40 million litres of anhydrous ethyl alcohol and the first additions of ethanol to gasoline took place in 1980. There were proposals to expand ethanol production with a plant at Chisumbanje having a capacity of 128 million litres per year. The 1980 cost of ethanol production was estimated at around 35 Zcents/litre. No figures are available for ethanol production, but on the basis of a 15% blend in gasoline, the 1987 consumption would have been 87 million litres of anhydrous ethyl alcohol.

APPENDIX F:

ENERGY TOTAL FINAL CONSUMPTION DATA FOR SELECTED COUNTRIES[12]

i ANGOLA
ii BOTSWANA
iii ETHIOPIA
iv KENYA
v LESOTHO
vi MALAWI
vii MOZAMBIQUE
viii SOUTH AFRICA
ix SWAZILAND
x TANZANIA
xi ZAIRE
xii ZAMBIA
xiii ZIMBABWE

Table F.1: ANGOLA

TOTAL FINAL CONSUMPTION

(UNITS '000s TOE)

	COAL	OIL	GAS	ELECT	COMMER-CIAL	TRADIT-IONAL	TOTAL	TRADIT/ TOTAL %AGE
1950	15.7	64.0		2.1	81.8			
1951	24.5	78.0		2.2	104.8			
1952	27.3	97.0		2.8	127.0			
1953	18.4	97.0		3.4	118.8			
1954	18.4	128.0		4.1	150.5			
1956	10.9	202.0		6.6	219.5			
1957	20.5	230.0		8.3	258.7			
1958	11.6	242.0		10.1	263.7			
1959	14.3	266.0		10.6	290.9			
1960	32.0	346.0		12.3	390.4			
1961	15.0	312.0		15.6	342.6			
1962	23.2	454.0		16.9	494.1			
1963	5.5	437.0		19.0	461.4			
1964	19.8	442.0		22.4	484.2			
1965	14.3	481.0		27.3	522.6			
1966	22.5	623.0		30.3	675.8			
1967	14.3	483.0		33.7	531.0			
1968	25.9	701.0		39.4	766.3			
1969	23.9	732.0		46.7	802.6			
1970	12.3	787.0		55.5	854.8			
1971	0.0	524.5	36.1	50.9	611.5	1452	2064	70.4
1972	0.0	787.8	47.8	57.6	893.2	1488	2381	62.5
1973	0.0	691.1	54.5	67.7	813.3	1519	2332	65.1
1974	0.0	640.8	57.1	84.6	782.5	1547	2330	66.4
1975	0.0	578.9	54.5	89.8	723.2	1559	2282	68.3
1976	0.0	519.6	47.5	89.4	656.6	1609	2266	71.0
1977	0.0	380.4	59.3	89.4	529.1	1647	2176	75.7
1978	0.0	668.2	59.3	89.4	816.9	1687	2504	67.4
1979	0.0	546.9	59.3	96.3	702.5	809	1512	53.5
1980	0.0	519.4	64.5	103.2	687.2	833	1520	54.8
1981	0.0	498.1	75.2	103.2	676.5	855	1532	55.8
1982	0.0	495.0	75.2	110.1	680.3	867	1547	56.0
1983	0.0	465.8	86.0	119.5	671.3	903	1574	57.4
1984	0.0	371.3	96.8	123.1	591.1	918	1509	60.8
1985	0.0	551.7	96.8	123.1	771.5	940	1712	54.9
1986	0.0	437.4	107.5	123.1	667.9	964	1632	59.1
1987	0.0	407.0	129.0	123.8	659.8	978	1638	59.7
1988	0.0	421.4	131.1	124.7	677.2	1001	1678	59.6

Table F.2: BOTSWANA

000'S TOE

YEAR	TRADITIONAL	COMMERCIAL
1971	177.1	152.8
1972	192.9	167.1
1973	208.6	181.4
1974	224.3	195.7
1975	240.0	209.9
1976	255.7	224.2
1977	271.4	238.5
1978	287.1	252.8
1979	302.9	267.1
1980	318.6	281.4
1981	334.3	295.7
1982	350.0	310.0
1983	365.7	324.3
1984	381.4	338.5
1985	397.1	352.8
1986	412.9	367.1
1987	428.6	381.4
1988	444.3	395.7

Table F.3: ETHIOPIA

Energy Statistics

YEAR	COMERCIAL ENERGY FORMS TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP kgOE/BURR 1990K	1985KWA	TRADITIONAL ENERGY	COMM/ TRADI	TOTAL ENERG	TRAD AS %	ENERGY PER CAPITA TOE/CAPITA		
	COAL	OIL	HYDRO	GAS	ELECT	TOTAL	1PT	3PT MA	000'S TOE		TRAD+ 000'S TO	TOTA	COMMERCIAL	TRAD	TOTAL
1970	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1971	0	375.5	0	0	45.6	421.1	0.053	NA	5101.00	0.083	5522.1	92.4	0.014	0.172	0.186
1972	0	353.7	0	0	46.5	400.2	0.048	0.051	5243.00	0.076	5643.2	92.9	0.013	0.172	0.185
1973	0	392.9	0	0	45.6	438.5	0.051	0.050	5375.00	0.082	5813.5	92.5	0.014	0.172	0.186
1974	0	395.7	0	0	44.8	440.5	0.051	0.049	5546.00	0.079	5986.5	92.6	0.014	0.173	0.187
1975	0	345.4	0	0	44.4	389.8	0.045	0.047	6712.00	0.058	7101.8	94.5	0.012	0.204	0.216
1976	0	358.6	0	0	43.9	402.5	0.045	0.045	6868.00	0.059	7270.5	94.5	0.012	0.203	0.215
1977	0	371.9	0	0	41.8	413.7	0.045	0.046	7029.00	0.059	7442.7	94.4	0.012	0.202	0.214
1978	0	386.2	0	0	44.4	430.6	0.048	0.048	7205.00	0.060	7635.6	94.4	0.012	0.201	0.213
1979	0	450.3	0	0	49.5	499.8	0.052	0.050	7376.00	0.068	7875.8	93.7	0.014	0.200	0.214
1980	0	440.2	0	0	52.6	492.8	0.049	0.051	7542.00	0.065	8034.8	93.9	0.013	0.200	0.213
1981	0	485.5	0	0	56.7	542.2	0.053	0.050	7732.00	0.070	8274.2	93.4	0.014	0.199	0.213
1982	0	454.2	0	0	60.4	514.6	0.049	0.050	7927.00	0.065	8441.6	93.9	0.013	0.199	0.212
1983	0	467.7	0	0	64.7	532.4	0.049	0.049	8122.00	0.066	8654.4	93.8	0.013	0.198	0.211
1984	0	469.7	0	0	69.8	539.5	0.050	0.052	8334.00	0.065	8873.5	93.9	0.013	0.198	0.210
1985	0	483.8	0	0	76.4	560.2	0.057	0.057	8533.00	0.066	9093.2	93.8	0.013	0.197	0.210
1986	0	591.6	0	0	76.9	668.5	0.063	0.062	8773.00	0.076	9441.5	92.9	0.015	0.197	0.212
1987	0	699.8	0	0	68	767.8	0.067	0.065	9020.00	0.085	9787.8	92.2	0.017	0.196	0.213
1988	0	706.8	0	0	68.1	774.9	0.065	NA	8765.00	0.088	9539.9	91.9	0.016	0.185	0.201
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table F.4: KENYA

ENERGY STATISTICS

YEAR	COMERCIAL ENERGY FORMS TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP TOE/REA 1985KW		TRADITIONAL ENERGY 000'S TOE	COMM/ TRADIT	TOTAL ENERGY TRAD+COM 000'S TOE	TRADIT AS % OF TOTAL	ENERGY PER CAP CAPITA COMMERCIAL
	COAL	OIL	HYDRO	GAS	ELECT	TOTAL	1PT	3PT MA					
1970	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1971	50.5	1072.3	0.0	0	67.5	1190.3	2.38E-05	NA	2662.00	0.447	3852.3	69.1	0.100
1972	24.6	1175.8	0.0	0	74.4	1274.8	2.18E-05	2.26E-05	2792.00	0.457	4066.8	68.7	0.103
1973	43.7	1241.8	0.0	0	80.0	1365.5	2.21E-05	2.18E-05	2960.00	0.461	4325.5	68.4	0.107
1974	41.2	1245.5	0.0	0	85.6	1372.3	2.14E-05	2.17E-05	2973.00	0.462	4345.3	68.4	0.104
1975	28.4	1273.3	0.0	0	92.2	1393.9	2.15E-05	2.18E-05	2981.00	0.468	4374.9	68.1	0.101
1976	38.1	1356.3	0.0	0	99.1	1493.5	2.25E-05	2.21E-05	3296.00	0.453	4789.5	68.8	0.105
1977	38.8	1468.7	0.0	0	109.5	1617.0	2.23E-05	2.21E-05	3423.00	0.472	5040.0	67.9	0.109
1978	32.1	1519.2	0.0	0	117.9	1669.2	2.16E-05	2.16E-05	3367.00	0.496	5036.2	66.9	0.108
1979	9.8	1558.4	0.0	0	127.2	1695.4	2.08E-05	2.10E-05	3534.00	0.480	5229.4	67.6	0.106
1980	10.5	1626.6	0.0	0	132.3	1769.4	2.06E-05	2.05E-05	3703.00	0.478	5472.4	67.7	0.106
1981	56.0	1598.1	0.0	0	143.0	1797.1	2.00E-05	1.95E-05	3906.00	0.460	5703.1	68.5	0.104
1982	28.9	1472.3	0.0	0	146.3	1647.5	1.80E-05	1.83E-05	4040.00	0.408	5687.5	71.0	0.091
1983	20.3	1402.0	0.0	0	150.2	1572.5	1.70E-05	1.77E-05	4215.00	0.373	5787.5	72.8	0.084
1984	52.3	1491.3	0.0	0	158.7	1702.3	1.80E-05	1.76E-05	4405.00	0.386	6107.3	72.1	0.087
1985	56.0	1534.4	0.0	0	173.2	1763.6	1.77E-05	1.77E-05	4613.00	0.382	6376.6	72.3	0.087
1986	52.9	1623.8	0.0	0	184.3	1861.0	1.74E-05	1.76E-05	4700.00	0.396	6561.0	71.6	0.088
1987	56.6	1723.0	0.0	0	204.0	1983.6	1.76E-05	1.72E-05	5000.00	0.397	6983.6	71.6	0.090
1988	69.5	1693.6	0.0	0	200.8	1963.9	1.64E-05	NA	5000.00	0.393	6963.9	71.8	0.085
1989	80.6	1801.2	0.0	0	214.0	2095.8	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	0.0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table F.5: LESOTHO

000'S TOE

YEAR	TRADITIONAL	COMMERCIAL
1971	258.1	91.1
1972	270.7	94.4
1973	283.2	97.6
1974	295.8	100.8
1975	308.4	104.1
1976	320.9	107.3
1977	333.5	110.5
1978	346.0	113.8
1979	358.6	117.0
1980	371.1	123.1
1981	383.7	120.2
1982	396.2	126.7
1983	408.8	129.9
1984	421.3	133.2
1985	433.9	136.4
1986	446.4	139.6
1987	459.0	142.9
1988	471.5	146.5

Table F.6: MALAWI

YEAR	COMERCIAL ENERGY TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP kg OE PER 1985 KW		TRADITIONAL ENERGY	TOTAL ENERGY (TRAD+COM)	TRADIT AS % OF	ENERGY PER CAPITA kg OE / CAP.			FINAL ENERGY
	COAL	OIL	GAS	HYDRO	ELECT	TOTAL	1PT	3PT MA	000'S TOE	000'S TOE	TOTAL	COMMERCIAL	TRAD	TOTAL	GROWTH
1950	NA	NA	NA	NA	0,16	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1951	NA	NA	NA	NA	0,17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1952	NA	NA	NA	NA	0,20	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1953	NA	NA	NA	NA	0,25	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1954	NA	NA	NA	NA	0,42	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1955	NA	NA	NA	NA	0,58	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1956	NA	NA	NA	NA	0,76	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1957	NA	NA	NA	NA	1,29	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1958	NA	NA	NA	NA	1,89	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1959	NA	NA	NA	NA	2,15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1960	NA	NA	NA	NA	2,41	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1961	NA	NA	NA	NA	3,01	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1962	NA	NA	NA	NA	3,27	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1963	NA	NA	NA	NA	3,36	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1964	38,13	49,0	0,0	0,0	4,91	92,0	0,16	NA	NA	NA	NA	24	NA	NA	NA
1965	41,82	50,0	0,0	0,0	5,68	97,5	0,15	0,16	NA	NA	NA	25	NA	NA	5,9
1966	48,59	64,0	0,0	0,0	7,15	119,7	0,16	0,15	NA	NA	NA	30	NA	NA	22,8
1967	33,21	66,0	0,0	0,0	8,62	107,8	0,13	0,15	NA	NA	NA	26	NA	NA	-9,9
1968	29,52	76,0	0,0	0,0	10,09	115,6	0,15	0,14	NA	NA	NA	27	NA	NA	7,2
1969	19,68	84,0	0,0	0,0	11,12	114,8	0,14	0,15	NA	NA	NA	27	NA	NA	-0,7
1970	27,06	92,0	0,0	0,0	12,41	131,5	0,16	0,15	920	1051,47	87,50	30	207	237	14,5
1971	27,67	105,0	0,0	0,0	13,70	146,4	0,15	0,16	NA	NA	NA	32	NA	NA	11,3
1972	32,56	113,0	0,0	0,0	16,20	161,8	0,16	0,15	NA	NA	NA	35	NA	NA	10,5
1973	35,06	117,0	0,0	0,0	17,93	170,0	0,13	0,14	NA	NA	NA	35	NA	NA	5,1
1974	35,38	118,9	0,0	0,0	18,89	173,2	0,13	0,13	NA	NA	NA	34	NA	NA	1,9
1975	48,41	111,2	0,0	0,0	22,00	181,6	0,13	0,13	1050	1231,56	85,26	35	200	235	4,8
1976	41,90	132,6	0,0	0,0	23,30	197,8	0,13	0,13	NA	NA	NA	37	NA	NA	8,9
1977	38,18	124,1	0,0	0,0	25,91	188,2	0,12	0,12	NA	NA	NA	34	NA	NA	-4,8
1978	34,09	133,0	0,0	0,0	26,60	193,7	0,11	0,11	1172	1365,66	85,82	34	206	240	2,9
1979	23,18	133,0	0,0	0,0	30,65	186,8	0,11	0,12	1210	1396,83	86,62	32	206	238	-3,5
1980	44,32	160,2	0,0	0,0	33,41	238,0	0,13	0,13	1251	1488,97	84,02	39	207	246	27,4
1981	46,37	144,6	0,0	0,0	33,41	224,3	0,13	0,13	1292	1516,34	85,21	36	207	243	-5,7
1982	49,01	139,1	0,0	0,0	33,41	221,5	0,13	0,13	1336	1557,53	85,78	35	208	243	-1,3
1983	30,68	134,3	0,0	0,0	38,19	203,2	0,11	0,12	1332	1535,20	86,76	31	201	232	-8,3
1984	26,60	130,2	0,0	0,0	40,23	197,1	0,11	0,11	1378	1575,07	87,49	29	201	230	-3,0
1985	22,50	137,1	0,0	0,0	39,54	199,1	0,10	0,10	1367	1566,10	87,29	28	194	222	1,0
1986	19,09	137,7	0,0	0,0	42,95	199,8	0,10	NA	1367	1566,78	87,25	27	188	215	0,3
1987	NA	NA	0,0	0,0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1988	NA	NA	0,0	0,0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1989	NA	NA	0,0	0,0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	0,0	0,0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table F.7: MOZAMBIQUE

ENERGY DATA

YEAR	COMERCIAL ENERGY FORMS IEA ENERGY TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP(BMT)		TRADITION	COMM/	TOTAL ENERGY	TRADITION	ENERGY PER CAPITA	
							TOE/REAL	1985MT	ENERGY	TRADITION	TRAD+COM	AS % OF	TOE/CAPITA	
	COAL	OIL	GAS	HYDRO	ELECT	TOTAL	1PT	3PT MA	000'S T		000'S TOE	TOTAL	COMMERCIAL	TRAD
1950	166.1	NA	0.0	0.0	3.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
1951	164.2	NA	0.0	0.0	4.0	NA	NA	NA	NA	NA	NA	NA	NA	NA
1952	191.9	NA	0.0	0.0	3.8	NA	NA	NA	NA	NA	NA	NA	NA	NA
1953	190.0	NA	0.0	0.0	4.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
1954	199.3	NA	0.0	0.0	4.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
1955	241.7	NA	0.0	0.0	4.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
1956	273.7	NA	0.0	0.0	7.1	NA	NA	NA	NA	NA	NA	NA	NA	NA
1957	315.5	NA	0.0	0.0	7.6	NA	NA	NA	NA	NA	NA	NA	NA	NA
1958	316.1	NA	0.0	0.0	7.7	NA	NA	NA	NA	NA	NA	NA	NA	NA
1959	304.4	NA	0.0	0.0	8.4	NA	NA	NA	NA	NA	NA	NA	NA	NA
1960	309.9	NA	0.0	0.0	14.3	NA	NA	NA	NA	NA	NA	NA	NA	NA
1961	347.5	182.3	0.0	0.0	19.5	549.3	NA	NA	NA	NA	NA	NA	NA	NA
1962	353.0	105.8	0.0	0.0	22.3	481.1	NA	NA	NA	NA	NA	NA	NA	NA
1963	315.5	90.D	0.0	0.0	23.5	429.0	NA	NA	NA	NA	NA	NA	NA	NA
1964	311.2	170.3	0.0	0.0	25.6	507.1	NA	NA	NA	NA	NA	NA	NA	NA
1965	293.9	89.3	0.0	0.0	27.1	410.3	NA	NA	NA	NA	NA	NA	NA	NA
1966	269.4	178.5	0.0	0.0	28.5	476.4	NA	NA	NA	NA	NA	NA	NA	NA
1967	257.7	155.3	0.0	0.0	31.1	444.1	NA	NA	NA	NA	NA	NA	0.051	NA
1968	343.2	263.3	0.0	0.0	35.2	641.7	NA	NA	NA	NA	NA	NA	0.071	NA
1969	380.7	302.3	0.0	0.0	40.5	723.5	NA	NA	NA	NA	NA	NA	0.079	NA
1970	357.3	263.3	0.0	0.0	48.1	668.7	NA	NA	NA	NA	NA	NA	0.071	NA
1971	385.0	362.6	0.0	0.0	58.1	805.7	NA	NA	2162	0.37	2967.70	72.85	0.084	0.225
1972	330.3	352.4	0.0	0.0	58.6	741.2	NA	NA	2210	0.34	2951.20	74.88	0.075	0.224
1973	361.0	371.5	0.0	0.0	68.3	800.8	NA	NA	2239	0.36	3039.80	73.66	0.079	0.222
1974	346.2	317.9	0.0	0.0	82.9	747.0	NA	NA	2287	0.33	3034.00	75.38	0.072	0.221
1975	318.0	278.5	0.0	0.0	69.5	665.9	NA	NA	2312	0.29	2977.90	77.64	0.063	0.218
1976	306.9	305.0	0.0	0.0	79.1	691.0	NA	NA	2339	0.30	3030.00	77.19	0.063	0.215
1977	192.5	404.5	0.0	0.0	75.4	672.4	NA	NA	2770	0.24	3442.40	80.47	0.060	0.248
1978	151.9	354.2	0.0	0.0	82.0	588.1	NA	NA	2766	0.21	3354.10	82.47	0.051	0.241
1979	141.5	335.9	0.0	0.0	90.4	567.8	NA	NA	2832	0.20	3399.80	83.30	0.048	0.240
1980	177.1	433.8	0.0	0.0	99.0	709.9	4.31	NA	2973	0.24	3682.90	80.72	0.059	0.246
1981	180.8	391.8	0.0	0.0	107.5	680.1	4.11	4.03	3062	0.22	3742.10	81.83	0.055	0.246
1982	149.4	329.0	0.0	0.0	116.0	594.4	3.67	3.97	3228	0.18	3822.40	84.45	0.047	0.253
1983	111.3	338.1	0.0	0.0	129.0	578.4	4.13	3.78	3280	0.18	3858.40	85.01	0.044	0.251
1984	76.9	305.0	0.0	0.0	132.4	514.3	3.54	3.82	3307	0.16	3821.30	86.54	0.038	0.246
1985	65.2	339.2	0.0	0.0	121.3	525.7	3.79	3.52	3365	0.16	3890.70	86.49	0.038	0.244
1986	40.6	361.5	0.0	0.0	51.6	453.6	3.24	3.29	3353	0.14	3806.60	88.08	0.032	0.236
1987	38.7	345.5	0.0	0.0	71.4	455.6	2.86	NA	3344	0.14	3799.60	88.01	0.031	0.229
1988	40.0	348.0	0.0	0.0	68.8	456.8	NA	NA	3527	0.13	3983.80	88.53	0.031	0.236
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table F.8.a: SOUTH AFRICA

YEAR	COMMERCIAL ENERGY FORMS: TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP TOE/REAL 1985 RANDS		TRADITIONAL ENERGY	TRADITIONAL AND COMMERCIAL			COMMERCIAL ENERGY	
	COAL	OIL	HYDRO	GAS	ELECT	TOTAL	1PT	3PT MA	000'S TOE	COMM/ TRADIT	TRADITIONAL + COMMERCIAL 000'S TOE	TRADITIONAL AS % OF TOTAL	PRIMARY CONSUMPTION 000's toe	EFFICIENC TFC/PRIMARY ENERGY
1950	8634	1767	0	0	826	11227	4.13E-04	NA	1799.5	6.2	13026.4	13.8	NA	NA
1951	9234	2001	0	0	878	12113	4.25E-04	4.2E-04	1880.7	6.4	13993.8	13.4	NA	NA
1952	9794	2101	0	0	924	12818	4.34E-04	4.2E-04	1964.2	6.5	14782.2	13.3	NA	NA
1953	9650	2121	0	0	1014	12785	4.13E-04	4.1E-04	2045.3	6.3	14830.5	13.8	NA	NA
1954	9638	2250	0	0	1121	13009	3.76E-04	4.0E-04	2126.5	6.1	15135.2	14.1	NA	NA
1955	10584	2470	0	0	1267	14322	4.16E-04	4.0E-04	2207.6	6.5	16529.7	13.4	NA	NA
1956	10944	2699	0	0	1368	15011	4.14E-04	4.1E-04	2291.2	6.6	17301.8	13.2	NA	NA
1957	11201	2855	0	0	1481	15537	4.13E-04	4.2E-04	2372.3	6.5	17909.8	13.2	NA	NA
1958	11788	3050	0	0	1564	16402	4.27E-04	4.1E-04	2453.5	6.7	18855.8	13.0	NA	NA
1959	11357	3168	0	0	1665	16190	4.04E-04	4.1E-04	2534.6	6.4	18725.0	13.5	NA	NA
1960	11525	3286	0	0	1797	16608	3.96E-04	4.0E-04	2615.8	6.3	19223.4	13.6	NA	NA
1961	11920	3507	0	0	1880	17307	3.95E-04	3.9E-04	2720.8	6.4	20027.9	13.6	NA	NA
1962	12046	3782	0	0	2025	17853	3.86E-04	3.9E-04	2825.8	6.3	20678.9	13.7	NA	NA
1963	12573	3979	0	0	2162	18714	3.76E-04	3.8E-04	2930.8	6.4	21644.8	13.5	NA	NA
1964	13322	4948	0	0	2337	20607	3.87E-04	3.8E-04	3035.8	6.8	23642.6	12.8	NA	NA
1965	14508	5121	0	0	2527	22155	3.86E-04	3.8E-04	3140.8	7.1	25296.2	12.4	NA	NA
1966	14130	5819	0	0	2684	22634	3.78E-04	3.8E-04	3245.8	7.0	25879.6	12.5	NA	NA
1967	14005	6183	0	0	2919	23106	3.61E-04	3.6E-04	3350.8	6.9	26456.7	12.7	NA	NA
1968	14400	5977	0	0	3145	23522	3.53E-04	3.5E-04	3455.8	6.8	26978.3	12.8	NA	NA
1969	14017	6580	0	0	3389	23986	3.39E-04	3.4E-04	3560.9	6.7	27547.3	12.9	NA	NA
1970	14202	7230	0	0	3754	25186	3.38E-04	3.5E-04	3665.9	6.9	28851.7	12.7	NA	NA
1971	16490	9036	0	139	4008	29673	3.78E-04	3.6E-04	3871.1	7.7	33544.2	11.5	46034.5	64.5
1972	15466	8951	0	139	4403	28959	3.61E-04	3.7E-04	4076.4	7.1	33035.3	12.3	44339.9	65.3
1973	15603	9969	0	150	4742	30464	3.67E-04	3.6E-04	4281.6	7.1	34745.2	12.3	47299.3	64.4
1974	15771	9680	0	176	5116	30743	3.47E-04	3.6E-04	4486.9	6.9	35229.4	12.7	48407.5	63.5
1975	16396	10288	0	231	5488	32403	3.57E-04	3.5E-04	4692.1	6.9	37094.6	12.6	52068.7	62.2
1976	16681	10480	0	234	5923	33317	3.61E-04	3.5E-04	4897.4	6.8	38214.8	12.8	54539.6	61.1
1977	16189	10372	0	224	6253	33037	3.42E-04	3.5E-04	5102.6	6.5	38139.7	13.4	54638.9	60.5
1978	15924	10568	0	230	6724	33446	3.37E-04	3.3E-04	5107.4	6.5	38553.6	13.2	55806.1	59.9
1979	14746	10168	0	284	7371	32569	3.17E-04	3.2E-04	5312.6	6.1	37881.7	14.0	56781.6	57.4
1980	15564	10345	0	321	7959	34190	3.16E-04	3.2E-04	5718.4	6.0	39907.9	14.3	61542.0	55.6
1981	16959	11347	0	312	8439	37057	3.27E-04	3.2E-04	5849.6	6.3	42906.3	13.6	68793.6	53.9
1982	16225	11615	0	284	8597	36721	3.27E-04	3.3E-04	5988.1	6.1	42709.2	14.0	74521.6	49.3
1983	14818	11825	0	322	8830	35795	3.26E-04	3.3E-04	6128.9	5.8	41923.5	14.6	78293.8	45.7
1984	16433	12729	0	323	9671	39156	3.47E-04	3.4E-04	6272.1	6.2	45428.4	13.8	83360.0	47.0
1985	15506	12651	0	305	10116	38578	3.43E-04	3.5E-04	6415.3	6.0	44993.2	14.3	83740.0	46.1
1986	15207	12814	0	302	10646	38969	3.46E-04	3.5E-04	6570.4	5.9	45539.8	14.4	84637.5	46.0
1987	15349	13177	0	296	10955	39776	3.46E-04	3.5E-04	6787.6	5.9	46563.6	14.6	88208.1	45.1
1988	16033	14100	0	298	11410	41841	3.51E-04	NA	6875.9	6.1	48717.1	14.1	91190.8	45.9

Table F.8.b: SOUTH AFRICA

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 F.8.c: SOUTH AFRICA

CONTINUED

000'S TOE

YEAR	TOTAL						
	INDUSTRY		TRANSPORT	AGRICULTURE*	RESIDENTIAL*	OTHER**	TOTAL
	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

Table F.8.d: SOUTH AFRICA

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 F.9: SWAZILAND

YEAR	INSTALLED CAPACITY (MEGAWATTS) PUBLIC HYDRO	PUBLIC DIESEL	PUBLIC TOTAL	SELF PRODUCERS HYDRO	SELF PRODUCERS DIE/STM	SELF PRODUCERS TOTAL	TOTAL HYDRO	TOTAL THERMAL	TOTAL INSTALLED	IMPORT CAPACITY ESKOM	PUBLIC +ESKOM CAPACITY	MAX DEMAND	RESERVE CAPACITY
1964	7,5	1,5	9,0	NA	NA	NA	NA	NA	NA	0,0	9,0	7,4	17,44
1965	10,0	2,5	12,5	NA	NA	NA	NA	NA	NA	0,0	12,5	9,8	21,92
1966	10,0	2,5	12,5	NA	NA	NA	NA	NA	NA	0,0	12,5	10,8	13,36
1967	10,0	7,0	17,0	NA	NA	NA	NA	NA	NA	0,0	17,0	11,7	31,29
1968	16,5	7,0	23,5	NA	NA	NA	NA	NA	NA	0,0	23,5	15,8	32,85
1969	21,5	7,0	28,5	1,0	30,3	31,3	22,5	38,3	60,8	0,0	28,5	19,8	30,53
1970	21,5	11,5	33,0	1,0	30,3	31,3	22,5	42,8	65,3	0,0	33,0	19,6	40,61
1971	21,5	11,5	33,0	1,0	30,3	31,3	22,5	42,8	65,3	0,0	33,0	17,0	48,48
1972	21,5	11,5	33,0	1,0	40,5	41,5	22,5	53,0	75,5	36,0	69,0	27,2	60,58
1973	21,5	9,5	31,0	1,0	40,5	41,5	22,5	51,0	73,5	36,0	67,0	28,4	57,61
1974	21,5	9,5	31,0	1,0	40,1	41,1	22,5	50,6	73,1	36,0	67,0	28,5	57,46
1975	20,5	9,5	30,0	1,0	39,3	40,3	21,5	49,8	71,3	36,0	66,0	33,2	49,70
1976	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	36,0	66,0	42,0	36,36
1977	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	36,0	66,0	43,2	34,55
1978	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	67,0	97,0	53,1	45,26
1979	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	67,0	97,0	57,2	41,03
1980	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	67,0	97,0	65,9	32,06
1981	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	67,0	97,0	72,0	25,77
1982	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	67,0	97,0	70,0	27,84
1983	20,5	9,5	30,0	NA	NA	NA	NA	NA	NA	67,0	97,0	78,0	19,59
1984	40,5	9,5	50,0	NA	NA	NA	NA	NA	NA	60,0	110,0	78,0	29,09
1985	40,5	9,5	50,0	NA	NA	NA	NA	NA	NA	60,0	110,0	81,0	26,36
1986	40,5	9,5	50,0	NA	NA	NA	NA	NA	NA	60,0	110,0	84,0	23,64
1987	40,5	9,5	50,0	NA	NA	NA	NA	NA	NA	60,0	110,0	97,0	11,82
1988	40,5	9,5	50,0	NA	NA	NA	NA	NA	NA	60,0	110,0	87,0	20,91
1989	40,5	9,5	50,0	NA	NA	NA	NA	NA	NA	60,0	110,0	92,0	16,36
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

* DIESEL AND STEAM

YEAR	ENERGY GENERATED GWh HYDRO	ENERGY GENERATED GWh DIESEL	ENERGY GENERATED GWh TOTAL	ENERGY GWh PURCHASED FROM ESKOM	ELECTRICITY SENT OUT INCLUDING IMPORTS GWh	LOSSES & OWN USE GWh	ELECTRICITY SOLD GWh	INT.USE & LOSSES % OF S.O
1964	17,8	0,7	18,5	0,0	18,5	1,3	17,2	7,0
1965	33,8	0,1	33,8	0,0	33,8	3,0	30,8	9,0
1966	39,8	0,1	40,0	0,0	40,0	2,9	37,1	7,2
1967	50,0	0,3	50,3	0,0	50,3	5,3	45,0	10,6
1968	64,4	6,3	70,7	0,0	70,7	7,0	63,7	9,8
1969	89,3	1,0	90,3	0,0	90,3	8,6	81,7	9,5
1970	93,7	2,6	96,3	0,0	96,3	10,1	86,2	10,5
1971	91,5	0,8	92,3	0,0	92,3	8,6	83,7	9,3
1972	124,9	5,7	130,6	0,0	130,6	10,5	120,1	8,0
1973	121,1	0,9	122,0	11,8	133,9	12,6	121,3	9,4
1974	121,7	0,5	122,2	18,2	140,4	14,1	126,2	10,1
1975	126,4	2,1	128,6	40,6	169,2	15,9	126,3	9,4
1976	144,8	1,6	146,4	58,9	205,3	21,4	183,9	10,4
1977	120,6	1,3	121,9	102,1	224,0	22,4	201,6	10,0
1978	139,6	4,7	144,3	104,2	248,4	25,6	222,8	10,3
1979	114,4	2,9	117,3	187,9	305,2	29,5	275,7	9,7
1980	123,0	2,0	125,0	209,0	334,0	35,7	298,3	10,7
1981	126,6	2,7	129,3	227,2	356,5	33,0	323,5	9,3
1982	70,4	4,8	75,2	330,6	405,8	40,7	365,1	10,0
1983	79,1	1,0	80,1	309,2	389,3	41,5	347,8	10,7
1984	152,1	2,0	154,1	236,5	390,6	46,2	344,4	11,8
1985	172,2	1,9	174,1	243,1	417,2	51,1	366,1	12,2
1986	150,5	2,3	152,8	282,0	434,8	52,0	382,8	12,0
1987	181,1	1,2	182,3	269,7	452,0	55,8	396,2	12,3
1988	209,9	0,8	210,7	254,6	465,3	52,3	413,0	11,2
1989	198,7	0,8	199,5	298,0	497,5	53,4	444,1	10,7
1990	NA	NA	NA	NA	NA	NA	NA	NA
1991	NA	NA	NA	NA	NA	NA	NA	NA

000'S TOE

YEAR	TRADITIONAL	COMMERCIAL
1971	76.9	343.6
1972	79.3	353.6
1973	81.8	363.7
1974	84.2	373.7
1975	86.6	383.8
1976	89.1	393.8
1977	91.5	403.9
1978	93.9	413.9
1979	96.4	424.0
1980	99.0	434.1
1981	101.3	444.1
1982	103.7	454.2
1983	106.1	464.2
1984	108.6	474.3
1985	110.5	484.3
1986	113.4	494.4
1987	115.9	504.4
1988	118.3	514.5

Table F.10: TANZANIA

ENERGY DATA

YEAR	COMERCIAL ENERGY FORMS TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP TOE/REAL 1985		TRADITIONAL ENERGY	COMM/ TRADIT	TOTAL ENERGY TRAD+COM	ENERGY PER CAPITA TOE/CAPITA		
	COAL	OIL	HYDRO	GAS	ELECT	TOTAL	1PT	3PT MA	000'S TOE		000'S TOE	COMMERCIAL	TRAD	TOTAL
1950	35,7	104,0	0	0	3,2	143,0	NA	NA	NA	NA	NA	0,017	NA	NA
1951	32,6	92,0	0	0	4,5	129,2	NA	NA	NA	NA	NA	NA	NA	NA
1952	44,9	107,0	0	0	5,0	157,0	NA	NA	NA	NA	NA	NA	NA	NA
1953	35,7	115,0	0	0	6,2	157,0	NA	NA	NA	NA	NA	NA	NA	NA
1954	33,2	121,0	0	0	6,8	161,0	NA	NA	NA	NA	NA	NA	NA	NA
1955	3,7	167,0	0	0	7,8	178,5	NA	NA	NA	NA	NA	0,019	NA	NA
1956	4,9	198,0	0	0	8,7	211,6	NA	NA	NA	NA	NA	NA	NA	NA
1957	1,2	236,0	0	0	9,4	246,6	NA	NA	NA	NA	NA	0,026	NA	NA
1958	0,6	251,0	0	0	10,1	261,7	NA	NA	NA	NA	NA	0,027	NA	NA
1959	1,2	212,0	0	0	10,7	223,9	NA	NA	NA	NA	NA	0,022	NA	NA
1960	1,2	257,0	0	0	11,6	269,8	NA	NA	NA	NA	NA	0,026	NA	NA
1961	1,8	216,0	0	0	12,2	230,0	NA	NA	NA	NA	NA	0,022	NA	NA
1962	2,5	233,0	0	0	13,6	249,1	NA	NA	NA	NA	NA	0,023	NA	NA
1963	1,8	248,0	0	0	14,7	264,5	NA	NA	NA	NA	NA	0,024	NA	NA
1964	0,6	326,0	0	0	16,0	342,6	NA	NA	NA	NA	NA	0,030	NA	NA
1965	1,2	366,0	0	0	18,4	385,6	6,2E-06	NA	NA	NA	NA	0,033	NA	NA
1966	2,5	396,0	0	0	21,7	420,2	6,0E-06	6,672E-06	NA	NA	NA	0,035	NA	NA
1967	1,2	544,0	0	0	24,3	569,5	7,8E-06	6,595E-06	NA	NA	NA	0,046	NA	NA
1968	2,5	428,0	0	0	27,0	457,5	6,0E-06	7,317E-06	NA	NA	NA	0,036	NA	NA
1969	1,8	602,0	0	0	30,9	634,7	8,1E-06	6,850E-06	NA	NA	NA	0,049	NA	NA
1970	2,5	495,0	0	0	34,1	531,6	6,4E-06	7,170E-06	NA	NA	NA	0,040	NA	NA
1971	1,8	558,4	0	0	37,6	597,8	6,9E-06	6,710E-06	6080,00	0,098	6677,8	0,044	0,446	0,490
1972	1,8	581,3	0	0	40,4	623,5	6,8E-06	6,989E-06	6250,00	0,100	6873,5	0,045	0,446	0,491
1973	1,2	646,1	0	0	42,9	690,2	7,3E-06	7,058E-06	6445,00	0,107	7135,2	0,048	0,449	0,497
1974	1,2	646,4	0	0	45,6	693,2	7,2E-06	7,007E-06	6760,00	0,103	7453,2	0,047	0,458	0,505
1975	1,3	629,0	0	0	47,9	678,2	6,6E-06	6,758E-06	7087,00	0,096	7765,2	0,044	0,463	0,507
1976	0,6	665,5	0	0	48,2	714,3	6,5E-06	6,406E-06	7300,00	0,098	8014,3	0,044	0,445	0,488
1977	0,6	636,2	0	0	50,5	687,3	6,1E-06	6,466E-06	7519,00	0,091	8206,3	0,041	0,444	0,485
1978	1,3	726,7	0	0	56,7	784,7	6,8E-06	6,392E-06	7764,00	0,101	8548,7	0,045	0,445	0,490
1979	1,3	676,1	0	0	62,4	739,8	6,3E-06	6,899E-06	8000,00	0,092	8739,8	0,041	0,445	0,486
1980	1,3	829,6	0	0	70,0	900,9	7,6E-06	6,738E-06	8250,00	0,109	9150,9	0,048	0,444	0,493
1981	1,3	663,5	0	0	71,7	736,5	6,3E-06	6,431E-06	8512,00	0,087	9248,5	0,038	0,444	0,482
1982	1,3	568,5	0	0	67,9	637,7	5,4E-06	5,623E-06	9289,00	0,069	9926,7	0,032	0,470	0,502
1983	5,0	532,8	0	0	70,1	607,9	5,2E-06	5,236E-06	9624,00	0,063	10231,9	0,030	0,472	0,501
1984	6,8	529,7	0	0	72,2	608,7	5,1E-06	5,123E-06	9975,00	0,061	10583,7	0,029	0,474	0,503
1985	10,5	523,0	0	0	74,4	607,9	5,0E-06	4,992E-06	10324,00	0,059	10931,9	0,028	0,475	0,503
1986	3,8	517,7	0	0	65,1	586,6	4,8E-06	4,792E-06	10400,00	0,056	10986,6	0,026	0,463	0,489
1987	3,1	518,0	0	0	64,8	585,9	4,5E-06	4,592E-06	10434,00	0,056	11019,9	0,025	0,449	0,475
1988	1,8	514,1	0	0	65,3	581,2	4,4E-06	NA	12355,00	0,047	12936,2	0,024	0,515	0,539
1989	NA	NA	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	0	0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table F.12: ZAMBIA

TABLE B: COMMERCIAL AND TRADITIONAL ENERGY

YEAR	COMMERCIAL ENERGY FORMS IEA ENERGY TOTAL FINAL CONSUMPTION 000'S TOE						ENERGY/GDP TOE/REAL 19 1985KWA		TRADITIONAL ENERGY	TRADITIONAL AS % OF	ENERGY PER CAPITA TOE/CAPITA		
	COAL	OIL	GAS	HYDRO	ELECT	TOTAL	1PT	3PT MA	000'S TOE	TOTAL	COMMERCIAL	TRADITIONAL	TOTAL
1964	606, 6	158, 9	0, 0	0, 0	235, 1	1000, 6	2, 312E-04		NA	NA	0, 3	NA	NA
1965	710, 2	206, 0	0, 0	.0, 0	251, 6	1167, 8	2, 086E-04	2, 142E-04	NA	NA	0, 3	NA	NA
1966	636, 5	195, 0	0, 0	0, 0	257, 3	1088, 8	2, 029E-04	2, 240E-04	NA	NA	0, 3	NA	NA
1967	847, 7	341, 0	0, 0	0, 0	278, 4	1467, 1	2, 606E-04	2, 386E-04	NA	NA	0, 4	NA	NA
1968	785, 7	381, 0	0, 0	0, 0	288, 8	1455, 5	2, 522E-04	2, 502E-04	NA	NA	0, 4	NA	NA
1969	672, 8	432, 0	0, 0	0, 0	309, 2	1414, 0	2, 378E-04	2, 332E-04	NA	NA	0, 3	NA	NA
1970	574, 5	439, 0	0, 0	0, 0	339, 1	1352, 5	2, 097E-04	2, 221E-04	NA	NA	0, 3	NA	NA
1971	496, 1	481, 0	0, 0	0, 0	375, 9	1353, 0	2, 187E-04	2, 167E-04	221	14, 0	0, 3	0, 050	0, 359
1972	559, 0	525, 6	0, 0	0, 0	403, 5	1488, 1	2, 217E-04	2, 276E-04	230	13, 4	0, 3	0, 051	0, 379
1973	520, 5	657, 2	0, 0	0, 0	437, 0	1614, 7	2, 424E-04	2, 345E-04	240	12, 9	0, 3	0, 051	0, 396
1974	454, 7	776, 0	0, 0	0, 0	473, 7	1704, 4	2, 395E-04	2, 429E-04	251	12, 8	0, 4	0, 052	0, 405
1975	417, 0	814, 4	0, 0	0, 0	476, 4	1707, 8	2, 469E-04	2, 432E-04	262	13, 3	0, 3	0, 053	0, 396
1976	430, 1	830, 5	0, 0	0, 0	499, 3	1759, 9	2, 434E-04	2, 423E-04	267	13, 2	0, 3	0, 052	0, 394
1977	400, 1	740, 4	0, 0	0, 0	485, 5	1626, 0	2, 366E-04	2, 357E-04	273	14, 4	0, 3	0, 052	0, 358
1978	389, 0	696, 3	0, 0	0, 0	484, 1	1569, 4	2, 273E-04	2, 304E-04	279	15, 1	0, 3	0, 051	0, 338
1979	339, 4	694, 5	0, 0	0, 0	489, 1	1523, 0	2, 273E-04	2, 261E-04	289	15, 9	0, 3	0, 052	0, 328
1980	335, 2	708, 1	0, 0	0, 0	501, 2	1544, 5	2, 238E-04	2, 189E-04	293	15, 9	0, 3	0, 053	0, 330
1981	276, 2	691, 1	0, 0	0, 0	537, 0	1504, 3	2, 054E-04	2, 130E-04	289	16, 1	0, 3	0, 049	0, 306
1982	297, 8	649, 7	0, 0	0, 0	545, 6	1493, 1	2, 097E-04	2, 071E-04	296	16, 5	0, 2	0, 049	0, 297
1983	253, 5	633, 8	0, 0	0, 0	550, 8	1438, 1	2, 060E-04	2, 075E-04	303	17, 4	0, 2	0, 049	0, 279
1984	262, 6	634, 2	0, 0	0, 0	542, 0	1438, 8	2, 069E-04	2, 001E-04	307	17, 6	0, 2	0, 048	0, 271
1985	281, 5	535, 2	0, 0	0, 0	509, 6	1326, 3	1, 875E-04	1, 980E-04	308	18, 8	0, 2	0, 046	0, 243
1986	332, 3	563, 2	0, 0	0, 0	523, 3	1418, 8	1, 995E-04	1, 938E-04	310	17, 9	0, 2	0, 043	0, 237
1987	290, 0	584, 1	0, 0	0, 0	506, 1	1380, 2	1, 945E-04	NA	310	18, 3	0, 2	0, 041	0, 223
1988	NA	NA	NA	NA	NA	NA	NA	NA	300	NA	NA	0, 040	NA
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table F.11: ZAIRE

YEAR	ENERGY CONSUMPTION OIL	ELECT	COAL	TOTAL	ENER/CAP kJ/CAP	ENER/GNP kJ PER Million Z
	000'S TONS OIL EQUIVALENT					
1967	NA	216.03	NA	NA	NA	NA
1968	NA	229.66	NA	NA	NA	NA
1969	NA	251.03	NA	NA	NA	NA
1970	NA	278.45	NA	NA	NA	NA
1971	NA	305.17	NA	NA	NA	NA
1972	NA	306.38	NA	NA	NA	NA
1973	NA	331.72	NA	NA	NA	NA
1974	775.35	290.92	45.84	1112.11	2145	1501
1975	799.62	297.23	101.62	1198.47	2242	1723
1976	765.11	298.03	108.66	1171.80	2124	1736
1977	689.98	298.69	133.78	1122.45	1969	1623
1978	655.98	282.79	134.88	1073.65	1822	1634
1979	632.47	298.37	126.82	1057.66	1737	1605
1980	685.82	318.54	144.04	1148.40	1824	1716
1981	714.83	338.06	136.86	1189.75	1829	1724
1982	662.54	332.39	147.62	1142.55	1702	1728
1983	696.25	336.31	136.88	1169.44	1689	1766
1984	NA	NA	NA	NA	NA	NA
1985	NA	NA	NA	NA	NA	NA
1986	NA	NA	NA	NA	NA	NA
1987	NA	NA	NA	NA	NA	NA

Table F.13: ZIMBABWE

YEAR	COMMERCIAL ENERGY FORMS IEA ENERGY - TOTAL FINAL CONSUMPTION -000'S TOE						ENERGY/GDP REAL 85 TOE/ ZIM Million $		TRADIT. ENERGY 000'sTOE	TOTAL ENERGY TRAD+COM 000'sTOE	TRADIT AS % OF TOTAL %	ENERGY/CAPITA TOE/CAPITA		
	COAL	OIL	GAS	HYDRO	ELECT	TOTAL		3-PT MA				COMMER	TRAD	TOTAL
1971	1168.3	547.3	0.0	0.0	303.8	2019.4	753.8		1000	3019.4	33.1	0.37	0.19	0.56
1972	1023.6	640.5	0.0	0.0	364.6	2028.7	697.0	753.4	1050	3078.7	34.1	0.36	0.19	0.55
1973	1267.4	713.6	0.0	0.0	423.6	2404.6	809.3	714.2	1101	3505.6	31.4	0.42	0.19	0.61
1974	994.8	625.7	0.0	0.0	455.5	2076.0	636.4	733.7	1130	3206.0	35.2	0.35	0.19	0.54
1975	1102.0	775.8	0.0	0.0	509.3	2387.1	755.5	727.3	1168	3555.1	32.9	0.39	0.19	0.59
1976	1288.8	683.0	0.0	0.0	532.9	2504.6	790.0	782.6	1212	3716.6	32.6	0.40	0.19	0.60
1977	1135.8	671.9	0.0	0.0	527.1	2334.7	802.3	796.0	1243	3577.7	34.7	0.36	0.19	0.56
1978	1088.1	689.0	0.0	0.0	507.2	2284.3	795.8	793.3	1276	3560.3	35.8	0.35	0.19	0.54
1979	1118.4	601.5	0.0	0.0	546.6	2266.5	781.7	784.0	1302	3568.5	36.5	0.33	0.19	0.52
1980	1251.4	648.5	0.0	0.0	597.1	2497.0	774.5	754.5	1362	3859.0	35.3	0.36	0.19	0.55
1981	1173.7	714.0	0.0	0.0	613.8	2501.5	707.4	719.7	1458	3959.5	36.8	0.34	0.20	0.54
1982	1140.9	660.2	0.0	0.0	629.3	2430.3	677.4	702.2	1503	3933.3	38.2	0.32	0.20	0.52
1983	1166.7	750.9	0.0	0.0	599.5	2517.1	721.7	689.4	1492	4009.1	37.2	0.32	0.19	0.51
1984	1069.1	717.9	0.0	0.0	567.3	2354.3	669.2	681.2	1544	3898.3	39.6	0.29	0.19	0.48
1985	1122.2	699.6	0.0	0.0	616.0	2437.8	652.6	673.3	1542	3979.8	38.7	0.29	0.18	0.47
1986	1236.0	783.7	0.0	0.0	645.3	2664.9	698.2	685.7	1703	4367.9	39.0	0.31	0.20	0.50
1987	1330.3	745.6	0.0	0.0	630.6	2706.5	706.4	NA	1709	4415.5	38.7	0.30	0.19	0.49
1988	1466.8	745.7	0.0	0.0	662.2	2874.6	NA	NA	1736	4610.6	37.7	NA	NA	NA
1989	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1990	NA	NA	NA	NA	NA	NA	NA	NA		NA	NA	NA	NA	NA

APPENDIX G:

ENERGY RESOURCES OF SELECTED COUNTRIES[12]

i ANGOLA
ii BOTSWANA
iii ETHIOPIA
iv KENYA
v LESOTHO
vi MALAWI
vii MOZAMBIQUE
viii SOUTH AFRICA ... See section 4.4 for details.
ix SWAZILAND
x TANZANIA
xi ZAIRE
xii ZAMBIA
xiii ZIMBABWE

i ANGOLA

i.a Fuelwood

Angola possesses some 50 million hectares of dense forests, and an additional 55 million hectares of woodland and savanna. The potential for fuelwood production is much greater than present consumption. However, the fuelwood potential is badly distributed relative to the regional demand pattern. Approximately half of the country's population live in areas with little wood potential, such as on the coast or in cities.

An estimate was carried out by the UNDP on the main forest formations in Angola using remote satellite sensing between 1984 and 1986. The results of this estimate are shown in Table G.1.

Table G.1. Forest inventory using satellite

Vegetation class	Area million hectares	Standing woody biomass per ha tons	Mean annual increment tons/ha/ year	Total annual increase million tons
Transitional rain forest	16,0	200	6,0	96
Dense high & medium high	33,2	71	2,2	73
Seasonal woodland & savannas	30,7	20	0,5	15
Dry deciduous	23,0	17	0,5	12
Other open forest and bush	15,8	13	0,4	7
Total	118,7	--	---	203
Average	-----	57	1,7	---

i.b Petroleum

The proven recoverable reserves of crude oil at the end of 1987 were 156 million tons. No values were published for any additional resources. Most of the crude oil being produced is from Cabinda Province which is the area that has been most explored. It is estimated that Cabinda crude oil production will fall from 70% of total production in the mid-1980's to 55% in 1990. The ratio of reserves-to-production was 13,7 years in 1986. Production in 1986 was 282 000 barrels per day, giving an estimated reserve of 183 million tons.

Exploration is slowly being expanded southwards from the Cabinda field. Exploration is also being carried out on-shore and in deep water (70-200 metres) areas. An estimated US$ 2,27 billion was spent on exploration between 1980 and 1986 and is estimated that a further US$ 2,05 billion will be spent up to 1990, with 13 foreign oil companies now active in Angola.

The attraction of Angola to foreign oil companies is the favourable geological terrain, the low production costs, and the government's enlightened attitude to profit sharing and profit repatriation.

i.c Coal

Angola does not have any reported coal reserves.

i.c Hydro-electricity

Angola is well endowed with hydro-potential with a number of large rivers flowing east to west. In addition, there are a number of rivers with their origin in Angola but flowing to the Indian Ocean, the most noteworthy of these being the Zambezi which has its origins in the east of the country. Traditionally the main hydro-power potential has been on the Kwanza (960 km long), Donde, Catumbela, and Cunene (945 km) Rivers. In addition, there is potential on the Kubango (975 km) and Queve Rivers.

Estimates of hydro-potential of Angola range from 70 000 GWh - 150 000GWh per year. Using the former figure and a load factor of 50%, the potential for power is 16 000 MW.

Because the potential hydro-power is so much larger than the demand in the foreseeable future, no serious study has been made of the potential across the whole country.

i.d Gas

Angola's natural gas resources are estimated at 30 000 million cubic metres. Of this 18 000 million occur as unassociated gas, whilst 12 000 million are associated with crude oil. Of the associated gas, 9 000 million were proven as at 1987. At present the ratio of gas-to-oil is approximately 0,28 cubic metres per ton. The non-associated gas is presently not being utilized, except for a small field offshore at Cabinda. The reserve capacity is therefore not accurately known, though the main reserves are thought to be off the Zaire Province coast.

i.e Other energy sources

No information is available on the potential for the use of agricultural residues or of the wind energy potential.

Angola has prospects for solar energy similar to other countries in Africa in the latitude belt 6 to 17. Especially in the southern area the cloud cover is light. In the wettest month, March, the average rainfall is 36 mm, whilst the driest month is June with 0 mm rainfall. The climate is tropical in the north of the country, temperate on the inland plateau, and sub-tropical in the south.

Angola is far from the Rift Valley which is the edge of the tectonic plate and thus is far from the possible location of volcanic activity and high underground temperatures. Therefore there is little possibility for geothermal energy.

ii BOTSWANA

ii.a Fuelwood

Some 50 percent of Botswana's total final energy demand is met by fuelwood. Fuelwood is the major source of energy for the rural population, although it is also widely used in urban areas. Woodlands surrounding the urban areas are being depleted, especially in the south-eastern areas. The region's harsh climatic conditions and frequent droughts make it difficult and expensive to replace depleted forest resources. The result is that people are spending more time collecting wood and it is becoming an increasingly expensive marketable product. Survey data to put the above into quantitative terms on a regional basis are only now being collected.

ii.b Petroleum and Gas

At present Botswana has no proven oil or gas reserves. However, three deep sedimentary basins, in which oil and/or gas may be found in commercial quantities, have been identified. Further exploitation is required to evaluate the extent of these possible reserves, if any.

ii.c Coal

Coal is Botswana's largest known energy resource. Deposits have been identified in ten areas. The main fields are situated in the Greater Morupule and Mmamabula areas of eastern Botswana. Total proven reserves are in excess of 17 billion tons. The coal quality varies considerably from area to area, although in general the calorific value is low, ash content is high, and volatility medium to high. Three workable coal fields have been identified. The only operating mine is at Palapye owned by Morupule colliery. Present capacity is 800 000 tons a year, but is being expanded to 1 000 000 tons a year.

The Government planned to develop the above resources for export, but the low steam coal price forced the shelving of these plans. There is optimism that they may be revived in the 1990's.

ii.d Hydro-electricity

Due to the lack of rivers with sufficient flow and scarcity of water in the region, no hydro-electric potential exists in Botswana.

ii.e Other sources of energy

Solar

The climate is well suited to the use of solar energy and various solar energy technologies are being used on a small scale, namely, solar water heaters, photovoltaics, solar-powered pumps. Research data to date have shown that there are relatively few cases where solar generation of electricity would be economically viable.

Wind

Data on wind speed characteristics in the region is scarce, but windmills are in use in some isolated parts of the country for pumping water. The Government is promoting the use of wind pumps as an alternative to diesel-powered pumps in isolated areas where electrification is not an option in the foreseeable future.

Biogas

Potential exists at large co-operatives and cattle posts for the use of biogas to power water pumping systems. A pilot plant has been installed by the Rural Innovations Centre at Diphawana and is functioning satisfactorily.

iii ETHIOPIA

iii.a Fuelwood

Ethiopia's forests cover about 27,15 million hectares or 22% of the total land area. Of this, 4,35 million hectares are considered closed forests and 22,8 million hectares are considered open forests. Average annual deforestation amounts to 88 000 hectares per year, while reforestation replaces only 18 000 hectares on average per year, resulting in a net loss of total forestry resources.

iii.b Oil and Gas

Ethiopia has no identified sources of oil and imports all its requirements which it refines at the Assab petroleum refinery. However, promising strikes of oil have been obtained between the Web and Webi-Shebelli Rivers. These await official confirmation and suggestions on how effective exploitation can be achieved.

Gas reserves have been discovered and proven recoverable reserves of 24 million m have been identified.

iii.c Coal

Ethiopia has no identified bituminous coal reserves. Lignite and sub-bituminous coal reserves have been identified and in 1987 proven reserves amounted to 23 million tons, of which 11 million tons were considered recoverable reserves. The major deposits are situated in Wollega, Gonar, Eritrea and Sidamo. These deposits tend to occur in the more deforested energy-poor regions.

iii.d Hydro-electricity

Ethiopia has a high rainfall and a precipitous topography which has endowed it with a relatively large hydro-electric potential. A number of hydro plants are already in operation, while a large number of sites have been identified at which power production could be coupled with irrigation schemes especially along the Blue Nile

River. Total hydro potential is estimated to be 20 000 GWh per year, with a potential installed capacity of 4000 MW which is sufficient to provide all Ethiopia's electricity requirements for the foreseeable future.

iii.e Other energy sources

Geothermal:

Ethiopia has considerable high enthalpy geothermal potential in areas in the Rift Valley. This potential has not yet been exploited, although estimates are now being made of the potential and feasibility studies are being undertaken to determine the optimum exploitation of identified potential. In 1984 its potential was estimated at 4000 MW.

Solar:

Much potential exists for the application of solar energy to displace electric water heating in households in the major towns and cities as well as in a number of industries including tanneries, hotels and hospitals.

Ethanol:

In 1984 the government had plans to build a 20 million litres per year distillery at Shoa using surplus molasses from the sugar industry as feedstock. The output would be used to make a 20% ethanol and regular gasoline blend.

Bagasse:

In 1984 surplus bagasse from the sugar industry amounted to 9 600 tons per year and was set to grow to 16 000 tons per year with the completion of new mills and expansion of old mills. Much of this surplus is used to substitute for fuelwood in lime-burning. With the appropriate investment, scope exists to increase bagasse surpluses by tenfold through more energy-efficient operation of the sugar mills. This would create a valuable fuel supply to industry and households

iv KENYA

Kenya's proven energy resources are relatively small. Known commercial energy resources are basically hydro and geothermal. Although these resources are deemed sufficient for providing most of the country's electricity requirements for the next decade, Kenya is almost totally dependent on imports for its oil and coal needs. Kenya's forest resources are being exploited at a greater rate than they can replenish themselves, resulting in deforestation.

iv.b Fuelwood

Forests cover about 2 million hectares or about 4% of Kenya's total land area. Forest resources are almost totally under public ownership and management. Indigenous forest reserves account for 88% of all forests. Demand is greater than sustainable supply and results in deforestation and associated problems. Woodfuels are being consumed at about four times the rate of incremental production. In 1982 it was estimated that the average yield from Kenya's forests was 3m per hectare per year. In order to meet demand with sustainable supply, yield would have to be increased to 20m or the area under forests increased.

iv.c Coal

No coal reserves have been discovered and all of the country's coal requirements are imported, mainly from Swaziland.

iv.d Oil and Gas

Kenya has no identified reserves of oil or gas although the sedimentary basins have not been fully explored and potential exists for future discoveries. Evidence from limited drilling in Kenya and neighbouring countries indicates that there are abundant source rocks and prospective reservoirs. Interest in exploration has increased over the past decade, especially for gas which is more likely to be found than oil.

iv.e Hydro-power

Kenya has hydro potential although it is relatively small. Proven resources, which are capable of development, are given as 1075 MW. Studies indicate that by the end of the century 560 MW of hydro-power could be added to the present 354 MW of installed hydro plant, giving an annual generation capacity of 4380 GWh.

iv.f Geothermal

Geothermal potential exists in the Rift Valley. Conservative estimates put the potential at 170 MW, while optimistic estimates put it at 1000 MW. Approximately 30 MW of geothermal potential are presently being exploited.

iv.g Ethanol

Two ethanol plants using molasses as feedstock were constructed in the early 1980's and were expected to supply 36 000 m annually. A third plant using sugar cane as a feedstock was being considered. The World Bank recommended that no further investment be made in the fuel alcohol programme as it felt that the economics of the plants had not been dealt with systematically and that the plants were to some extent a drain on the economy.

iv.h Solar

Kenya's entire area lies between the 5 south and north latitudes and consequently solar radiation is high and constant throughout the year. The average annual insolation for the country is estimated at 5,5 kWh/m^2/day. Thus a relatively large potential exists for the exploitation of solar energy with respect to the minimal contribution it makes at present.

iv.i Wind

Studies have indicated two areas in the country suitable for wind pumping or power generation. It is thought that the potential for wind power may be equally good in other parts of the country.

iv.j Bagasse

This by-product of sugar production is used to provide all the electrical and process steam requirements of the sugar industry. However, the export of excess electricity from these industries is not considered economically viable.

iv.k Biogas

One of the most promising forms of non-conventional energy is biogas. In 1982 there were about 100 biogas digesters in Kenya, most of them on large farms. This energy form is usually suitable only for rural areas far from the electricity grid.

v LESOTHO

v.a Fuelwood

Most of Lesotho is bare and mountainous with temperatures fluctuating between 30 C in summer and below 0 C in winter, which is not favorable for tree growth. Thus fuelwood is in short supply and Lesotho relies on the RSA for most of its requirements. There is potential for reforestation and progress has been made through a Woodlot Project but has been slow.

v.b Petroleum

Lesotho has no proven oil reserves and imports all of its petroleum product requirements. Exploration work has been undertaken in the past without success. The World Bank reviewed available exploration data in 1983 and concluded that the geological structures of Lesotho is such that it is unsuitable for oil or gas. The rough terrain would make the necessary seismic work and drilling difficult and expensive. The costs would be further inflated due to Lesotho's isolated position.

The Government of Lesotho is none the less still keen to promote petroleum exploration and has approached several foreign governments for technical assistance in this regard.

v.c Coal

Lesotho imports all its coal requirements, having no proven reserves of its own. A survey carried out by UNDP in the early 1980's ruled out the possibilities of discovering economically viable deposits of coal in Lesotho, although narrow seams of coal have been located.

These thin seams are essentially outcrops of the Beaufort and Stromberg series originating in the RSA. Thin and unpersistant views of coal are found over a belt 150 km long and 35 km wide in the Mohale's Hoek, Mafeteng, Qacha's Nek, Maseru and Leribe districts. The thickest vein is estimated to be 15 cm, with coal quality varying from poor to good grade bituminous. The possibility of economic exploitation of these deposits is remote.

v.d Hydro-electricity

Lesotho's largest energy resource is hydro-electricity which is largely untapped. The relatively large hydro potential is based principally on the Senqu (Orange) and Senqunyane Rivers. The World Bank gives the technically exploitable hydro-electric potential as being approximately 2 000 GWh per year, with an installed capacity of 450 MW. The cost of exploiting this potential is high due to the lack of natural heads and the erratic seasonal flow patterns and Lesotho will rely on the RSA buying water from any project undertaken.

The Lesotho Highlands Water Project, identified in the early 1950's, is presently under construction. It is a joint venture with the RSA and includes the construction of dams, reservoirs, tunnels, and hydro-power stations, as well as the export of large quantities of water to the RSA. Phase 1a, costed at $1,5 billion, is due for completion in 1995/96.

This first phase will see the construction of two dams and reservoirs, a 75 MW hydro-power station, 82 km of tunnels and a complete supporting infrastructure of roads, housing and communications. This forms the beginning of a thirty-year development project which will ultimately deliver 70 m of water per second to the RSA from five main storage reservoirs and have an installed capacity in excess of 200 MW. In addition to an improved infrastructure and domestic power supply, Lesotho will also receive more than 50 years' royalty fees in return for the water delivered to the RSA.

Potential also exists for mini- and micro-hydro schemes in areas remote from the grid, with installed capacities ranging from 30 kW to 7 MW. Mini-hydro schemes are presently under construction at Mantsenyane, Semonkong, Tlokoeng and Tsoelike.

v.e Other Energy Sources

Solar and Wind:

Large seasonal variations in climatic conditions make the harnessing of solar and wind power difficult. A number of telecommunication stations and police outposts have been equipped with photovoltaic power kits. A number of windmills for pumping water from boreholes were installed by the Southern Cross but are now mostly inoperative due to a lack of maintenance.

Solar water heater and crop dryers have been developed to the prototype stage using locally available materials.

It is unlikely that any large-scale exploitation of solar or wind power is possible in the foreseeable future.

Animal Residues:

Dung in the form of dried chunks or briquettes is a widely used fuel in rural areas and is estimated to supply more than 40% of rural energy consumption. The preferred source is cow dung which is obtained from livestock kraals. Households that do not own cattle collect dung from the fields in the dry winter for use in the summer.

Biogas:

The Government of Lesotho has recognized the potential of biogas production using dung and is supporting a pilot project on Biogas Production Systems. A number of digesters have been constructed or are under construction. Initial results are promising and indicate that underground biogas generators can produce year-round despite the frost conditions in winter. However, the application of this energy source is restricted to areas where animals are stabled and where large-scale gathering of animal waste from grazing ground is not required.

vi MALAWI

vi.a Fuelwood

Malawi, which has a land area of 118 484 square kilometers, is covered by 5 million hectares of indigenous forest and wooded land. The above comprises parks and game reserves (20%) and natural woodland (80%) of which 20% is forestry reserves and protected hill slopes.

Although fuelwood is Malawi's main source of energy, consumption exceeds the level of sustainable yield on a national level by approximately 30%, resulting in the depletion of the natural forest cover. This depletion was estimated in 1980 to be 3,5% per annum in terms of gross area.

Although nationally fuelwood demand cannot be sustained, in the northern region, which is relatively sparsely populated and less developed, the sustainable supply of fuelwood is well in excess of demand. However, in the more densely populated and developed central and southern regions, the sustainable supply falls far short of consumption and localized fuelwood shortages are emerging. The availability of fuelwood is, however, currently not a source of acute concern to the public in general, although the continued availability of fuelwood is potentially a serious problem.

vi.b Petroleum and gas

Malawi's oil and gas potential has historically been considered poor and as yet there have been no reported oil reserves. However, a study by a team from Duke University in 1981 indicated that the sediments under Lake Malawi were 2km thick and contained structures which could contain gas or oil deposits. The results of this work are not yet available. Shell Oil also undertook exploration in 1981 and has shown interest in performing geophysical work in the lower Shire Valley and on parts of the lake.

If hydrocarbon deposits are proven, they are likely to be limited and their commercial development would entail overcoming substantial practical difficulties.

vi.c Coal

Five coal deposits have been identified in the far north and far south. Their exploitation has been hampered by the distance of the northern deposits from the industrial areas and the lack of knowledge about the economic viability of the coal reserves. In 1985 the Malawi Geological Survey Department put the proven reserves at 15,78 million tons, of which 15 million tons were associated with the Ngana deposit in the far north.

None of the above deposits were exploited until 1985 when opencast mining began at the Kaziwiziwi deposit in the Livingstonia coal field. The deposit is of excellent quality, but its potential is limited by the fact that mineable reserves are estimated to be only 150 000 tons. In 1988 the production was 26 140 tons.

The Ngana deposit, although having 15 million tons' reserve, has a mineable reserve of 1,6-1,8 million tons. The coal is of a low quality and is far from the industrial centres, making its development for industrial purposes unfeasible at present.

Detailed exploration of the Chiromo and Lengwe deposits in the lower Shire Valley began in 1989.

vi.d HYDRO ELECTRICITY

Hydro power is a very important energy resource to Malawi and its exploitation has saved the country considerable outflow of foreign exchange. The total hydro potential is documented as being 1000 MW. The majority of hydro sites are located on the Middle Shire River which is the only river to have existing hydro capacity and to have been evaluated for hydro potential in detail. The World Bank gives the potential of the Middle Shire River as being 500 MW, with a potential annual production of 3500 GWhs.

The other main rivers with hydro potential are the South Rukuru and Bua Rivers. However, these have not been investigated in detail.

vi.e OTHER ENERGY SOURCES

Ethanol is produced from sugar cane at the Dwanga Sugar Estate and is blended with petrol, meeting more than 10% of the annual petrol demand. The distillation capacity is 60 000 litres per day and the annual target is 10 million litres. Certain grades of ethanol are being exported to neighbouring countries. Cassava is also being investigated as a potential feedstock.

There is potential in Malawi to replace isolated diesel-based power by mini-hydro schemes and their development could result in significant diesel fuel savings. Despite the promising potential of this resource, there is little information available on it. In the northern region a number of mini-hydro sites with capacities of 100-500 kW have been identified particularly on the North Rukuru, Manchewe, and Chilumba Rivers.

Malawi's location assures it of fairly high levels of solar radiation throughout the year and this resource could be harnessed for a variety of applications, although its contribution to the total final consumption would not be significant in the foreseeable future.

Bagasse, cotton husks and rice hulls are used in small quantities as industrial fuel.

Some research is being performed on the use of digesters for producing biogas from animal and agricultural wastes, but the contribution from this source is unlikely to be significant during this decade.

vii MOZAMBIQUE

vii.a Fuelwood

Fuelwood supplies approximately 90% of the total final energy requirements and is a commodity which is rapidly being depleted. Areas around the major cities have been deforested. There is little information on the potential for fuelwood, though recent work is expanding the information database.

An inventory of forestry resources was carried out in 1979/80 and was based on satellite imagery and aerial photographs from 1972. This survey showed that Mozambique had 56,6 million hectares of forest, which is equivalent to 71% of the country's land area. This however includes large areas of open savanna with low levels of wood production potential. Relatively dense forest covers possibly only 5 million hectares.

Total forestry area is 19 million hectares. It is estimated that the natural increase in the standing volume in these forests is approximately equal to the country's demand for forestry products. However, there are serious imbalances between supply and demand in certain areas. The remaining dense forests are concentrated in the provinces of Sofala, Manica, Niassa, and Cabo Delgado, which all have low population densities and thus a fuelwood surplus.

Several plantations were started near Maputo in the 1960's in order to supply Maputo's rapidly increasing demand. Only 3 000 hectares of plantation were established and the project has now come to a standstill.

Similar afforestation schemes have been started around Beira and Nampula, but with similar poor results.

vii.b Petroleum

Geologically Mozambique consists mainly of pre-Cambrian and younger rocks which are not suitable sites for petroleum. However, there are a number of sections of Karroo sedimentary basins which may be suitable for deposits of hydrocarbons. Geological surveys have shown that there is more chance of gas in the onshore areas of Karroo sediment, whilst the offshore deposits could contain oil. Three gas deposits have been found and the oil exploration programme was revived in 1981 with three offshore surveys. ENH, who are responsible for the exploration and development of hydrocarbons, has made agreements with East Germany and the USSR in 1982 for technical assistance with the exploration programme.

Onshore exploration by private oil companies is unlikely because of the gas-prone nature of the area and ENH are carrying out their own seismological survey.

The most promising zones for oil are the Rovuma basin in the north on the border with Tanzania, the Zambezi basin, and off the coast of Gaza. Shell and Exxon explored the northern onshore area, but with little success and have now pulled out. However, ENH consider that there is still the potential for oil in this area and are discussing the possibility of a joint programme with Tanzania. In 1988 BP carried out test drilling off Xai-Xai but found no oil. In late 1989 it was expected that Amoco would start an offshore drilling programme.

vii.c Coal

There are three major known coal deposits in Mozambique, all located in the central west part of the country, in Tete Province, all at substantial distances from the main domestic markets and from the coast. In addition, there are a number of coal occurrences in the northern region at Maniamba and Lugenda, and one at Espungabera in the central region and on the Mozambique-Zimbabwe border.

The Tete Province deposits are located at Muchanha-Vuzi, on the north side of the Cahora Bassa Dam, at Senangoe, south-east of the Dam, at Moatize, near the town of Tete, and at Goma, east of the other deposits. The only operating colliery is at Moatize. Only the Moatize coal deposits are adequately surveyed, but estimates have been made of proven, probable, and possible reserves. These values are shown in Table G.2.

Table G.2. Coal reserves in Mozambique

	Reserves in Million Tons			
Region	Proven	Probable	Possible	Total
Moatize	87	737	1145	1969
Minjova			3000	3000
Sanangoe			1000	1000
Mucanha-Vuzi	851	749	1962	3562
Total	938	1486	7107	9531

In the Moatize region there are six coal seams with thicknesses ranging from 1,8 metres to 40 metres separated by some 40 to 50 metre layers of sandstone. The seams are at depths of between 100 and 200 metres. The coal has an ash content of 15% to 25% and a sulphur content of 0,8%.

In addition to the reserves shown in Table G.2, there are a number of other occurrences. At Maniaba thin coal seams have been located on the east side of Lake Nyasa. Very little is known about these deposits, but it is known that the ash content is high, in the range 35% to 40%. Outcrops have also been found along the Lugenda River. Little is known of these deposits, but it appears that they are scattered and individually small. The country has therefore enough reserves for domestic consumption and for exports.

vii.d Hydro-electricity

Mozambique is well endowed with hydropower for electricity generation. Its hydro potential has been surveyed during the mid-1980's and there is now a substantial database of site, river flow statistics, etc. Most of this survey work was carried out by Portuguese and Norwegian companies. About 100 sites have been identified. The result of this survey is that there are around 12 500 MW of available hydropower, with an estimated annual generation of 60 000 GWh.

Some of the areas have highly seasonal river flows and the development of hydropower would need to be coupled to the development of thermal power plant.

The main potential for hydropower can be divided into four areas:

Zone A. This lies south of the Save River. It has a relatively low potential of 230 MW, but it is near the main economic region of the country and therefore the exploitation of this zone will be highly desirable once economic conditions improve.

Zone B. There is a potential for 1150 MW of plant in the region between the Save and Zambezi Rivers. This region already has 90 MW of installed hydro-plant.

Zone C. The Zambezi River basin has the highest potential for hydropower, estimated as 10 000 MW with an energy potential of 45 000 GWh, two-thirds of which is on the Zambezi itself. Of this potential, 6500 MW could come from 4 sites within a stretch of river of 230 km.

Zone D. The region north of the Zambezi has a potential for 1100 MW, mostly on the Lugio and Lugenda Rivers. These rivers are very seasonal and therefore the firm energy would be low unless augmented with other forms of generation.

The largest single potential project is the extension of Cahora Bassa. Since the dam is already built, the cost of this expansion would be low and was estimated by the World Bank as being able to supply electricity at US cents 1,5/kWh at 1982 prices. The construction could involve six units of 200 MW each, giving an installed capacity of 1200 MW. The construction period would take 7 years from start to commissioning of the final set. Whilst there is enthusiasm for this project, it cannot take place until there is sufficient demand for it. Such a demand can only come from South Africa or from a new capital project.

Another proposal for hydropower is for the integrated use of the Kariba and Cahora Bassa Power Stations. In this concept Kariba Dam would be used as a regulating dam to increase the firm energy available from the two systems. Such an optimization could increase the firm power by 600 GWh/year.

vii.e Gas

Seismic surveys for gas were carried out in the early 1970's and large gas reserves were found in the Buzi area near Beira and at Pande, 150 km south of Buzi. It is estimated that there are about 320 000 million cubic metres of gas in these fields. The potential for using these fields is receiving increased attention. Originally it was intended to pipe this gas to South Africa, but after independence this idea was abandoned. Recent interest has been on the development of the Pande field to produce gas for an ammonia plant and for other chemical purposes. Detailed exploration work on these fields has been disrupted by the action of Renamo, but it was announced early in 1991 that exploration work would be resumed and that South African companies could be involved in the proposed projects. It is also reported that SASOL in South Africa might be interested in using the gas.

Exploration for oil has shown that the onshore Karroo deposits are more likely to produce gas than oil. At present the exploration interest is in finding oil. Therefore gas exploration is not taking place, especially since the known gas deposits are large enough for exploitation to take place before consideration need be given to any new fields. There is, however, the expectation that future finds of gas are possible.

vii.f Other energy sources

The Government is conscious of the deteriorating conditions in the supply of fuelwood and alternative methods of supplying household and small industrial concerns with energy are being investigated.

Solar

Mozambique is similar to other countries in this region in having high solar radiation levels. The insolation in Maputo is above 5 kWh/m^2 per day and there is therefore scope for the application of solar radiation. However, the economic conditions in the country preclude any large-scale application in the foreseeable future.

Wind

Wind speeds are generally low, with average speeds being between 0,7 and 2,6 m/s. With such speeds there is scope for the use of wind for water pumping but not for any large-scale generation of electricity.

Biogas

Developments in the utilisation of biogas producers has shown that there is significant potential for biogas production, especially where fuelwood is scarce and expensive.

Ethanol

Ethanol has been produced on a small scale for hospital use from a number of vegetable crops, namely, sugar, cashew, manioc, maize, and fruit. No analysis has been made of the potential for the production of fuel alcohol.

Agricultural residues

Agricultural residues have traditionally been used as fuel. Three main sources are identified:

(a) coconut husks, shells, and wood,
(b) cashew nut shell, and
(c) bagasse.

No information is available concerning the national resource of these crop residues.

viii SOUTH AFRICA

See section 4.4.

ix SWAZILAND

ix.a Fuelwood

No accurate estimate has been made of the forestry potential for providing fuelwood. The Forestry Section of the Ministry for Agriculture and Co-operatives has estimated that indigenous forests cover 52 000 hectares. The mean annual increment of the forests is low, with an estimated average of 3 m /ha per year. This gives a total sustainable yield of 360 000 m /year. In addition to the indigenous forests there are approximately 7 500 hectares of black wattle forests which were introduced to supply bark for the tanning process. Two-thirds of these forests have been allowed to generate to a level where the sustainable yield is about 7 m /ha compared with 15-18 m /ha of the remaining wattle forests. Only some 50% of this wood is currently used for fuelwood. In addition there are various company forests utilized for fuelwood.

The demand for fuelwood will be mainly influenced by demographic factors since, in keeping with other countries in Africa, there is a large population move from rural to urban areas. The urban population in Swaziland rose from 18% in 1980 to nearly 25% in 1985 and is expected to rise to 45% by the year 2000. Using these estimates, the demand for fuelwood will reach the sustainable level by 1990, and by 2000 there will be a shortage of some 40% of demand. In order to meet this shortage, over-cutting of the forests would need to be carried out, leading to a deforestation of about 60% by the year 2000.

Even though there is currently no apparent shortage of fuelwood, there are in fact local shortages in some of the more populated regions. A study carried out jointly by the Ministry of Natural Resources, Land Utilization and Energy, and the Deutsche Gesselschaft fur Technische Zusammenarbeit of the Federal Republic of Germany showed that there is already a perceived shortage.

There is therefore a need to adopt more efficient means of burning fuelwood to extend existing resources, and there appears to be a need to develop woodlots for areas with scarcities.

ix.b Petroleum

Swaziland is not considered to have any potential for petroleum production. One-third of the country is underlaid with very old rocks, some of the oldest in the world. Whilst there are shale areas in the rest of the country, their geological formation is not conducive for petroleum production.

ix.c Coal

Swaziland was known to have coal resources some one hundred years ago. However, little was known about the extent of the deposits until the formation of the Geological Survey and Mines Department in the late 1950's. The oil shocks in the 1970's increased interest in coal mining and significant surveys have now been carried out.

Coal-bearing strata underlie some one-sixth of Swaziland. They lie in one continuous field with an average width of 15 km and forming part of the field which extends into South Africa. The coal is at depths of less than 200 m and dips gently towards the east. The geology is relatively complex, with inclusions of igneous dykes. In general, mining conditions are similar to those in the adjacent coalfields in South Africa.

The total resources have been assessed at 549 million tons of mineable coal, of which 116 million are proven reserves and 92 million are proven saleable after washing. In addition, there is an estimated 450 million tons of potential reserves. Thus the total of demonstrated and potential coal reserves is 999 million tons.

Most of the exploration has to date been on the shallow western side of the coalfield and the Lower Coal Zone in particular. The Upper Coal Zone is relatively unexplored because of its known poor quality compared with the Lower Zone. Only about 40% of the coal measures have been adequately explored. It has been estimated that, making assumptions of coal measures in the unexplored areas, the total coal reserves are of the order of 1000 million tons. This should be compared with the present coal consumption of the country of about 240 000 tons per annum.

Table G.3: Mineable coal reserves on run-of-mine basis

Area	Mineable Total	Saleable Proven	Proven (washed)
Mhlume	18,4	18,4	14,7
Area 1	128,0	9,1	5,4
Area 2	55,0	41,2	39,1
Area 3	36,1	20,6	12,1
Maloma	44,2	7,8	5,8
Lubukhu Block (N)	132,5	18,9	14,7
Lubukhu Block (S)	70,8		
	-----	-----	-----
Lower Coal Zone	485,2	116,0	91,8
Upper Coal Zone	64,1		
Additional Potential	450,0		

TOTAL	999,3		

The Swaziland coal has some desirable qualities such as low sulphur and low volatiles, which make it a clean burning coal. However, it is an anthracitic coal, compared with the bituminous South African coals, which creates combustion problems which make it difficult to burn in conventional stoker boilers. A number of customers who had used Swazi coal have changed to using South African coals because of these problems.

The mineable reserves expressed on a run-of-mine basis are shown in Table G.3.

ix.d Hydro-electricity

In 1970 the United Nations financed a study of the hydro-potential of Swaziland. This study identified 21 possible sites with a total energy potential of 3000 GWh. The same study tried to estimate the likely abstraction of water by South Africa from the rivers before entering Swaziland. The study came to the conclusion that due to water abstraction the potential energy would decline by 40% to 1800 GWh. An energy study carried out in 1982 by the Federal Republic of Germany re-assessed these Figureures to take account of actual river flows recorded in the intervening period and to eliminate some uneconomic sites. This survey came up with a hydro-potential of between 550 and 700 GWh, of which 30-40% has already been developed.

ix.e Other Energy Sources

Bagasse

With the large sugar industry in Swaziland there is potential for generating power at the sugar mills for feeding into the national grid. It has been estimated that the maximum recovery of energy from a sugar mill would be 50 kWh per ton of cane crushed. Using this figure, the sugar mill's surplus capacity, i.e. surplus to their own needs, would amount to about 110 GWh or about 30% of total electricity generated by the Swaziland Electricity Board. However, studies indicateed that capital investment would result in electricity production costs of US cents 6/kWh, which is higher than the present cost of imported power.

Whilst there is currently no great incentive to develop this potential, it is one of the more promising options for power generation.

Ethanol

One of Swaziland's most promising alternative energy options is ethanol. Having to import all its petroleum products, the use of ethanol as a substitute for gasoline is an attractive means of becoming less dependent on imported energy.

Consideration has already been given to ethanol production from surplus molasses. At present the three sugar mills produce 127 000 tons of molasses per year. The main outlet for this is export, but this has been difficult because of problems with railing through Mozambique and with the cost of railage. Molasses therefore has a nuisance value only and is stored in tanks and in open pits which lead to environmental problems. The ethonal production potential is estimated to be 32,0 Megalitres per annum with a 15% blend in gasoline.

Other renewable sources

Swaziland is situated between the 25 and 28 south latitudes and therefore in common with other countries in Africa has good solar potential. However, it is doubtful whether solar power can make any significant contribution to the energy demand in the short or medium term. A number of demonstration programmes have already been instituted but without any wide acceptance.

Little is known about the potential for wind energy, but having no exposed coastline, it is likely that wind velocities will be similar to those in South Africa and thus not suitable for any large-scale application. Swaziland is also a small country and therefore electricity grid extension is likely to be cheaper than the introduction of wind generators.

x TANZANIA

x.a Fuelwood

Tanzania has forestry resources covering 40% of the country. Of this, 43,2 million hectares is covered with natural forests, 950 000 ha with closed tropical forests, 29 000 ha with planted trees in woodlots, 60 000 ha with softwoods, and 6 000 ha with hardwood.

Table G.4 shows the sustainable fuelwood supply, consumption and deficit for 1983. Theoretically a production of 20 million m is possible from Tanzania forests, although in practice the sustainable supply is of the order of 16 million m.

Table G.4 Sustainable fuelwood rupply, consumption and deficit for 1983 (thousands of m per annum)

Miombo Forest	Woodlots	Total Supply	Consumption	Deficit
15 064	524	15 593	39 103	23 510

This can be attributed to three factors. Firstly, a large proportion of the forests are remote from population areas. Secondly, industrial plantation and associated industries were traditionally located in thinly populated areas which make the wood residues produced unexploitable for use as domestic fuelwood. Lastly, the village afforestation programme made a slow start and in particular communal woodlots were unsuccessful due to a lack of interest.

The deficit of 23 510 m per annum means that the country is cutting two and a half times more fuelwood than the forests can supply on a sustainable basis. This is leading to serious deforestation at a rate of 0,5 million ha per year. Environmental degradation is visible around many communities and it has been estimated that households are on average spending 20% of their time in the collection of fuelwood.

x.b Petroleum

Sedimentary basins with hydrocarbon potential have been identified in the inland Rift Valley basins and in the eastern coastal basins. No oil discoveries have yet been made, which could be due to the low level of exploration which has taken place and the fact that the volume of completed work is low. Further exploration in various parts of the Rift Valley and coastal sedimentary basin is required before the potential for indigenous petroleum resources can be assessed.

x.c Coal

Tanzania's coal resources are estimated at 1,9 billion tons, of which 304 million tons are considered proven. Table G.5 shows a breakdown of coal reserves and the respective coal fields.

Table G.5 Coal Resources (millions of tons)

Field	Measured	Inferred	Total
Ketewaka-Mchuchuma	186,6	495,0	681,6
Songwe-Kiwira	35,0	595,0	615,0
Galula	-	53,0	53,0
Njuga	-	126,0	126,0
Liweta	-	34,0	34,0
Ngaka	-	152,0	249,7
Mbamba bay	-	29,0	29,0
Mhukuku	-	19,0	19,0
Ufipa	-	17-57	17-57
Total	319,3	1520-1560	1824-1864

Coal is presently being exploited at the Songwe-Kiwira mine in the south which has a capacity of 100 000 t/y and at the Ilima mine in the Songwe-Kiwira field which has a capacity of 20 000 t/y.

x.d Hydro-electricity

Tanzania has a relatively large hydro-electric potential estimated at 6000 MW and 20 000 GWh per year. Installed hydro-electric capacity is presently 333 MW.

A notable feature of the hydropower potential is the concentration of major sites on the Rufiji and Ruhindji Rivers, the limited number of medium-size sites, and the many potential sites for mini-hydropower.

Approximately a hundred sites for hydro-electric plants have been identified. A further sixty mini-hydro potential sites have been identified with a total installed capacity of 66 MW or 300 GWh per year. The distribution of these sites is such that 77% have a potential of less than 1000 kW and 23% have a potential of between 1000 and 2000 MW. In 1987 there were about 20 mini-hydro-electric plants in operation, with a total installed capacity of approximately 4000 kW.

x.e Gas

Gas has been discovered at Songo-Songo on Kilwa Island, at Mnazi Bay and at Kimbiji. Table G.6 shows the natural gas reserves in Tanzania.

Table G.6 Natural gas reserves (billion m^3)

	Songo-Songo	Mnazi Bay	Kimbiji	Total
Proven	32,77	0,65	130	163,42
Probable & possible	10,12	16,59	-	26,71
Total	42,89	17,24	130	190,13

These reserves have not yet been utilised, The Songo-Songo reserves are too distant from the energy-consuming market of Dar-es-Salaam, and the reserves at Kimbiji, 40 km south of Dar-es-Salaam, have only recently been confirmed. A study into the viability of using natural gas from Songo-Songo to generate electricity has been ordered.

x.f Other Energy Forms

Biomass

Tanzania has considerable biomass resources in the form of forest residues, wood processing wastes, surplus softwoods, agricultural residues, animal wastes, and sugar industry residues.

Utilization of softwoods for timber and pulp is well below the annual allowable cut and the proportion which could be economically used for fuelwood amounts to some 23 000 TOE per year. However, these softwood plantations are remote from areas where over-cutting of forests for fuelwood is taking place.

It was estimated that in 1980 the 120 000 ha of cocoanut plantations along the coast and on the islands of Zanzibar, Pemba and Mafia, had a potential for cocoanut shells and husks of over 28 500 TOE.

Cashew nut shells and husks are also potential fuels, as well as maize residues. The conversion of dung into biogass fuel is potentially an extra fuel resource for Tanzania. The World Bank estimated that the potential for production from this resource would be about 46 000 TOE. In 1984 there were already 300 biogas installations in institutions and community centres.

Bagasse, a by-product from Tanzania sugar mills, is used to fuel the mill boilers. At present there is no excess available for electricity generation, although improvements to the mills could result in excess bagasse. Molasses is another by-product of the sugar industry. Of the total molasses production 34% ends up as waste and could be used in an anhydrous ethanol plant. This possibility was investigated by the government, but further work has been postponed due to lack of foreign exchange and the marginal viability of the intended project.

Solar and Wind

The Tanzanian climate offers good potential for solar and wind energy. In the short to medium term their applications are more limited than biomass. Apart from the use of a few photovoltaic panels mainly used by the Tanzanian Posts and Telecommunications Corporation, there is no significant use of solar energy. In 1984 some hundred small water pumping windmills had been installed throughout the country and the exploitation of wind energy appears to be more practical than solar energy.

Geothermal

Although there is evidence that Tanzania has geothermal potential, its large hydro potential and gas reserves make its development unfeasible.

xi ZAIRE

xi.a Fuelwood

Zaire is a very heavily forested country, possibly the most forested country in Africa, with a forest cover of 122 million hectare. Forests are classified into three main groups of economic interest :-

a) The Mayumbe forests in Bas-Zaire - 240 000 ha.

b) The dense mountain forests and open forests of the periphery - 21 million ha.

c) The tropical forests of the Central Basin - 101 million ha.

Only a small fraction of the forests are being exploited commercially. However, the peripheral forests are starting to be degraded due to slash-and-burn cultivation. The Mayumbe forests are already heavily depleted due to demand for industrial timber and for wood energy.

Table G.7 shows the theoretical energy potential of forests in Zaire on a sustainable basis. However, it must be recognised that the figures quoted are optimistic if the imbalance between areas of surplus capacity and the areas of maximum demand are considered.

Table G.7: Theoretical Forest Energy Potential in Zaire (without reforestation) .

Source Forest Notes	Area ha Million	Density m3/ha	Gross Energy Poten MTOE *a	Maximum Annual Drawdown t/ha/yr *b	Net Annual Energy MTOE *c
Central	101,000	300	7800	4,0	83,2
Mayumbe	,24	135	8	2,5	0,2
Peripheral	21,00	100	540	1,5	10.8
TOTAL	122,24		8348	8,0	94,2

Notes

*a Based on 25% moisture and 0,343 TOE/ton

*b Assuming a regeneration of 5 m /ha/year

*c Exploitable anually on a sustainable basis

Estimates of the potential timber production for energy purpose, on a sustainable basis, show that less than 2% of the forests can be extracted. Practical considerations which limit the ability to exploit fuelwood on a regular basis include the fact that 40% of the Central Basin forests are not fully accessible due to seasonal flooding, and that the most prolific forests are located at large distances from the centres of fuelwood demand.

xi.b Petroleum

The potential oil-bearing areas of Zaire can be divided into three sections - the Tanganyika Graben area on the east of the country, the Central Basin, and the Coastal Basin.

The exploration of the east-most Tanganyika Graben area dates back to the 1920's. The area stretches along the eastern border of Zaire and some shallow wells have yielded small quantities of oil on the boundary between Zaire and Uganda. Recent exploration (1983) in this area has been financed by the World Bank and several oil companies and has been coordinated by Duke University in the USA.

Exploration of the Central Basin in the middle of the country started in 1951 but has not been successful. The Basin extends over 800 000 km^2, most of it covered by dense rain forest. Concessions have been awarded to a number of oil companies the most recent being to a Japanese company. The exploration conducted to date is insufficient to yield any accurate assessment of the potential. Exploration in this region is hampered by the very difficult access to the area, the lack of infrastructure, and the large amount of finance necessary under these conditions.

Exploration offshore of the Coastal Basin in the west of the country started in 1956. Forty oil wells had been sunk by 1983 and led to five operating oil fields and one gas field. On-shore exploration has been going on since 1959 and eighty wells had been sunk to 1983. Four oil fields have been discovered. One of the off-shore fields, Mibale, contains 48% of the recoverable reserves of the Basin. At the moment only the Basin oil fields are producing. The estimated operating cost of these fields is US $ 0,4 per barrel

The original recoverable proven reserves of the Coastal Basin were 127,7 million barrels for the off-shore fields and 101,0 million barrels for the on-shore fields. Of these amounts cumulative production up to 1983 was 61,9 million barrels for the off-shore fields and 1,5 million barrels in the on-shore fields. The net remaining reserves are therefore as given in Table G.8.

Table G.8: Oil reserves in the coastal basin (Million barrels).

	Original Proven	Remaining Proven	Undevel Proven	Possible	Total Remaining
Off-shore	127,7	56,5	9,2	0,6	65,7
On-shore	101,0	99,5			99,5

xi.c Coal

Coal deposits exist in the eastern part of the country at Luena in Shaba Province and at Lukuga north-west of Kalemie in Northern Shaba Province. Total estimated in-situ reserves are 8,6 million tons for Luena, and 78 million tons for Lukuga. The coal is of low quality with an ash content of 20 - 28%. Reserves are given in Table G.9.

Table G.9: Coal Reserves.

		Luena	Lukuga
Reserves - Million tons			
Speculative		20	700
In-situ		8,6	78
Recoverable	4,3	50	

Coal production is small with the 1983 production for Luena and Lukuga being 99 400 tons and 11 000 tons respectively. The main consumers are the Gecamines mining complex and the Cimshaba cement works. However the Luena mine does not produce any coking coal and Gecamines has to import coal and coke for metallurgical purposes, mainly from Zambia.

A third deposit is located at Walikale in the north-eastern corner of Lake Kivu but little is known about the quality or quantity of this deposit.

xi.d Hydro-electricity

The Zaire River is the second largest river in the world (after the Amazon). It drains an area of approximately 3,7 million square kilometres and has a length of 4374 km. It has a flow varying from 30 00 to 60 00 cubic metres per second at Kinshasa. The remarkably uniform flow, compared with other rivers, is due to its position straddling the equator and making use of the seasonal variations in different parts of the country. Whilst the river is navigable over much of its length, and, in fact, provides one of the few ways of transporting goods to and from the interior, there are a number of steep drops in certain places providing sites for potential hydro-energy. Of particular interest is the Inga site between Kinshasa and the Atlantic.

It is variously estimated to have a total exploitable energy potential from 530 000 to over 750 000 GWh per year. This would allow an installed capacity of between 85 000 MW and 100 000 MW. Consideration must however, be given to seasonal variations and the installed capacity would then be less than this figure. Little work has been carried out on the hydro-electric capabilities of this river on the basis of firm supply. The Inga site downstream of Kinshasa is estimated to have a potential of 300 000 GWh. This could allow of an installed capacity of approximately 25 000 MW.

Whatever the correct figure the amount of energy available is far greater than could ever be used by Zaire. The energy statistics for 1985 show that the total electricity consumption for all the countries south of the equator was 146 500 GWh, which is approximately half of the potential at Inga, and only 20% of the total capacity of the river.

Zaire could therefore supply all the electricity required by the sub-continent until well into the next century.

Besides the supply of electricity in large generating units there is also significant scope for the supply of communities far from the grid using micro-hydro schemes.

xi.e Gas

One of the oil fields discovered in the Coastal Basin is a gas producer but has not been put into production.

In Lake Kivu there is an estimated 50 billion Nm of gas dissolved in the waters at a depth of 300 m. This gas contains 25% of methane, 73,5% carbon dioxide, and 1,5% of inert gases. At present some of this gas is being used after washing with surface water to remove some of the carbon dioxide thereby enriching the gas to 72% methane with a calorific value of 19 MJ/m .

The gas flow is initiated by supplying a small amount of compressed air at the bottom of the collection pipe. Once the dissolved gas starts flowing it comes out of solution and the gas flow is then self-sustaining.

xi.f Other Energy Forms

Agricultural residues

Many agro-industries in Zaire already use any available residues generated during the processing of cash crops for internal fuel requirements. Some 600 000 tons oil equivalent are already being used in this way. There does not appear to be any major resources which could be used mainly because of transport distances and problems .

Solar energy

Whilst it has been estimated by the Zaire meteorological service that the average solar insolation is 4,7 kWh/m^2/day there is very little information concerning daily variations or number of sun days. Approximately 250 small photovoltaic systems have been installed mainly for lighting purposes.

Geothermal energy

Since Zaire adjoins the Rift Fault coming down through Africa it should have some geothermal potential. It was, in fact, the first country in Africa to exploit geothermal energy when, in the 1960's a copper mine in Katanga generated several hundred kW from a hot spring at 60 C. Countries adjoining Zaire, such as Zambia and Uganda have installed some geothermal potential or are carrying out exploration.

xii ZAMBIA

xii.a Fuelwood

The resource situation concerning fuelwood is uncertain because of the lack of adequate data. Attempts are being made by the Natural Resources Department to obtain satellite photographs on which an assessment of fuelwood potential can be made. However, it is estimated that 55% of the total land area is covered by forests. State forests represent 10% of the total land area, whilst another 25% of the total land is available for fuelwood development.

Stocking intensities in the Copperbelt are reported as 70-140 m /ha. The potential for fuelwood production is much lower in the low rainfall southern part of the country than in the north.

xii.b Petroleum

Until recently it was considered that the geology of Zambia (and of Zimbabwe) was not suitable for oil reserves. However, there are some sedimentary deposits in the Zambezi Basin which are now considered to be potential oil areas. There are four main sedimentary deposits in the west of the country, the largest being the Barotse Basin covering about 150 000 square kilometers and extending into Botswana and Angola. In December 1989 the Mobil Company signed an agreement with the Zambian Government which allows it to prospect for oil in the Zambezi Basin. This agreement covers a three-year period and places all the financial risk on Mobil. This exploration effort is paralleled by a similar exploration effort by Mobil in the Zimbabwe section of the Zambezi Basin.

An exploration by Mobil and Placid Oil in the north-east of the country did not result in any oil finds.

xii.c Coal

Zambia has several coal deposits in the south of the country and in the north-east. The probable total reserve is 280 million tons, though there is no proper assessment of the country's coal resources. Between 1965 and 1967, 80 boreholes were sunk in an exploratory survey. Three coal deposits were located at Nkandabwe, Siankondobo, and Mulungwa. The only active mine is the Maamba Colliery which is mining the deposit at Siankondobo. The estimated reserves in the various areas are shown in Table G.10.

Table G.10. Coal reserves (Million tons)

Area	Proved	Probable	Total
Nkandabwe		80	80
Mulungwa		100	100
Siankondobo	58	33	91
Total	58	213	281

The coal in the Siankondobo deposit is a high ash coal. Little is known about the quality of the other coal deposits.

xii.d Hydro-electricity

Zambia has substantial hydro-potential and could be a net exporter of electricity. An overall hydro-potential survey has not been carried out, but a consultant's survey for ZESCO in 1975 identified some potential sites and calculated that the reserve was 3924 MW and 21 406 GWh per year.

Table G.11. Potential hydro-power

Potential site	Capacity (MW)	Available energy (GWh/annum)
Kariba N Extension	300	600
Kafue Stape III	450	2500
Itewzhi-Tezhi	80	510
Lusiwasi III	40	146
Victoria Falls & Nangweshi	250	1900
Mpata Gorge	500	3000
Luapula	884	5000
Batoka Gorge	800	4250
Devil's Gorge	6 20	3500
Total	3924	21406

The potential capacity from the Zambezi and Luapula Rivers is shown in Table G.11. The potential developments at most of these sites requires co-operation between Zambia and either Zimbabwe or Zaire. The quantities given in Table G.11 are the estimated entitlement for Zambia from these projects.

xii.e Other energy sources

Solar

Yearly average insolation in Zambia is about 5,4 kWh/m^2 per day, with a high of 6,2 kWh/m^2 in the area of Victoria Falls. Seasonal variations occur with a peak during the October/November period. Prospects are therefore good for the use of solar energy for water heating and especially for agricultural processes such as crop-drying.

Wind

Reasonable wind potential is available during the period August to October when the wind direction is south-easterly. Whilst potential for uses such as water pumping in remote areas is good, it is doubtful whether any significant large-scale potential is viable.

Biogas

No survey has been made of biogas potential, but some parts of the country have high concentrations of livestock, and therefore some exploitation could be possible.

Ethanol

In common with Zimbabwe, the Government has investigated the potential for the use of ethanol as an extender for gasoline. However, reducing amounts of gasoline production has led to a slow-down in the application of ethanol and no overall resource analysis has been carried out.

e.5 Geothermal

There are over 100 thermal springs heated by deep circulation in the major fault zones in the country. However, there are no volcanic activities, and it has been estimated that the vertical temperature gradient is between 23 C and 50 C per kilometer of depth. Hence, workable temperatures of 150-370 C would occur only at depths of 8 kilometers, making this an economically unattractive energy source when compared with the more traditional forms.

xiii ZIMBABWE

xiii.a Fuelwood

Zimbabwe has a predominantly dry woodland vegetation with a low annual rainfall varying from 300 mm per year in the south to 1000 mm in the north. Mean annual forest growth rates are low with a once-only recoverable rate of 74 m/ha. In densely populated areas the fuelwood shortage is critical. In general overall fuelwood supplies exceed demand, but due to the high cost of transport and the low level of income of users, the distribution to areas in which shortages occur is limited.

With the small surplus available the potential capacity will be used up within a decade. The only areas where supply is adequate is in North Midlands and in West Mashonaland. Thus the fuelwood situation is critical unless commercial wood-lots can be created. With the lack of control over fuelwood supply this is unlikely to take place.

The present charcoal production is small but there is potential for charcoal production from forestry residues.

xiii.b Petroleum

Zimbabwe's geology consists mainly of basement and metamorphic rocks and therefore the potential for petroleum reserves is small. However, there is an area of sedimentary rocks in the western and north-western region, which could have some petroleum content.

It was announced in 1990 that Mobil Oil was about to begin exploration in the Zambezi Valley.

xiii.c Coal

Zimbabwe has large reserves of coal which has been the main contributor to the country's energy need. The coal reserves are spread through 24 coalfields divided into those in the Zambezi Valley and those in the Sabi Limpopo region. It is estimated that coal resources amount to 29 202 million tons of which 2 194 million tons are classified as Reserves and 27 008 million tons are in the Resource category. The division of this coal into the main coalfields is shown in Table G.12.

Table G.12. In-situ coal reserves and resources (Million tons)

Area	Resources	Reserves	Total
A Zambezi Basin			
Wankie	561	1188	1749
Lubimbi	22120	163	22283
Lusulu	2750	250	3000
Lubu-Sebugu	83		83
Sengwa		400	400
Marowa		15	15
Sessami-Kaonga	1000		1000
	26529	2001	28530
B Sabi-Limpopo Basin			
Massabi	30		30
Bubye	30	30	60
Sabi	419	163	582
	479	193	672
Grand Total	27008	2194	29202

Of this coal approximately 10% is coking coal and the remainder is steam coal. Coal seam thicknesses are high with average thicknesses, in those areas where adequate drilling has been carried out, of 9 to 10 metres of which the bottom 2 to 5 metres are coking quality.

xiii.d Hydro-electricity

Because of the rainfall pattern in Zimbabwe, most of the river flow is intermittent and not suitable for significant hydro potential. The two rivers which are exceptions to this are the Zambezi and the Sabi which are fed by various perrenial rivers. With a present installed hydro capacity on the Zambezi of 1374 MW, there is a further potential for 5030 MW, to be shared with Zambia. Therefore the Zimbabwe's share of additional capacity on the Zambezi is 2515 MW with an average energy capacity of 13 285 GWh per year. These hydro extensions could take place at the Batoka Dam, extensions to the North and South Bank of Kariba, the Victoria Falls, the Mupata Gorge Dam, and at Sengwa.

xiii.e Gas

Zimbabwe does not have any known gas reserves.

xiii.f Other Energy Forms

Agricultural residues

In spite of the fact that most of the population lives in the rural areas, very little attention has been paid to the use of agricultural wastes. Communal land holds about 4,7 million head of livestock and other areas hold some 2,7 million. With the rehabilitation of livestock farming taking place, there will be increasing opportunity for biogas production from waste. However, the contribution from this source is likely to be small in the medium term.

Zimbabwe has investigated the use of vegetable oils to replace diesel fuel, but with the present prices for vegetable oils on the world market, it is unlikely that their use would be economic.

Renewable energy

Zimbabwe is in a high solar radiation belt and therefore the technical opportunities for the use of solar energy are high. It has some 2 800 sunshine hours per year and an insolation figure of 5,7 kWh/m^2/day. The potential for the utilization of solar energy for crop drying, for hot water production, and for water pumping is available, but the amount which can be developed depends on the economics of each situation. The government has encouraged research into the use of solar energy and it is envisaged that increasing use will be made of it. In comparison with the commercial and traditional forms of energy, it will remain a small quantity and in specific situations.

Meteorological records show that the best conditions for the use of wind energy are along the highveld (near Bulawayo, Que Que, Gatooma, etc) where high wind speeds occur from July to October. The wind power potential is estimated at around 100 watts/m^2. As with solar energy the costs are high compared with commercial energy forms and especially with grid electricity, but there is potential for wind energy utilization in remote areas. The amounts which could be used are small and the best prospect is the traditional one of pumping water.

Geothermal

In spite of the fact that Zimbabwe is far from the Rift Valley fault with its geothermal activity, there are a number of hot-water springs with temperatures between 31 C and 97 C. It is estimated by the Geological Survey Department that the potential for energy production from these springs is likely to be small.

YEAR	POPULATION			ECONOMIC DATA					
				GDP MILLION 1985 US$*			GDP/CAPITA, 1985 US$*		
	RSA	OTHER	TOTAL	RSA	OTHER	ESA	RSA	OTHER	ESA
1971	22,6	150,2	172,8	46059,0	55576,4	101635,4	2034,7	370,0	588,0
1972	23,3	154,3	177,6	46620,1	59360,2	105980,3	2001,4	384,7	596,8
1973	24,0	158,6	182,6	60762,6	65731,7	126494,3	2536,2	414,5	692,9
1974	24,6	163,2	187,9	69876,8	72632,7	142509,5	2836,0	444,9	758,5
1975	25,3	168,1	193,4	65407,5	71878,2	137285,7	2580,9	427,7	709,8
1976	26,1	173,6	199,6	58642,3	71436,6	130078,9	2250,7	411,6	651,7
1977	26,2	178,7	204,9	60645,7	79615,3	140261,0	2317,4	445,4	684,5
1978	27,4	184,1	211,5	65850,9	84683,4	150534,4	2401,5	459,9	711,6
1979	28,4	189,6	217,9	74929,7	84261,6	159191,3	2642,9	444,5	730,5
1980	29,6	195,8	225,4	98229,1	79282,9	177512,0	3316,5	404,9	787,5
1981	30,3	201,8	232,2	91179,6	74836,3	166015,9	3005,1	370,8	715,1
1982	31,7	207,9	239,5	77607,9	70654,4	148262,3	2450,9	339,9	619,0
1983	32,6	214,1	246,8	82930,6	65600,6	148531,2	2541,2	306,4	601,9
1984	33,1	220,5	253,6	70394,8	57908,7	128303,5	2128,0	262,6	505,9
1985	33,7	227,3	261,0	51345,7	56448,7	107794,4	1524,7	248,3	413,0
1986	34,5	234,8	269,3	55699,6	59449,4	115148,9	1615,2	253,2	427,6
1987	35,3	242,3	277,6	69806,0	64482,7	134288,7	1976,7	266,1	483,7
1988	36,2	250,0	286,2	71069,1	65380,3	136449,4	1963,6	261,5	476,7

* LOCAL CURRENCY CONVERTED TO US$ AT PREVAILING EXCHANGE RATE AND DEFLATED USING THE US$ DEFLATOR FOR 1985.

APPENDIX I: ESTIMATES OF REGIONAL ENERGY CONSUMPTION AND INDICATORS 1971 -1988

(Reference: 10,12,15,55,12,36,56,57)

RSA - South Africa

ESA - East and Southern Africa Region

OTHER - ESA Excluding South Africa

TRADITIONAL ENERGY CONSUMPTION DATA AND ESTIMATES FOR SELECTED COUNTRIES
000'S TOE (Reference 12)

YEAR	BOTSWANA	BURUNDI	ETHIOPIA	KENYA	LESOTHO	MALAWI	RWANDA	RSA	SUDAN	SWAZILAND	TANZANIA	UGANDA	ZAMBIA	ZAIRE	ZIMBABWE
1971	177.1	743.9	5101.0	2662.0	258.1	887.3	885.5	3871.1	5729.0	76.9	6080.0	3814.0	2038.1	4862.0	1000.0
1972	192.9	759.9	5243.0	2792.0	270.7	928.0	915.0	4076.4	5902.0	79.3	6250.0	3864.0	2121.1	4987.0	1050.0
1973	208.6	776.3	5375.0	2960.0	283.2	968.7	945.9	4281.6	6075.0	81.8	6445.0	3911.0	2213.3	5121.0	1101.0
1974	224.3	792.6	5546.0	2973.0	295.8	1009.3	977.9	4486.9	6264.0	84.2	6760.0	3955.0	2314.8	5271.0	1130.0
1975	240.0	809.1	6712.0	2981.0	308.4	1050.0	1011.1	4692.1	6455.0	86.6	7087.0	3988.0	2416.2	4920.0	1168.0
1976	255.7	825.4	6868.0	3296.0	320.9	1090.7	1045.4	4897.4	6507.0	89.1	7300.0	4030.0	2462.3	5063.0	1212.0
1977	271.4	841.5	7029.0	3423.0	333.5	1131.3	1080.7	5102.6	6665.0	91.5	7519.0	4062.0	2517.7	5245.0	1243.0
1978	287.1	857.6	7205.0	3367.0	346.0	1172.0	1117.1	5107.4	6879.0	93.9	7764.0	4096.0	2573.0	5403.0	1276.0
1979	302.9	875.2	7376.0	3534.0	358.6	1210.0	1154.4	5312.6	7022.0	96.4	8000.0	4132.0	2665.2	5594.0	1302.0
1980	318.6	894.8	7542.0	3703.0	371.1	1251.0	1192.2	5718.4	7228.0	99.0	8250.0	4222.0	2702.1	5782.0	1362.0
1981	334.3	916.3	7732.0	3906.0	383.7	1292.0	1231.0	5849.6	7424.0	101.3	8512.0	4250.7	2665.2	5975.0	1458.0
1982	350.0	939.6	7927.0	4040.0	396.2	1336.0	1270.7	5988.1	7612.0	103.7	9289.0	4376.2	2729.8	6166.0	1503.0
1983	365.7	964.8	8122.0	4215.0	408.8	1332.0	1311.5	6128.9	7861.0	106.1	9624.0	4509.7	2794.3	6357.0	1492.0
1984	381.4	992.2	8334.0	4405.0	421.3	1378.0	1354.0	6272.1	8023.0	108.6	9975.0	4650.9	2831.2	6546.0	1544.0
1985	397.1	1020.7	8533.0	4613.0	433.9	1367.0	1398.0	6415.3	8200.0	110.5	10324.0	4800.4	2840.4	6733.0	1542.0
1986	412.9	1052.5	8773.0	4700.0	446.4	1367.0	1444.2	6570.4	8400.0	113.4	10400.0	4957.6	2858.9	6937.0	1703.0
1987	428.6	1085.3	9020.0	7664.0	459.0	1367.0	1492.7	6787.6	4686.0	115.9	10434.0	5122.8	2858.9	7169.0	1709.0
1988	444.3	1119.9	8765.0	7290.0	471.5	1367.0	1544.4	6875.9	4862.0	118.3	12355.0	5295.8	2766.7	7400.0	1736.0

COMMERCIAL ENERGY TOTAL FINAL CONSUMPTION DATA AND ESTIMATES FOR SELECTED COUNTRIES
000's TOE (Reference 12)

YEAR	BOTSWANA	BURUNDI	ETHIOPIA	KENYA	LESOTHO	MALAWI	SWAZILAN	RSA	RWANDA	SUDAN	TANZANIA	UGANDA	ZAMBIA	ZAIRE	ZIMBABWE
1971	152.8	21.0	421.1	1190.3	91.1	146.4	343.6	29673	26.4	776.0	597.8	443.4	1353.0	1149.2	2019.4
1972	167.1	21.5	400.2	1274.8	94.4	161.8	353.6	28959	32.3	758.2	623.5	431.9	1488.1	1149.7	2028.7
1973	181.4	22.0	438.5	1365.5	97.6	170.0	363.7	30464	34.3	830.7	690.2	390.3	1614.7	1150.1	2404.6
1974	195.7	22.1	440.5	1372.3	100.8	173.2	373.7	30743	34.1	719.1	693.2	402.4	1704.4	1112.1	2076.0
1975	209.9	22.2	389.8	1393.9	104.1	181.6	383.8	32403	41.9	773.7	678.2	384.3	1707.8	1198.5	2387.1
1976	224.2	24.0	402.5	1493.5	107.3	197.8	393.8	33317	51.7	848.3	714.3	329.4	1759.9	1171.8	2504.6
1977	238.5	28.0	413.7	1617.0	110.5	188.2	403.9	33037	53.1	904.4	687.3	331.6	1626.0	1122.5	2334.7
1978	252.8	32.7	430.6	1669.2	113.8	193.7	413.9	33446	59.7	900.2	784.7	276.1	1569.4	1073.7	2284.3
1979	267.1	33.0	499.8	1695.4	117.0	186.8	424.0	32569	61.1	958.4	739.8	233.3	1523.0	1057.7	2266.5
1980	281.4	44.1	492.8	1769.4	123.1	238.0	434.1	34190	64.3	1016.4	900.9	276.9	1544.5	1148.4	2497.0
1981	295.7	54.8	542.2	1797.1	120.2	224.3	444.1	37057	60.0	1085.7	736.5	184.3	1504.3	1189.8	2501.5
1982	310.0	49.1	514.6	1647.5	126.7	221.5	454.2	36721	125.3	1101.0	637.7	187.1	1493.1	1142.6	2430.3
1983	324.3	53.8	532.4	1572.5	129.9	203.2	464.2	35795	141.4	1177.6	607.9	247.0	1473.1	1169.4	2517.1
1984	338.5	68.5	539.5	1702.3	133.2	197.1	474.3	39156	141.0	1129.4	608.7	245.8	1438.1	1239.4	2354.3
1985	352.8	64.3	560.2	1763.6	136.4	199.1	484.3	38578	143.9	1248.1	607.9	249.3	1438.8	1309.5	2437.8
1986	367.1	72.6	668.5	1861.0	139.6	199.8	494.4	38969	132.0	1297.3	586.6	266.2	1326.3	1379.5	2664.9
1987	381.4	77.6	767.8	1983.6	142.9	199.0	504.4	39776	132.8	1537.1	585.9	269.3	1418.8	1449.5	2706.5
1988	395.7	82.7	774.9	1982.0	146.5	199.0	514.5	41841	132.9	1537.3	581.2	320.5	1380.2	1519.5	2874.6

TABLE I.1:

YEAR	COMMERCIAL ENERGY				COMMERCIAL ENERGY				TRADITIONAL			TOTAL ENERGY		
	ELECTRICITY		COAL	OIL	TOTAL				RSA	OTHER	TOTAL	RSA	OTHER	ESA
	RSA	OTHER	RSA	RSA	RSA	OTHER	ESA	ELECTRICITY						
1971	4008,2	1462,4	16490,4	9036,0	29534,6	10041,2	39575,8	5470,6	3871,1	43472,1	47343,2	33405,7	53513,4	86919,1
1972	4403,4	1588,6	15466,0	8951,0	28820,4	10333,5	39153,9	5992,0	4076,4	44854,5	48930,9	32896,8	55188,0	88084,8
1973	4741,6	1747,9	15603,0	9969,0	30313,6	11216,6	41530,2	6489,5	4281,6	46285,5	50567,1	34595,2	57502,1	92097,3
1974	5115,9	1814,0	15771,0	9679,6	30566,5	10832,5	41399,0	6929,9	4486,9	47755,5	52242,4	35053,4	58588,0	93641,4
1975	5487,6	1910,2	16396,0	10287,5	32171,1	11335,2	43506,3	7397,8	4692,1	49707,3	54399,4	36863,2	61042,5	97905,7
1976	5923,2	1982,7	16681,0	10479,6	33083,8	11756,6	44840,4	7905,9	4897,4	51179,3	56076,7	37981,2	62935,9	100917,1
1977	6252,7	1982,4	16189,0	10371,6	32813,3	11568,4	44381,7	8235,1	5102,6	53012,1	58114,7	37915,9	64580,5	102496,4
1978	6724,3	1974,0	15924,0	10568,4	33216,7	11563,0	44779,7	8698,3	5107,4	54077,1	59184,5	38324,1	65640,1	103964,2
1979	7370,9	2064,9	14746,0	10168,2	32285,1	11572,3	43857,4	9435,8	5312,6	54679,3	59991,9	37597,7	66251,6	103849,3
1980	7959,1	2199,3	15564,0	10345,0	33868,1	12456,0	46324,1	10158,4	5718,4	56619,9	62338,3	39586,5	69075,9	108662,4
1981	8438,5	2324,6	16959,0	11347,4	36744,9	12351,5	49096,4	10763,1	5849,6	58185,9	64035,5	42594,5	70537,5	113132,0
1982	8597,2	2372,4	16225,0	11614,9	36437,1	12006,5	48443,6	10969,6	5988,1	60447,2	66435,3	42425,2	72453,7	114878,9
1983	8829,6	2379,4	14818,0	11825,4	35473,0	12206,0	47679,0	11209,0	6128,9	62166,8	68295,7	41601,9	74372,8	115974,7
1984	9670,7	2387,1	16433,0	12729,2	38832,9	12201,5	51034,4	12057,8	6272,1	63899,4	70171,5	45105,0	76100,9	121205,9
1985	10115,8	2486,2	15506,0	12651,4	38273,2	12645,5	50918,7	12602,0	6415,3	65554,7	71970,0	44688,5	78200,3	122888,8
1986	10645,9	2513,5	15207,0	12814,2	38667,1	13174,2	51841,3	13159,4	6570,4	67031,4	73601,8	45237,5	80205,6	125443,1
1987	10954,6	2572,2	15349,0	13176,7	39480,3	13980,1	53460,4	13526,8	6787,6	67310,5	74098,1	46267,9	81290,7	127558,6
1988	11410,1	2597,5	16033,0	14099,8	41542,9	14307,6	55850,5	14007,6	6875,9	69617,4	76493,3	48418,8	83924,9	132343,7

* LOCAL CURRENCY CONVERTED TO US$ AT PREVAILING EXCHANGE RATE AND DEFLATED USING THE US$ DEFLATOR FOR 1985.

TABLE I.2:

YEAR	COMMERCIAL		TRADITIONAL + COMMERCIAL			TRADITIONAL
	ELECTRICITY AS A PERCENTAGE OF TFC (COMMERCIAL)	RSA AS A PERCENTAGE OF ESA	TRADITIONAL ENERGY AS A % OF TFC	ELECTRICITY AS A % OF TFC	RSA AS A PERCENTAGE OF ESA	ENERGY: RSA AS A % OF ESA
1971	13,8	74,6	54,5	6,3	38,4	8,2
1972	15,3	73,6	55,5	6,8	37,3	8,3
1973	15,6	73,0	54,9	7,0	37,6	8,5
1974	16,7	73,8	55,8	7,4	37,4	8,6
1975	17,0	73,9	55,6	7,6	37,7	8,6
1976	17,6	73,8	55,6	7,8	37,6	8,7
1977	18,6	73,9	56,7	8,0	37,0	8,8
1978	19,4	74,2	56,9	8,4	36,9	8,6
1979	21,5	73,6	57,8	9,1	36,2	8,9
1980	21,9	73,1	57,4	9,3	36,4	9,2
1981	21,9	74,8	56,6	9,5	37,7	9,1
1982	22,6	75,2	57,8	9,5	36,9	9,0
1983	23,5	74,4	58,9	9,7	35,9	9,0
1984	23,6	76,1	57,9	9,9	37,2	8,9
1985	24,7	75,2	58,6	10,3	36,4	8,9
1986	25,4	74,6	58,7	10,5	36,1	8,9
1987	25,3	73,8	58,1	10,6	36,3	9,2
1988	25,1	74,4	57,8	10,6	36,6	9,0

TABLE I.3:

YEAR	ENERGY INDICATORS: PER CAPITA CONSUMPTION						ENERGY INDICATORS: INTENSITY					
	COMMERCIAL GJ PER CAPITA			COMMERCIAL + TRADITIONAL GJ PER CAPITA			COMMERCIAL ENERGY ENERGY INTENSITY (MJ PER 1985 US$*)			COMMERCIAL + TRADITIONAL ENERGY INTENSITY (MJ PER 1985 US$*)		
	RSA	OTHER	ESA	RSA	OTHER	ESA	RSA	OTHER	ESA	RSA	OTHER	ESA
1971	54,7	2,8	9,6	61,8	14,9	21,1	26,9	7,6	16,3	30,4	40,3	35,8
1972	51,8	2,8	9,2	59,2	15,0	20,8	25,9	7,3	15,5	29,6	39,0	34,8
1973	53,0	3,0	9,5	60,5	15,2	21,1	20,9	7,1	13,8	23,9	36,7	30,5
1974	52,0	2,8	9,2	59,6	15,0	20,9	18,3	6,2	12,2	21,0	33,8	27,5
1975	53,2	2,8	9,4	60,9	15,2	21,2	20,6	6,6	13,3	23,6	35,6	29,9
1976	53,2	2,8	9,4	61,1	15,2	21,2	23,6	6,9	14,4	27,1	36,9	32,5
1977	52,5	2,7	9,1	60,7	15,1	21,0	22,7	6,1	13,3	26,2	34,0	30,6
1978	50,8	2,6	8,9	58,6	14,9	20,6	21,1	5,7	12,5	24,4	32,5	28,9
1979	47,7	2,6	8,4	55,6	14,6	20,0	18,1	5,8	11,5	21,0	32,9	27,3
1980	47,9	2,7	8,6	56,0	14,8	20,2	14,4	6,6	10,9	16,9	36,5	25,6
1981	50,7	2,6	8,9	58,8	14,6	20,4	16,9	6,9	12,4	19,6	39,5	28,6
1982	48,2	2,4	8,5	56,1	14,6	20,1	19,7	7,1	13,7	22,9	43,0	32,5
1983	45,5	2,4	8,1	53,4	14,6	19,7	17,9	7,8	13,5	21,0	47,5	32,7
1984	49,2	2,3	8,4	57,1	14,5	20,0	23,1	8,8	16,7	26,8	55,1	39,6
1985	47,6	2,3	8,2	55,6	14,4	19,7	31,2	9,4	19,8	36,5	58,0	47,8
1986	47,0	2,4	8,1	55,0	14,3	19,5	29,1	9,3	18,9	34,0	56,5	45,6
1987	46,8	2,4	8,1	54,9	14,1	19,3	23,7	9,1	16,7	27,8	52,8	39,8
1988	48,1	2,4	8,2	56,1	14,1	19,4	24,5	9,2	17,2	28,5	53,8	40,6

* LOCAL CURRENCY CONVERTED TO US$ AT PREVAILING EXCHANGE RATE AND DEFLATED USING THE US$ DEFLATOR FOR 1985.

APPENDIX J: Tabulated Presentation of the Results of Forecast.

RSA - South Africa

ESA - East and Southern Africa Region

OTHER - ESA Excluding South Africa

Table J.1: Economic Data

YEAR	POPULATION			ECONOMIC DATA																	
				GDP MILLION 1985 US$*									GDP/CAPITA 1985 US$*								
	RSA (2,3 % GR)	OTHER (3,0 % GR)	TOTAL	RSA			OTHER			ESA			RSA			OTHER			ESA		
				(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1989	37,1	257,5	294,6	71779,8	72703,7	72703,7	66034,1	66884,1	66884,1	137813,9	139587,7	139587,7	1935,1	1960,0	1960,0	256,4	259,7	259,7	467,8	473,8	473,8
1990	37,9	265,3	303,2	72497,6	74375,8	74375,8	66694,5	68422,4	68422,4	139192,0	142798,2	142798,2	1910,5	1960,0	1960,0	251,4	258,0	258,0	459,1	471,0	471,0
1991	38,8	273,2	312,0	73222,5	76086,5	76086,5	67361,4	69996,1	69996,1	140583,9	146082,6	146082,6	1886,2	1960,0	1960,0	246,6	256,2	256,2	450,5	468,2	468,2
1992	39,7	281,4	321,1	73954,8	77836,5	77836,5	68035,0	71606,0	71606,0	141989,8	149442,5	149442,5	1862,2	1960,0	1960,0	241,8	254,5	254,5	442,2	465,4	465,4
1993	40,6	289,8	330,5	74694,3	79626,7	80171,6	68715,4	73253,0	73754,2	143409,7	152879,7	153925,8	1838,6	1960,0	1973,4	237,1	252,7	254,5	434,0	462,6	465,8
1994	41,6	298,5	340,1	75441,3	81458,1	82576,7	69402,5	74937,8	75966,8	144843,8	156395,9	158543,5	1815,2	1960,0	1986,9	232,5	251,0	254,5	425,9	459,8	466,2
1995	42,5	307,5	350,0	76195,7	83331,7	85054,0	70096,5	76661,3	78245,8	146292,2	159993,0	163299,8	1792,1	1960,0	2000,5	228,0	249,3	254,5	418,0	457,1	466,5
1996	43,5	316,7	360,2	77719,6	85831,6	88456,2	71498,5	78961,2	81375,7	149218,0	164792,8	169831,8	1786,9	1973,4	2033,7	225,7	249,3	256,9	414,2	457,5	471,5
1997	44,5	326,2	370,7	79274,0	88406,6	91994,4	72928,4	81330,0	84630,7	152202,4	169736,6	176625,1	1781,6	1986,9	2067,5	223,6	249,3	259,4	410,6	457,9	476,4
1998	45,5	336,0	381,5	80859,5	91058,8	95674,2	74387,0	83769,9	88015,9	155246,5	174828,7	183690,1	1776,4	2000,5	2101,9	221,4	249,3	261,9	406,9	458,2	481,5
1999	46,6	346,1	392,7	82476,6	93790,5	99501,2	75874,7	86283,0	91536,5	158351,4	180073,5	191037,7	1771,2	2014,2	2136,8	219,2	249,3	264,5	403,3	458,6	486,5
2000	47,6	356,5	404,1	84126,2	96604,2	103481,2	77392,2	88871,5	95198,0	161518,4	185475,7	198679,2	1766,0	2028,0	2172,3	217,1	249,3	267,1	399,7	459,0	491,6
2001	48,7	367,2	415,9	85808,7	99502,4	108137,9	78940,1	91537,6	99481,9	164748,8	191040,0	207619,8	1760,8	2041,8	2219,0	215,0	249,3	270,9	396,1	459,3	499,2
2002	49,9	378,2	428,0	87524,9	102487,4	113004,1	80518,9	94283,8	103958,6	168043,8	196771,2	216962,7	1755,7	2055,8	2266,8	212,9	249,3	274,9	392,6	459,7	506,9
2003	51,0	389,5	440,5	89275,4	105562,1	118089,3	82129,3	97112,3	108636,7	171404,6	202674,4	226726,0	1750,5	2069,9	2315,5	210,8	249,3	278,9	389,1	460,1	514,7
2004	52,2	401,2	453,4	91060,9	108728,9	123403,3	83771,9	100025,7	113525,4	174832,7	208754,6	236928,7	1745,4	2084,0	2365,3	208,8	249,3	283,0	385,6	460,4	522,6
2005	53,4	413,3	466,6	92882,1	111990,8	128956,4	85447,3	103026,4	118634,0	178329,4	215017,2	247590,5	1740,3	2098,3	2416,2	206,8	249,3	287,1	382,2	460,8	530,6
2006	54,6	425,7	480,3	95204,1	115350,5	134759,5	87583,5	106117,2	123972,6	182787,6	221467,7	258732,0	1743,7	2112,7	2468,1	205,8	249,3	291,3	380,6	461,1	538,7
2007	55,9	438,4	494,3	97584,2	118811,0	140823,7	89773,1	109300,7	129551,3	187357,3	228111,8	270375,0	1747,1	2127,1	2521,2	204,8	249,3	295,5	379,1	461,5	547,0
2008	57,1	451,6	508,7	100023,9	122375,4	147160,7	92017,4	112579,8	135381,1	192041,2	234955,1	282541,9	1750,5	2141,7	2575,4	203,8	249,3	299,8	377,5	461,9	555,4
2009	58,5	465,1	523,6	102524,5	126046,6	153782,9	94317,8	115957,2	141473,3	196842,3	242003,8	295256,2	1753,9	2156,3	2630,8	202,8	249,3	304,2	376,0	462,2	563,9
2010	59,8	479,1	538,9	105087,6	129828,0	160703,2	96675,8	119435,9	147839,6	201763,3	249263,9	308542,8	1757,4	2171,1	2687,4	201,8	249,3	308,6	374,4	462,6	572,6
2011	61,2	493,4	554,6	107714,8	133722,9	167934,8	99092,7	123018,9	154492,4	206807,4	256741,8	322427,2	1760,8	2185,9	2745,2	200,8	249,3	313,1	372,9	462,9	581,3
2012	62,6	508,3	570,8	110407,6	137734,6	175491,9	101570,0	126709,5	161444,5	211977,6	264444,1	336936,4	1764,2	2200,9	2804,2	199,8	249,3	317,6	371,3	463,3	590,3
2013	64,0	523,5	587,5	113167,8	141866,6	183389,0	104109,2	130510,8	168709,5	217277,0	272377,4	352098,6	1767,7	2216,0	2864,5	198,9	249,3	322,3	369,8	463,6	599,3
2014	65,5	539,2	604,7	115997,0	146122,6	191641,5	106712,0	134426,1	176301,5	222709,0	280548,7	367943,0	1771,1	2231,1	2926,1	197,9	249,3	327,0	368,3	464,0	608,5
2015	67,0	555,4	622,4	118896,9	150506,3	200265,4	109379,8	138458,9	184235,0	228276,7	288965,2	384500,4	1774,6	2246,4	2989,1	196,9	249,3	331,7	366,8	464,3	617,8
2016	68,5	572,0	640,6	121869,4	155021,5	210278,7	112114,2	142612,7	193446,8	233983,6	297634,1	403725,5	1778,1	2261,8	3068,0	196,0	249,3	338,2	365,3	464,6	630,2
2017	70,1	589,2	659,3	124916,1	159672,1	220792,6	114917,1	146891,0	203119,1	239833,2	306563,1	423911,7	1781,5	2277,2	3148,9	195,0	249,3	344,7	363,8	465,0	643,0
2018	71,7	606,9	678,6	128039,0	164462,3	231832,2	117790,0	151297,8	213275,1	245829,0	315760,0	445107,3	1785,0	2292,8	3232,0	194,1	249,3	351,4	362,3	465,3	655,9
2019	73,4	625,1	698,5	131240,0	169396,1	243423,8	120734,8	155836,7	223938,8	251974,7	325232,8	467362,7	1788,5	2308,5	3317,3	193,1	249,3	358,3	360,8	465,6	669,1
2020	75,1	643,8	718,9	134521,0	174478,0	255595,0	123753,2	160511,8	235135,8	258274,1	334989,8	490730,8	1792,0	2324,3	3404,9	192,2	249,3	365,2	359,3	466,0	682,6

* LOCAL CURRENCY CONVERTED TO US$ AT PREVAILING EXCHANGE RATE AND DEFLATED USING THE US$DEFLATOR FOR 1985.
SCENARIO GIVEN IN BRACKETS

Table J.2: Energy Total Final Consumption

YEAR	COMMERCIAL ENERGY - TOTAL FINAL CONSUMPTION (TFC)																	
	ELECTRICITY						COAL						OIL					
	RSA			OTHER			RSA			OTHER			RSA			OTHER		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1989	11539,1	11706,8	11706,8	2458,4	2458,4	2458,4	16217,1	16456,4	16456,4	2490,5	2523,0	2523,0	14352,6	14681,3	14681,3	9377,0	9500,0	9500,0
1990	11674,0	12021,6	12021,6	2541,5	2607,4	2607,4	16399,8	16882,9	16882,9	2524,2	2589,6	2589,6	14603,4	15271,3	15271,3	9502,7	9748,9	9748,9
1991	11815,0	12355,5	12355,5	2737,6	2844,7	2844,7	16581,1	17312,0	17312,0	2652,5	2756,2	2756,2	14851,9	15869,0	15869,0	9985,8	10376,3	10376,3
1992	11962,2	12709,6	12709,6	2942,2	3096,7	3096,7	16760,8	17743,6	17743,6	2782,1	2928,1	2928,1	15097,9	16473,5	16473,5	10473,7	11023,5	11023,5
1993	12115,9	13085,1	13199,4	3155,5	3363,9	3386,9	16938,8	18177,1	18309,0	2913,0	3105,4	3126,6	15341,0	17083,6	17269,3	10966,6	11690,8	11770,8
1994	12276,2	13483,3	13723,3	3377,6	3647,0	3697,1	17115,1	18612,2	18880,7	3045,2	3288,1	3333,3	15581,0	17698,4	18079,9	11464,4	12378,8	12548,8
1995	12443,3	13905,5	14283,8	3608,9	3946,8	4028,4	17289,6	19048,6	19458,1	3178,8	3476,5	3548,3	15817,7	18316,7	18903,8	11967,2	13087,9	13358,5
1996	12791,7	14489,5	15083,7	3887,5	4293,2	4424,5	17634,7	19618,9	20234,8	3346,5	3695,7	3808,8	16283,8	19126,3	20017,9	12598,4	13913,4	14338,8
1997	13159,7	15114,8	15951,6	4181,0	4662,6	4851,8	17979,0	20193,6	21025,1	3518,5	3923,8	4083,1	16748,8	19945,5	21161,0	13246,0	14772,0	15371,5
1998	13548,5	15784,6	16894,1	4489,9	5056,2	5312,5	18322,4	20772,1	21828,3	3694,9	4161,0	4371,9	17211,7	20772,4	22330,8	13910,4	15665,0	16459,0
1999	13959,1	16502,2	17918,2	4814,8	5475,3	5808,7	18664,5	21353,8	22643,3	3875,9	4407,6	4676,0	17671,7	21605,1	23524,4	14591,8	16593,4	17603,8
2000	14393,0	17271,6	19032,0	5156,4	5921,2	6342,8	19004,9	21938,0	23469,4	4061,6	4664,0	4996,0	18127,8	22441,7	24738,8	15290,5	17558,5	18808,5
2001	14851,4	18096,7	20395,9	5515,3	6395,5	6950,6	19343,4	22524,2	24409,9	4251,9	4930,4	5358,3	18579,2	23279,8	26124,7	16007,0	18561,5	20172,4
2002	15335,9	18982,2	21892,8	5892,3	6899,6	7607,5	19679,7	23111,4	25364,5	4447,0	5207,2	5741,5	19024,8	24117,3	27534,5	16741,5	19603,5	21615,1
2003	15847,9	19932,9	23537,5	6287,8	7434,9	8317,3	20013,3	23699,1	26332,0	4647,0	5494,7	6146,8	19463,7	24951,9	28963,8	17494,4	20686,0	23140,8
2004	16389,3	20954,2	25346,6	6702,8	8003,3	9083,5	20343,9	24286,5	27310,9	4851,9	5793,3	6575,2	19895,0	25781,3	30407,8	18266,1	21810,2	24753,7
2005	16961,7	22052,1	27338,6	7137,9	8606,4	9910,1	20671,3	24872,7	28299,8	5062,0	6103,4	7028,0	20317,6	26602,8	31861,3	19056,9	22977,5	26458,3
2006	17718,6	23233,0	29534,5	7631,1	9245,9	10801,6	21076,1	25457,1	29297,2	5303,1	6425,3	7506,4	20833,9	27414,1	33318,7	19964,5	24189,2	28259,3
2007	18526,4	24503,9	31958,0	8150,8	9923,7	11762,4	21477,4	26038,9	30301,5	5551,7	6759,3	8011,7	21339,6	28212,5	34774,3	20900,6	25446,9	30161,6
2008	19388,7	25872,6	33453,0	8698,2	10641,9	12797,3	21874,9	26617,1	31719,0	5808,1	7106,0	8545,2	21833,2	28995,5	36401,1	21865,8	26752,0	32170,2
2009	20309,9	27347,7	35009,0	9274,6	11402,4	13911,5	22268,0	27191,1	33194,3	6072,5	7465,7	9108,5	22313,2	29760,6	38094,2	22861,0	28106,0	34290,7
2010	21294,4	28938,4	36627,8	9881,1	12207,4	15110,6	22656,2	27759,9	34729,2	6345,0	7838,7	9702,9	22778,3	30505,0	39855,7	23886,9	29510,6	36528,6
2011	22347,1	29825,3	38311,6	10519,3	13059,2	16400,3	23039,0	28610,7	36325,7	6625,8	8225,7	10330,1	23227,1	31439,8	41687,8	24944,3	30967,2	38889,9
2012	23473,3	30733,9	40062,3	11190,3	13960,0	17786,8	23415,9	29482,3	37985,7	6915,3	8626,9	10991,8	23658,2	32397,7	43592,9	26034,0	32477,6	41380,7
2013	24065,7	31664,7	41882,3	11895,6	14912,3	19276,9	24006,9	30375,2	39711,3	7213,5	9042,8	11689,5	24255,3	33378,8	45573,2	27156,7	34043,5	44007,6
2014	24669,5	32618,0	43773,5	12636,8	15918,6	20877,5	24609,1	31289,6	41504,5	7520,7	9473,9	12425,2	24863,8	34383,7	47631,1	28313,3	35666,6	46777,2
2015	25284,6	33594,0	45738,3	13415,2	16981,8	22596,1	25222,8	32225,9	43367,5	7837,2	9920,8	13200,7	25483,8	35412,6	49769,1	29504,7	37348,7	49696,6
2016	25911,3	34593,2	48005,7	14232,7	18104,4	24557,7	25847,9	33184,4	45517,3	8163,1	10383,7	14085,0	26115,5	36465,9	52236,3	30731,8	39091,7	53025,9
2017	26549,7	35615,9	50371,0	15090,7	19289,5	26673,3	26484,7	34165,4	47760,0	8498,7	10863,4	15021,8	26758,8	37543,9	54810,0	31995,3	40897,5	56552,5
2018	27199,7	36662,3	52837,6	15991,1	20540,1	28954,1	27133,2	35169,3	50098,8	8844,3	11360,2	16013,8	27414,0	38647,0	57494,0	33296,2	42768,0	60287,4
2019	27861,6	37732,9	55409,2	16935,6	21859,3	31412,1	27793,5	36196,3	52537,1	9200,0	11874,8	17064,2	28081,1	39775,6	60292,2	34635,4	44705,2	64241,8
2020	28535,4	38828,0	58089,2	17926,0	23250,6	34060,1	28465,6	37246,7	55078,2	9566,2	12407,7	18176,1	28760,2	40929,9	63208,4	36013,9	46711,2	68427,8

SCENARIO GIVEN IN BRACKETS

Table J.2: - continued

YEAR	COMMERCIAL ENERGY - TOTAL FINAL CONSUMPTION																		TRADITIONAL			TOTAL ENERGY - COMMERCIAL + TRADITIONAL								
	TOTAL COMMERCIAL									TOTAL CARRIERS									RSA	OTHER	ESA	RSA			OTHER			ESA		
	RSA			OTHER			ESA			ELECTRICITY			COAL			OIL														
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)				(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1989	42109	42844	42844	14126	14126	14126	56234	56970	56970	13998	14165	14165	18708	18979	18979	23730	24181	24181	6972	70570	77542	49081	49816	49816	84696	84696	84696	133776	134512	134512
1990	42677	44176	44176	14568	14946	14946	57246	59122	59122	14216	14629	14629	18924	19472	19472	24106	25020	25020	7058	72687	79745	49735	51234	51234	87255	87633	87633	136990	138866	138866
1991	43248	45537	45537	15376	15977	15977	58624	61514	61514	14553	15200	15200	19234	20068	20068	24838	26245	26245	7141	74841	81982	50389	52677	52677	90217	90818	90818	140605	143495	143495
1992	43821	46927	46927	16198	17048	17048	60019	63975	63975	14904	15806	15806	19543	20672	20672	25572	27497	27497	7221	77031	84252	51041	54147	54147	93229	94079	94079	144270	148226	148226
1993	44396	48346	48778	17035	18160	18284	61431	66506	67062	15271	16449	16586	19852	21282	21436	26308	28774	29040	7297	79257	86554	51693	55643	56075	96292	97417	97541	147985	153060	153616
1994	44972	49794	50684	17887	19314	19579	62860	69108	70263	15654	17130	17420	20160	21900	22214	27045	30077	30629	7371	81518	88889	52343	57164	58055	99405	100832	101097	151748	157996	159152
1995	45551	51271	52646	18755	20511	20935	64305	71782	73581	16052	17852	18312	20468	22525	23006	27785	31405	32262	7440	83814	91254	52991	58711	60086	102568	104325	104749	155559	163036	164835
1996	46710	53235	55336	19832	21902	22572	66543	75137	77909	16679	18783	19508	20981	23315	24044	28882	33040	34357	7507	86143	93650	54217	60742	62843	105975	108045	108715	160192	168787	171558
1997	47888	55254	58138	20945	23358	24306	68833	78612	82444	17341	19777	20803	21498	24117	25108	29995	34718	36533	7569	88505	96075	55457	62823	65707	109451	111864	112812	164908	174687	178519
1998	49083	57329	61053	22095	24882	26143	71178	82211	87197	18038	20841	22207	22017	24933	26200	31122	36437	38790	7628	90900	98528	56711	64957	68681	112995	115782	117043	169706	180739	185725
1999	50295	59461	64086	23283	26476	28088	73578	85938	92174	18774	21978	23727	22540	25761	27319	32263	38199	41128	7683	93326	101009	57979	67145	71769	116608	119802	121414	174587	186947	193183
2000	51526	61651	67240	24509	28144	30147	76034	89795	97387	19549	23193	25375	23066	26602	28465	33418	40000	43547	7734	95782	103517	59260	69386	74975	120291	123926	125929	179551	193312	200904
2001	52774	63901	70930	25774	29887	32481	78548	93788	103412	20367	24492	27346	23595	27455	29768	34586	41841	46297	7781	98268	106049	60555	71682	78712	124042	128155	130749	184597	199837	209461
2002	54040	66211	74792	27081	31710	34964	81121	97921	109756	21228	25882	29500	24127	28319	31106	35766	43721	49150	7824	100782	108606	61865	74035	82616	127883	132492	135746	189727	206527	218362
2003	55325	66584	78833	28429	33616	37605	83754	102200	116438	22136	27368	31855	24660	29194	32479	36958	45638	52105	7863	103323	111186	63188	76447	86696	131752	136939	140928	194940	213386	227624
2004	56628	71022	83065	29821	35607	40412	86449	106629	123478	23092	28958	34430	25196	30080	33886	38161	47591	55162	7897	105891	113788	64526	78919	90963	135711	141497	146303	200237	220417	237266
2005	57951	73528	87500	31257	37687	43396	89207	111215	130896	24100	30658	37249	25733	30976	35328	39374	49580	58320	7928	108483	116410	65878	81455	95427	139739	146170	151879	205618	227625	247306
2006	59629	76104	92150	32899	39880	48567	92527	115965	138718	25350	32479	40336	28379	31882	36804	40796	51603	61578	7953	111098	119052	67582	84057	100104	143997	150959	157666	211579	235016	257769
2007	61343	78755	97034	34603	42130	49936	95946	120865	146969	26677	34428	43720	27029	32798	38313	42240	53659	64936	7974	113736	121711	69318	86730	105008	148339	155866	163672	217657	242596	268680
2008	63097	81485	101573	36372	44500	53513	99469	125985	155086	28087	36515	46250	27883	33723	40264	43699	55748	68571	7991	116395	124386	71088	89477	109584	152767	160895	169908	223855	250371	279472
2009	64891	84299	106297	38208	46974	57311	103099	131273	163608	29564	38750	48921	28340	34857	42303	45174	57867	72385	8004	119073	127076	72895	92303	114301	157281	166047	176384	230178	258350	290685
2010	66729	87203	111213	40113	49557	61342	106842	136760	172555	31176	41148	51738	29001	35599	44432	46665	60016	76384	8011	121769	129780	74740	95215	119224	181882	171325	183111	236622	268540	302335
2011	68613	89876	116325	42089	52252	65620	110703	142128	181945	32866	42884	54712	29665	36836	46658	48171	62407	80578	8015	124481	132495	76626	97890	124340	166570	176733	190101	243198	274823	314441
2012	70547	92614	121641	44139	55064	70159	114687	147878	191800	34664	44694	57849	30331	38109	48977	49692	64875	84974	8013	127207	135221	78561	100627	129654	171347	182272	197367	249907	282899	327021
2013	72328	95419	127167	46266	57999	74974	118594	153417	202141	35961	46577	61159	31220	39418	51401	51412	67422	89581	8007	129947	137954	80335	103426	135174	176213	187945	204921	256548	291371	340095
2014	74142	98291	132909	48471	81059	80080	122613	159350	212989	37306	48537	64651	32130	40764	53930	53177	70050	94408	7997	132698	140694	82139	106288	140906	181168	193757	212777	283308	300045	353683
2015	75991	101233	138875	50757	64251	85493	126748	165484	224368	38700	50576	68334	33060	42147	58568	54989	72761	99466	7982	135458	143440	83973	109214	146857	186215	199709	220951	270188	308923	367808
2016	77875	104243	145759	53128	67580	91689	131002	171823	237428	40144	52698	72563	34011	43568	59602	56847	75558	105282	7963	138225	146188	85837	112206	153722	191353	205805	229894	277190	318011	383616
2017	79793	107325	152941	55585	71050	98248	135378	178376	251189	41640	54905	77044	34983	45029	62782	58754	78441	111363	7939	140999	148937	87732	115264	160880	196583	212049	239246	284315	327313	400126
2018	81747	110479	160430	58132	74668	105255	139879	185147	265688	43191	57202	81792	35978	46530	66113	60710	81415	117761	7910	143778	151688	89657	118389	168341	201907	218444	249031	291564	336833	417372
2019	83736	113705	168238	60771	78439	112718	144507	192144	280957	44797	59592	86821	36994	48071	69601	62717	84481	124534	7878	146554	154432	91614	121582	176116	207325	224994	259272	298939	346576	435389
2020	85761	117005	176376	63506	82369	120664	149267	199374	297040	46461	62079	92149	38032	49654	73254	84774	87641	131636	7840	149333	157174	93602	124845	184216	212839	231702	269997	306441	356548	454213

SCENARIO GIVEN IN BRACKETS

Table J.2: - continued

YEAR	COMMERCIAL ENERGY: TOTAL FINAL CONSUMPTION (TFC)												TRADITIONAL + COMMERCIAL ENERGY (TFC)															TRADITIONAL ENERGY RSA AS A % OF ESA
	OIL AS PERCENTAGE OF COMMERCIAL			COAL AS PERCENATGE OF COMMERCIAL			ELECTRICITY AS % OF COMMERCIAL			RSA AS % OF ESA			TRADITIONAL ENERGY AS PERCENTAGE			COAL AS PERCENTAGE			OIL AS PERCENTAGE			ELECTRICITY AS PERCENTAGE			RSA AS % OF TOTAL			
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	
1989	42,2	42,4	42,4	33,3	33,3	33,3	24,9	24,9	24,9	74,9	75,2	75,2	58,0	57,6	57,6	14,0	14,1	14,1	17,7	18,0	18,0	10,5	10,5	10,5	36,7	37,0	37,0	9,0
1990	42,1	42,3	42,3	33,1	32,9	32,9	24,8	24,7	24,7	74,6	74,7	74,7	58,2	57,4	57,4	13,8	14,0	14,0	17,6	18,0	18,0	10,4	10,5	10,5	36,3	36,9	36,9	8,9
1991	42,4	42,7	42,7	32,8	32,6	32,6	24,8	24,7	24,7	73,8	74,0	74,0	58,3	57,1	57,1	13,7	14,0	14,0	17,7	18,3	18,3	10,3	10,6	10,6	35,8	36,7	36,7	8,7
1992	42,6	43,0	43,0	32,6	32,3	32,3	24,8	24,7	24,7	73,0	73,4	73,4	58,4	56,8	56,8	13,5	13,9	13,9	17,7	18,6	18,6	10,3	10,7	10,7	35,4	36,5	36,5	8,6
1993	42,8	43,3	43,3	32,3	32,0	32,0	24,9	24,7	24,7	72,3	72,7	72,7	58,5	56,5	56,3	13,4	13,9	14,0	17,8	18,8	18,9	10,3	10,7	10,8	34,9	36,4	36,5	8,4
1994	43,0	43,5	43,6	32,1	31,7	31,6	24,9	24,8	24,8	71,5	72,1	72,1	58,6	56,3	55,9	13,3	13,9	14,0	17,8	19,0	19,2	10,3	10,8	10,9	34,5	36,2	36,5	8,3
1995	43,2	43,8	43,8	31,8	31,4	31,3	25,0	24,9	24,9	70,8	71,4	71,5	58,7	56,0	55,4	13,2	13,8	14,0	17,9	19,3	19,6	10,3	10,9	11,1	34,1	36,0	36,5	8,2
1996	43,4	44,0	44,1	31,5	31,0	30,9	25,1	25,0	25,0	70,2	70,9	71,0	58,5	55,5	54,6	13,1	13,8	14,0	18,0	19,6	20,0	10,4	11,1	11,4	33,8	36,0	36,6	8,0
1997	43,6	44,2	44,3	31,2	30,7	30,5	25,2	25,2	25,2	69,6	70,3	70,5	58,3	55,0	53,8	13,0	13,8	14,1	18,2	19,9	20,5	10,5	11,3	11,7	33,6	36,0	36,8	7,9
1998	43,7	44,3	44,5	30,9	30,3	30,0	25,3	25,4	25,5	69,0	69,7	70,0	58,1	54,5	53,1	13,0	13,8	14,1	18,3	20,2	20,9	10,6	11,5	12,0	33,4	35,9	37,0	7,7
1999	43,8	44,4	44,6	30,6	30,0	29,6	25,5	25,6	25,7	68,4	69,2	69,5	57,9	54,0	52,3	12,9	13,8	14,1	18,5	20,4	21,3	10,8	11,8	12,3	33,2	35,9	37,2	7,6
2000	44,0	44,5	44,7	30,3	29,6	29,2	25,7	25,8	26,1	67,8	68,7	69,0	57,7	53,5	51,5	12,8	13,8	14,2	18,6	20,7	21,7	10,9	12,0	12,6	33,0	35,9	37,3	7,5
2001	44,0	44,6	44,8	30,0	29,3	28,8	25,9	26,1	26,4	67,2	68,1	68,6	57,4	53,1	50,6	12,8	13,7	14,2	18,7	20,9	22,1	11,0	12,3	13,1	32,8	35,9	37,6	7,3
2002	44,1	44,6	44,8	29,7	28,9	28,3	26,2	26,4	26,9	66,6	67,6	68,1	57,2	52,6	49,7	12,7	13,7	14,2	18,9	21,2	22,5	11,2	12,5	13,5	32,6	35,8	37,8	7,2
2003	44,1	44,7	44,7	29,4	28,6	27,9	26,4	26,8	27,4	66,1	67,1	67,7	57,0	52,1	48,8	12,7	13,7	14,3	19,0	21,4	22,9	11,4	12,8	14,0	32,4	35,8	38,1	7,1
2004	44,1	44,6	44,7	29,1	28,2	27,4	26,7	27,2	27,9	65,5	66,6	67,3	56,8	51,6	48,0	12,6	13,6	14,3	19,1	21,6	23,2	11,5	13,1	14,5	32,2	35,8	38,3	6,9
2005	44,1	44,6	44,6	28,8	27,9	27,0	27,0	27,6	28,5	65,0	66,1	66,8	56,6	51,1	47,1	12,5	13,6	14,3	19,1	21,8	23,6	11,7	13,5	15,1	32,0	35,8	38,6	6,8
2006	44,1	44,5	44,4	28,5	27,5	26,5	27,4	28,0	29,1	64,4	65,6	66,4	56,3	50,7	46,2	12,5	13,6	14,3	19,3	22,0	23,9	12,0	13,8	15,6	31,9	35,8	38,8	6,7
2007	44,0	44,4	44,2	28,2	27,1	26,1	27,8	28,5	29,7	63,9	65,1	66,0	55,9	50,2	45,3	12,4	13,5	14,3	19,4	22,1	24,2	12,3	14,2	16,3	31,8	35,8	39,1	6,6
2008	43,9	44,2	44,2	27,8	26,8	26,0	28,2	29,0	29,8	63,4	64,7	65,5	55,6	49,7	44,5	12,4	13,5	14,4	19,5	22,3	24,5	12,5	14,6	16,5	31,8	35,7	39,2	6,4
2009	43,8	44,1	44,2	27,5	26,4	25,9	28,7	29,5	29,9	62,9	64,2	65,0	55,2	49,2	43,7	12,3	13,4	14,6	19,6	22,4	24,9	12,9	15,0	16,8	31,7	35,7	39,3	6,3
2010	43,7	43,9	44,3	27,1	26,0	25,7	29,2	30,1	30,0	62,5	63,8	64,5	54,8	48,7	42,9	12,3	13,4	14,7	19,7	22,5	25,3	13,2	15,4	17,1	31,6	35,7	39,4	6,2
2011	43,5	43,9	44,3	26,8	25,9	25,6	29,7	30,2	30,1	62,0	63,2	63,9	54,5	48,2	42,1	12,2	13,4	14,8	19,8	22,7	25,6	13,5	15,6	17,4	31,5	35,6	39,5	6,0
2012	43,3	43,9	44,3	26,4	25,8	25,5	30,2	30,3	30,2	61,5	62,7	63,4	54,1	47,8	41,3	12,1	13,5	15,0	19,9	22,9	26,0	13,9	15,8	17,7	31,4	35,6	39,6	5,9
2013	43,4	43,9	44,3	26,3	25,7	25,4	30,3	30,4	30,3	61,0	62,2	62,9	53,8	47,3	40,6	12,2	13,5	15,1	20,0	23,1	26,3	14,0	16,0	18,0	31,3	35,5	39,7	5,8
2014	43,4	44,0	44,3	26,2	25,6	25,3	30,4	30,5	30,4	60,5	61,7	62,4	53,4	46,9	39,8	12,2	13,6	15,2	20,2	23,3	26,7	14,2	16,2	18,3	31,2	35,4	39,8	5,7
2015	43,4	44,0	44,3	26,1	25,5	25,2	30,5	30,6	30,5	60,0	61,2	61,9	53,1	46,4	39,0	12,2	13,6	15,4	20,4	23,6	27,0	14,3	16,4	18,6	31,1	35,4	39,9	5,6
2016	43,4	44,0	44,3	26,0	25,4	25,1	30,6	30,7	30,6	59,4	60,7	61,4	52,7	46,0	38,1	12,3	13,7	15,5	20,5	23,8	27,4	14,5	16,6	18,9	31,0	35,3	40,1	5,4
2017	43,4	44,0	44,3	25,8	25,2	25,0	30,8	30,8	30,7	58,9	60,2	60,9	52,4	45,5	37,2	12,3	13,8	15,7	20,7	24,0	27,8	14,6	16,8	19,3	30,9	35,2	40,2	5,3
2018	43,4	44,0	44,3	25,7	25,1	24,9	30,9	30,9	30,8	58,4	59,7	60,4	52,0	45,0	36,3	12,3	13,8	15,8	20,8	24,2	28,2	14,8	17,0	19,6	30,8	35,1	40,3	5,2
2019	43,4	44,0	44,3	25,6	25,0	24,8	31,0	31,0	30,9	57,9	59,2	59,9	51,7	44,6	35,5	12,4	13,9	16,0	21,0	24,4	28,6	15,0	17,2	19,9	30,6	35,1	40,5	5,1
2020	43,4	44,0	44,3	25,5	24,9	24,7	31,1	31,1	31,0	57,5	58,7	59,4	51,3	44,1	34,6	12,4	13,9	16,1	21,1	24,6	29,0	15,2	17,4	20,3	30,5	35,0	40,6	5,0

SCENARIO GIVEN IN BRACKETS

Table J.3: Energy Indicators - per capita consumption

YEAR	ENERGY INDICATORS - PER CAPITA FINAL CONSUMTION																	
	COMMERCIAL GJ PER CAPITA									TOTAL (TRADITIONAL + COMMERCIAL) GJ PER CAPITA								
	RSA			OTHER			TOTAL			RSA			OTHER			TOTAL		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1989	47,6	48,4	48,4	2,3	2,3	2,3	8,0	8,1	8,1	55,4	56,3	56,3	13,8	13,8	13,8	19,0	19,1	19,1
1990	47,1	48,8	48,8	2,3	2,4	2,4	7,9	8,2	8,2	54,9	56,6	56,6	13,8	13,8	13,8	18,9	19,2	19,2
1991	46,7	49,1	49,1	2,4	2,5	2,5	7,9	8,3	8,3	54,4	56,9	56,9	13,8	13,9	13,9	18,9	19,3	19,3
1992	46,2	49,5	49,5	2,4	2,5	2,5	7,8	8,3	8,3	53,9	57,1	57,1	13,9	14,0	14,0	18,8	19,3	19,3
1993	45,8	49,9	50,3	2,5	2,6	2,6	7,8	8,4	8,5	53,3	57,4	57,8	13,9	14,1	14,1	18,8	19,4	19,5
1994	45,3	50,2	51,1	2,5	2,7	2,7	7,7	8,5	8,7	52,8	57,6	58,5	14,0	14,2	14,2	18,7	19,5	19,6
1995	44,9	50,5	51,9	2,6	2,8	2,9	7,7	8,6	8,8	52,2	57,9	59,2	14,0	14,2	14,3	18,6	19,5	19,7
1996	45,0	51,3	53,3	2,6	2,9	3,0	7,7	8,7	9,1	52,2	58,5	60,5	14,0	14,3	14,4	18,6	19,6	20,0
1997	45,1	52,0	54,7	2,7	3,0	3,1	7,8	8,9	9,3	52,2	59,2	61,9	14,1	14,4	14,5	18,6	19,7	20,2
1998	45,2	52,8	56,2	2,8	3,1	3,3	7,8	9,0	9,6	52,2	59,8	63,2	14,1	14,4	14,6	18,6	19,8	20,4
1999	45,3	53,5	57,7	2,8	3,2	3,4	7,9	9,2	9,8	52,2	60,4	64,6	14,1	14,5	14,7	18,6	19,9	20,6
2000	45,3	54,2	59,1	2,9	3,3	3,5	7,9	9,3	10,1	52,1	61,0	65,9	14,1	14,6	14,8	18,6	20,0	20,8
2001	45,4	54,9	61,0	2,9	3,4	3,7	7,9	9,4	10,4	52,1	61,6	67,7	14,2	14,6	14,9	18,6	20,1	21,1
2002	45,4	55,6	62,9	3,0	3,5	3,9	7,9	9,6	10,7	52,0	62,2	69,4	14,2	14,7	15,0	18,6	20,2	21,4
2003	45,5	56,3	64,8	3,1	3,6	4,0	8,0	9,7	11,1	51,9	62,8	71,2	14,2	14,7	15,2	18,5	20,3	21,6
2004	45,5	57,0	66,7	3,1	3,7	4,2	8,0	9,9	11,4	51,8	63,4	73,1	14,2	14,8	15,3	18,5	20,4	21,9
2005	45,5	57,7	68,7	3,2	3,8	4,4	8,0	10,0	11,8	51,7	63,9	74,9	14,2	14,8	15,4	18,5	20,4	22,2
2006	45,8	58,4	70,7	3,2	3,9	4,6	8,1	10,1	12,1	51,9	64,5	76,8	14,2	14,9	15,5	18,5	20,5	22,5
2007	46,0	59,1	72,8	3,3	4,0	4,8	8,1	10,2	12,5	52,0	65,1	78,8	14,2	14,9	15,6	18,5	20,6	22,8
2008	46,3	59,8	74,5	3,4	4,1	5,0	8,2	10,4	12,8	52,1	65,6	80,3	14,2	14,9	15,8	18,4	20,6	23,0
2009	46,5	60,4	76,2	3,4	4,2	5,2	8,3	10,5	13,1	52,3	66,2	81,9	14,2	15,0	15,9	18,4	20,7	23,3
2010	46,8	61,1	77,9	3,5	4,3	5,4	8,3	10,6	13,4	52,4	66,7	83,5	14,2	15,0	16,0	18,4	20,7	23,5
2011	47,0	61,6	79,7	3,6	4,4	5,6	8,4	10,7	13,7	52,5	67,0	85,2	14,1	15,0	16,1	18,4	20,7	23,8
2012	47,2	62,0	81,4	3,6	4,5	5,8	8,4	10,8	14,1	52,6	67,4	86,8	14,1	15,0	16,3	18,3	20,8	24,0
2013	47,3	62,4	83,2	3,7	4,6	6,0	8,5	10,9	14,4	52,6	67,7	88,5	14,1	15,0	16,4	18,3	20,8	24,3
2014	47,4	62,9	85,0	3,8	4,7	6,2	8,5	11,0	14,8	52,5	68,0	90,1	14,1	15,1	16,5	18,2	20,8	24,5
2015	47,5	63,3	86,8	3,8	4,8	6,4	8,5	11,1	15,1	52,5	68,3	91,8	14,0	15,1	16,7	18,2	20,8	24,8
2016	47,6	63,7	89,1	3,9	4,9	6,7	8,6	11,2	15,5	52,5	68,6	94,0	14,0	15,1	16,8	18,1	20,8	25,1
2017	47,7	64,1	91,4	4,0	5,1	7,0	8,6	11,3	16,0	52,4	68,9	96,1	14,0	15,1	17,0	18,1	20,8	25,4
2018	47,8	64,5	93,7	4,0	5,2	7,3	8,6	11,4	16,4	52,4	69,2	98,3	13,9	15,1	17,2	18,0	20,8	25,8
2019	47,8	64,9	96,1	4,1	5,3	7,6	8,7	11,5	16,9	52,3	69,4	100,6	13,9	15,1	17,4	17,9	20,8	26,1
2020	47,9	65,3	98,4	4,1	5,4	7,9	8,7	11,6	17,3	52,2	69,7	102,8	13,9	15,1	17,6	17,9	20,8	26,5

SCENARIO GIVEN IN BRACKETS

Table J.4: Energy Indicators - energy indicators

YEAR	ENERGY INDICATORS - INTENSITY																	
	COMMERCIAL ENERGY ENERGY INTENSITY (MJ PER 1985 US$*)									TOTAL ENERGY - COMMERCIAL + TRADITIONAL ENERGY INTENSITY (MJ PER 1985 US$*)								
	RSA			OTHER			ESA			RSA			OTHER			ESA		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
1989	24,6	24,7	24,7	9,0	8,8	8,8	17,1	17,1	17,1	28,6	28,7	28,7	53,7	53,1	53,1	40,7	40,4	40,4
1990	24,7	24,9	24,9	9,2	9,2	9,2	17,2	17,3	17,3	28,7	28,9	28,9	54,8	53,7	53,7	41,2	40,7	40,7
1991	24,7	25,1	25,1	9,6	9,6	9,6	17,5	17,6	17,6	28,8	29,0	29,0	56,1	54,4	54,4	41,9	41,2	41,2
1992	24,8	25,3	25,3	10,0	10,0	10,0	17,7	17,9	17,9	28,9	29,1	29,1	57,4	55,1	55,1	42,6	41,6	41,6
1993	24,9	25,4	25,5	10,4	10,4	10,4	17,9	18,2	18,3	29,0	29,3	29,3	58,7	55,7	55,4	43,2	41,9	41,8
1994	25,0	25,6	25,7	10,8	10,8	10,8	18,2	18,5	18,6	29,1	29,4	29,5	60,0	56,4	55,8	43,9	42,3	42,1
1995	25,0	25,8	25,9	11,2	11,2	11,2	18,4	18,8	18,9	29,1	29,5	29,6	61,3	57,0	56,1	44,6	42,7	42,3
1996	25,2	26,0	26,2	11,6	11,6	11,6	18,7	19,1	19,2	29,2	29,7	29,8	62,1	57,3	56,0	45,0	42,9	42,3
1997	25,3	26,2	26,5	12,0	12,0	12,0	18,9	19,4	19,6	29,3	29,8	29,9	62,9	57,6	55,9	45,4	43,1	42,3
1998	25,4	26,4	26,7	12,4	12,4	12,4	19,2	19,7	19,9	29,4	29,9	30,1	63,6	57,9	55,7	45,8	43,3	42,4
1999	25,6	26,6	27,0	12,9	12,9	12,9	19,5	20,0	20,2	29,5	30,0	30,2	64,4	58,2	55,6	46,2	43,5	42,4
2000	25,7	26,7	27,2	13,3	13,3	13,3	19,7	20,3	20,5	29,5	30,1	30,4	65,1	58,4	55,4	46,6	43,7	42,4
2001	25,8	26,9	27,5	13,7	13,7	13,7	20,0	20,6	20,9	29,6	30,2	30,5	65,8	58,7	55,1	46,9	43,8	42,3
2002	25,9	27,1	27,7	14,1	14,1	14,1	20,2	20,9	21,2	29,6	30,3	30,6	66,5	58,9	54,7	47,3	44,0	42,2
2003	26,0	27,2	28,0	14,5	14,5	14,5	20,5	21,1	21,5	29,7	30,3	30,8	67,2	59,1	54,4	47,7	44,1	42,1
2004	26,1	27,4	28,2	14,9	14,9	14,9	20,7	21,4	21,8	29,7	30,4	30,9	67,9	59,3	54,0	48,0	44,2	42,0
2005	26,1	27,5	28,4	15,3	15,3	15,3	21,0	21,7	22,2	29,7	30,5	31,0	68,5	59,4	53,6	48,3	44,4	41,9
2006	26,2	27,6	28,7	15,7	15,7	15,7	21,2	21,9	22,5	29,7	30,5	31,1	68,9	59,6	53,3	48,5	44,5	41,7
2007	26,3	27,8	28,9	16,2	16,2	16,2	21,5	22,2	22,8	29,8	30,6	31,2	69,2	59,8	52,9	48,7	44,6	41,6
2008	26,4	27,9	28,9	16,6	16,6	16,6	21,7	22,5	23,0	29,8	30,6	31,2	69,6	59,9	52,6	48,8	44,6	41,4
2009	26,5	28,0	29,0	17,0	17,0	17,0	21,9	22,7	23,2	29,8	30,7	31,1	69,9	60,0	52,2	49,0	44,7	41,3
2010	26,6	28,1	29,0	17,4	17,4	17,4	22,2	23,0	23,4	29,8	30,7	31,1	70,2	60,1	51,9	49,1	44,8	41,1
2011	26,7	28,2	29,0	17,8	17,8	17,8	22,4	23,2	23,6	29,8	30,7	31,0	70,4	60,2	51,6	49,3	44,8	40,9
2012	26,8	28,2	29,0	18,2	18,2	18,2	22,7	23,4	23,9	29,8	30,6	31,0	70,7	60,3	51,2	49,4	44,8	40,7
2013	26,8	28,2	29,1	18,6	18,6	18,6	22,9	23,6	24,1	29,7	30,5	30,9	70,9	60,3	50,9	49,5	44,8	40,5
2014	26,8	28,2	29,1	19,0	19,0	19,0	23,1	23,8	24,3	29,7	30,5	30,8	71,1	60,4	50,6	49,5	44,8	40,3
2015	26,8	28,2	29,1	19,4	19,4	19,4	23,3	24,0	24,4	29,6	30,4	30,7	71,3	60,4	50,3	49,6	44,8	40,1
2016	26,8	28,2	29,0	19,9	19,9	19,9	23,5	24,2	24,6	29,5	30,3	30,6	71,5	60,5	49,8	49,6	44,8	39,8
2017	26,8	28,2	29,0	20,3	20,3	20,3	23,7	24,4	24,8	29,4	30,2	30,5	71,7	60,5	49,4	49,7	44,7	39,5
2018	26,8	28,1	29,0	20,7	20,7	20,7	23,8	24,6	25,0	29,3	30,2	30,4	71,8	60,5	48,9	49,7	44,7	39,3
2019	26,7	28,1	29,0	21,1	21,1	21,1	24,0	24,8	25,2	29,2	30,1	30,3	72,0	60,5	48,5	49,7	44,6	39,0
2020	26,7	28,1	28,9	21,5	21,5	21,5	24,2	24,9	25,4	29,2	30,0	30,2	72,1	60,5	48,1	49,7	44,6	38,8

* LOCAL CURRENCY CONVERTED TO US$ AT PREVAILING EXCHANGE RATE AND DEFLATED USING THE US$DEFLATOR FOR 1985.
SCENARIO GIVEN IN BRACKETS

APPENDIX K: Graphical Presentation of Historic and Forecast Total Final Consumption of Commercial Energy in:

SOUTH AFRICA (RSA).

Figure K.1:

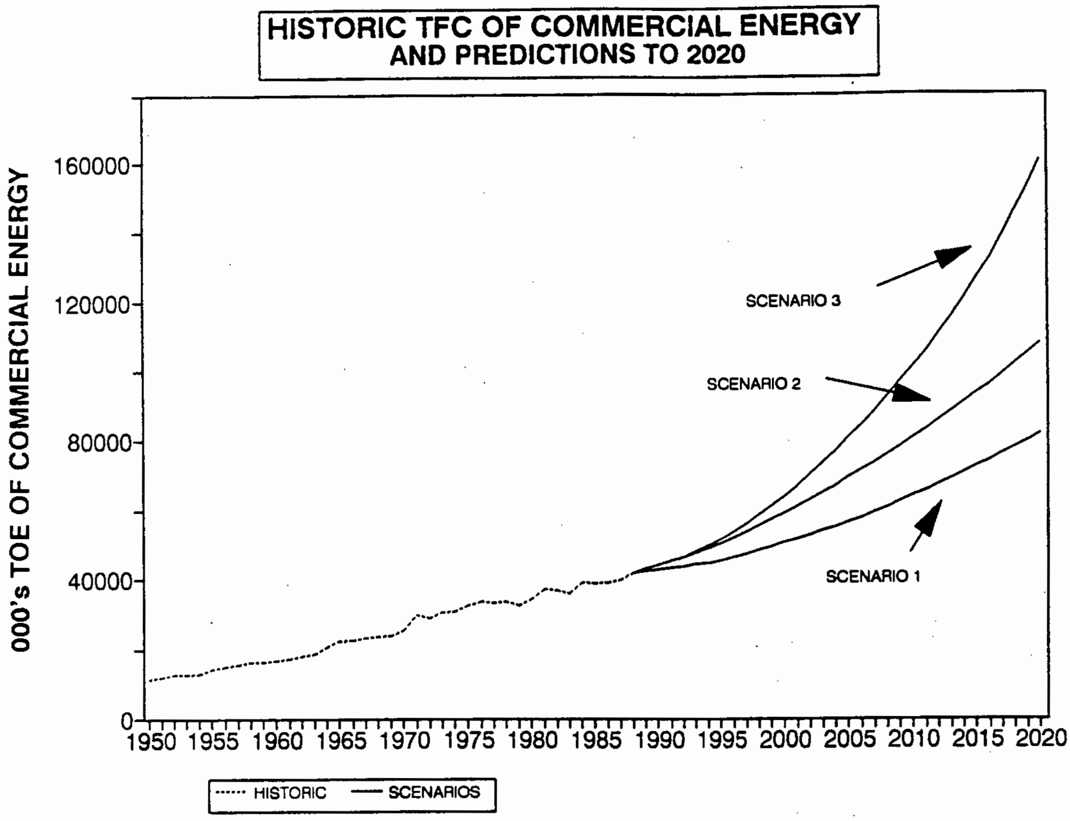


Figure K.2

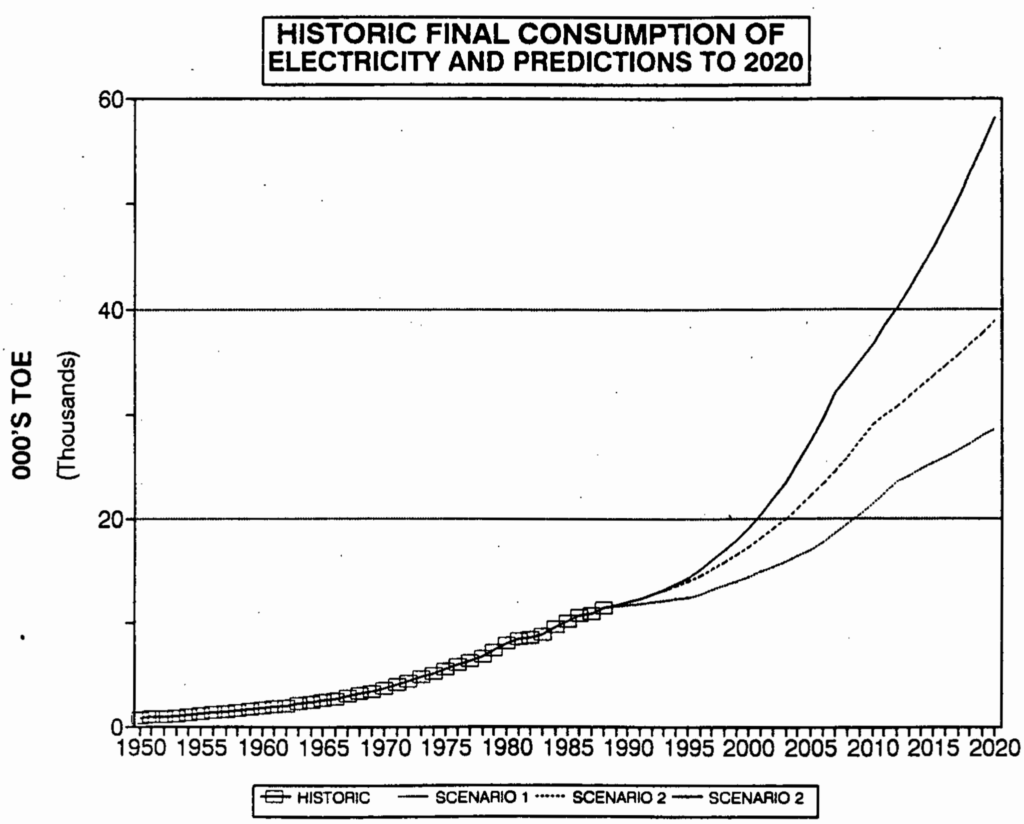


Figure K.3:

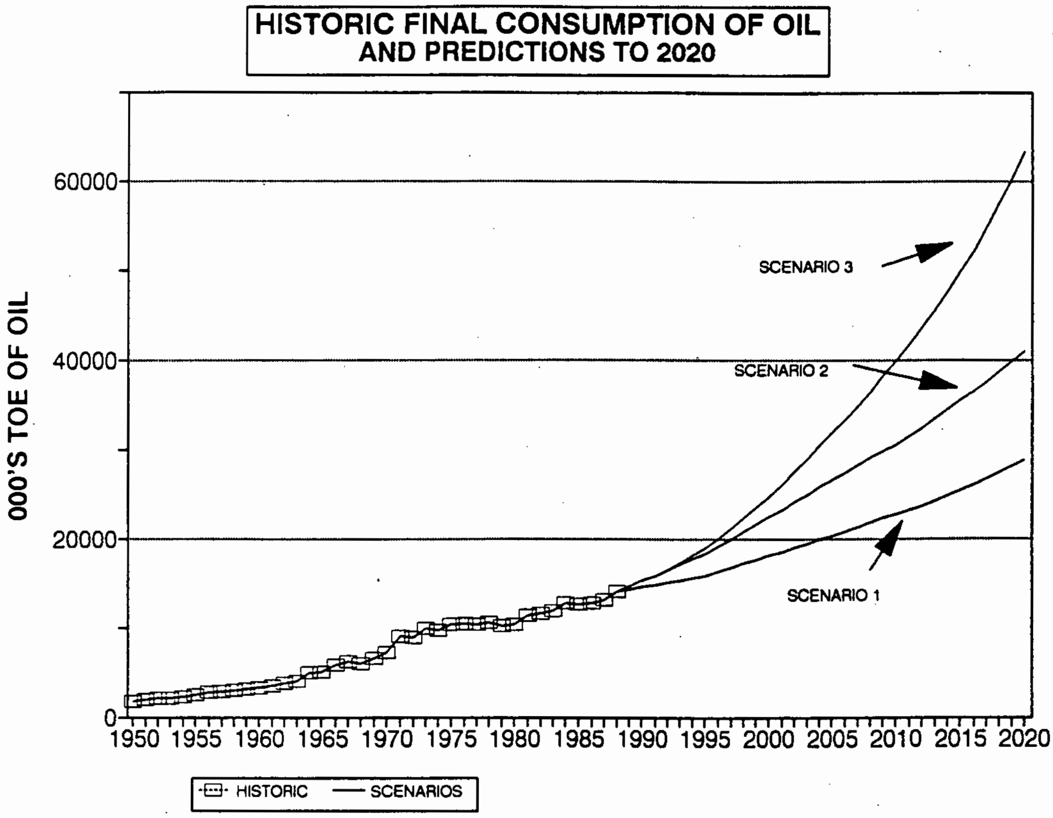


Figure K.4

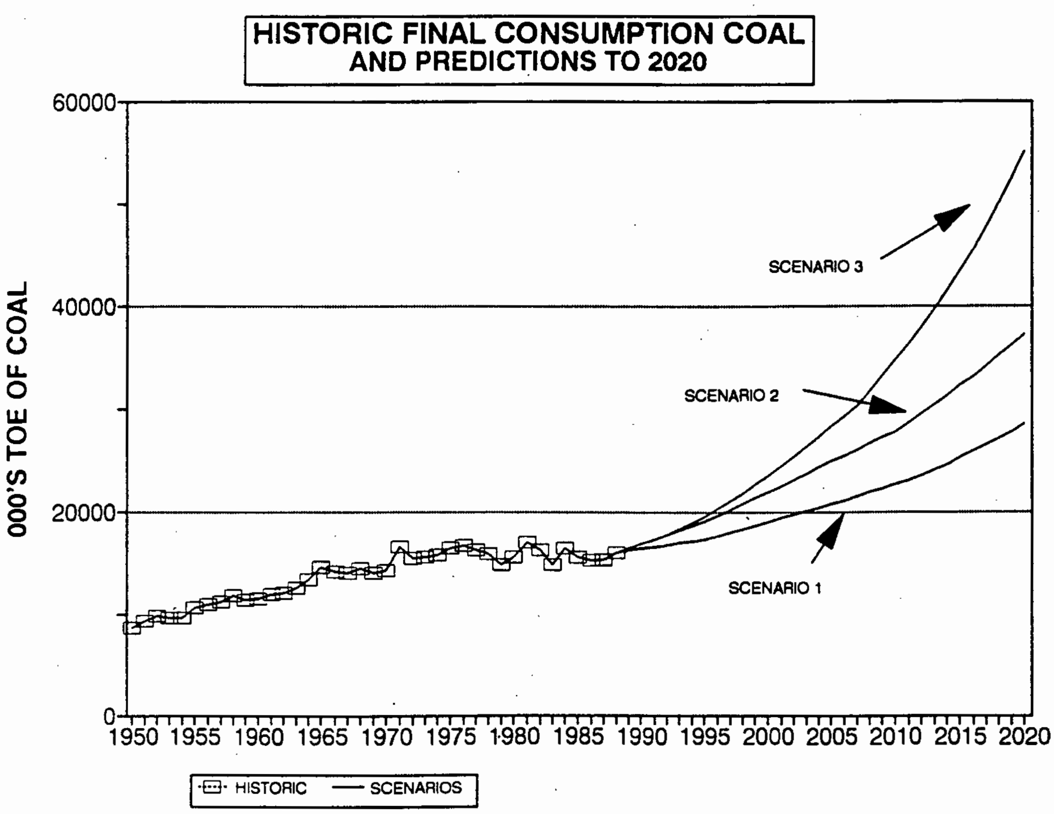


Figure K.5:

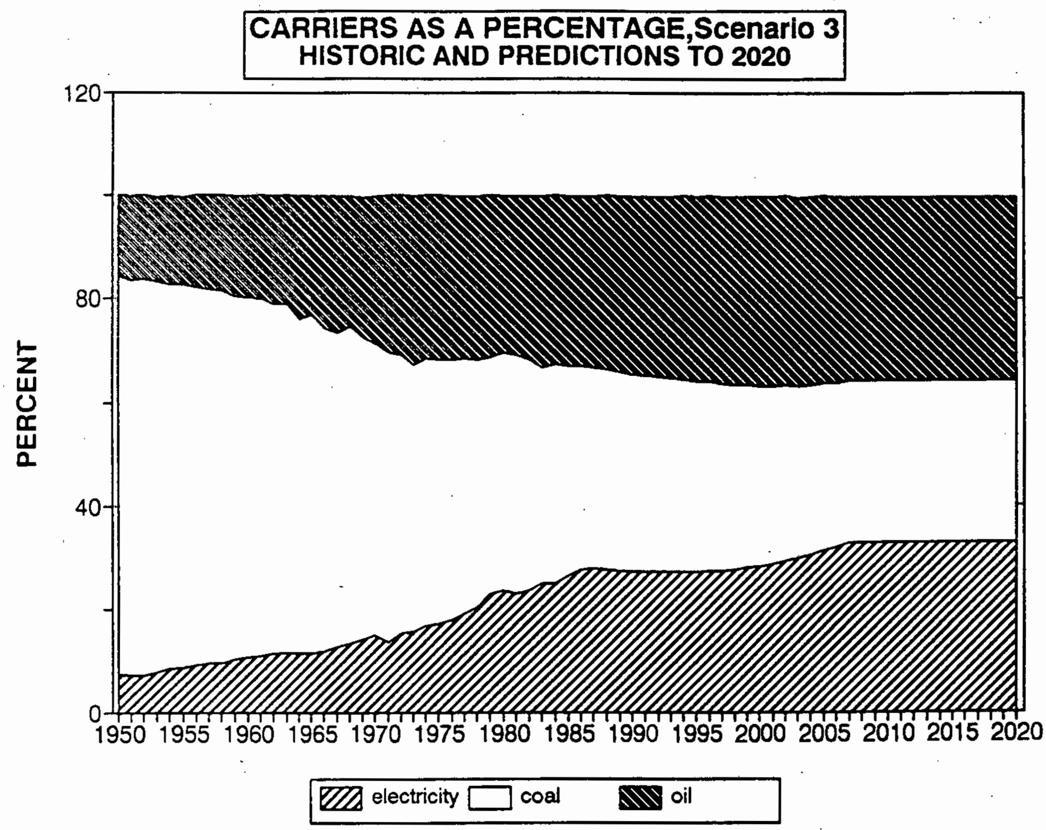
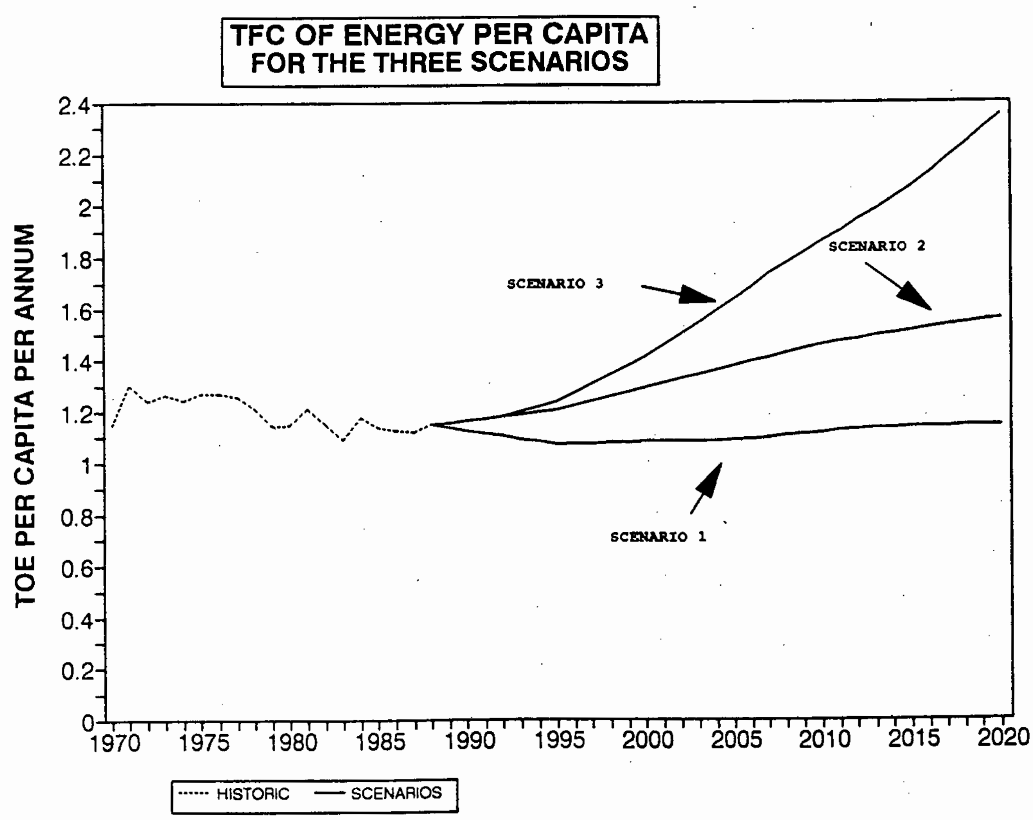


Figure K.6



APPENDIX L: GRAPHICAL PRESENTATION OF HISTORICAL AND FORECAST TFC OF ENERGY (TRADITIONAL & COMMERCIAL) IN:

SOUTH AFRICA (RSA)

Figure L.1:

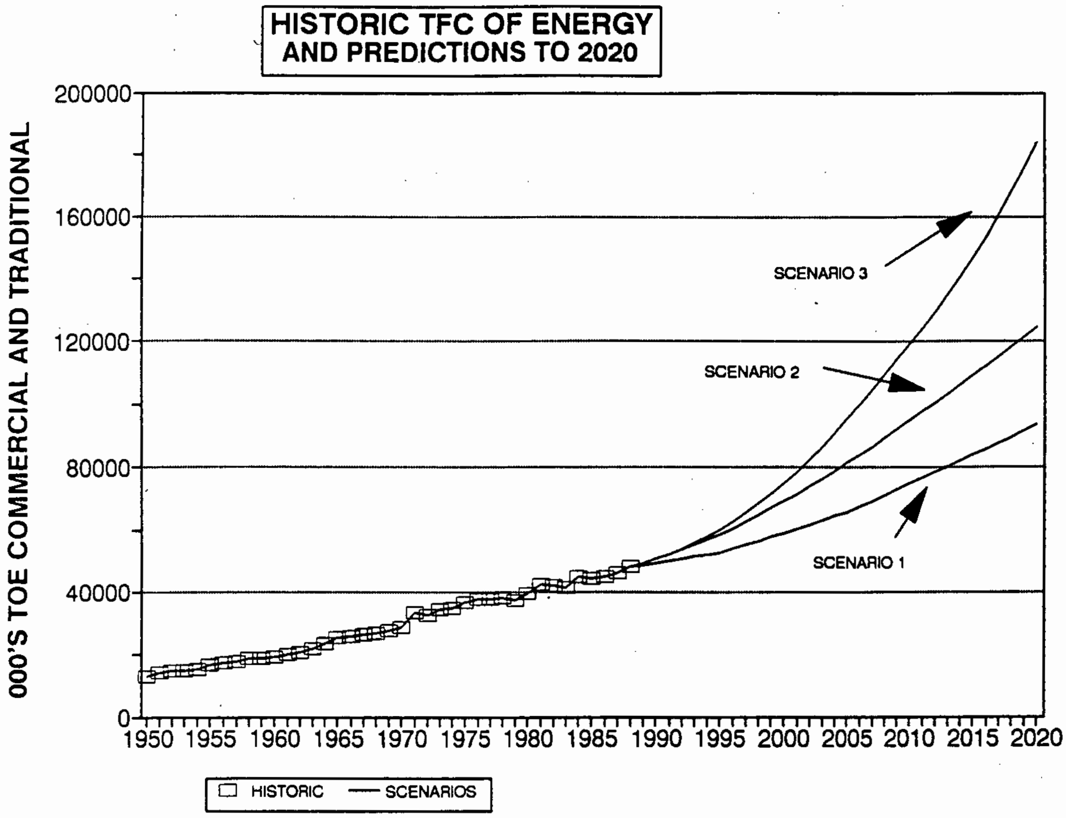


Figure L.2

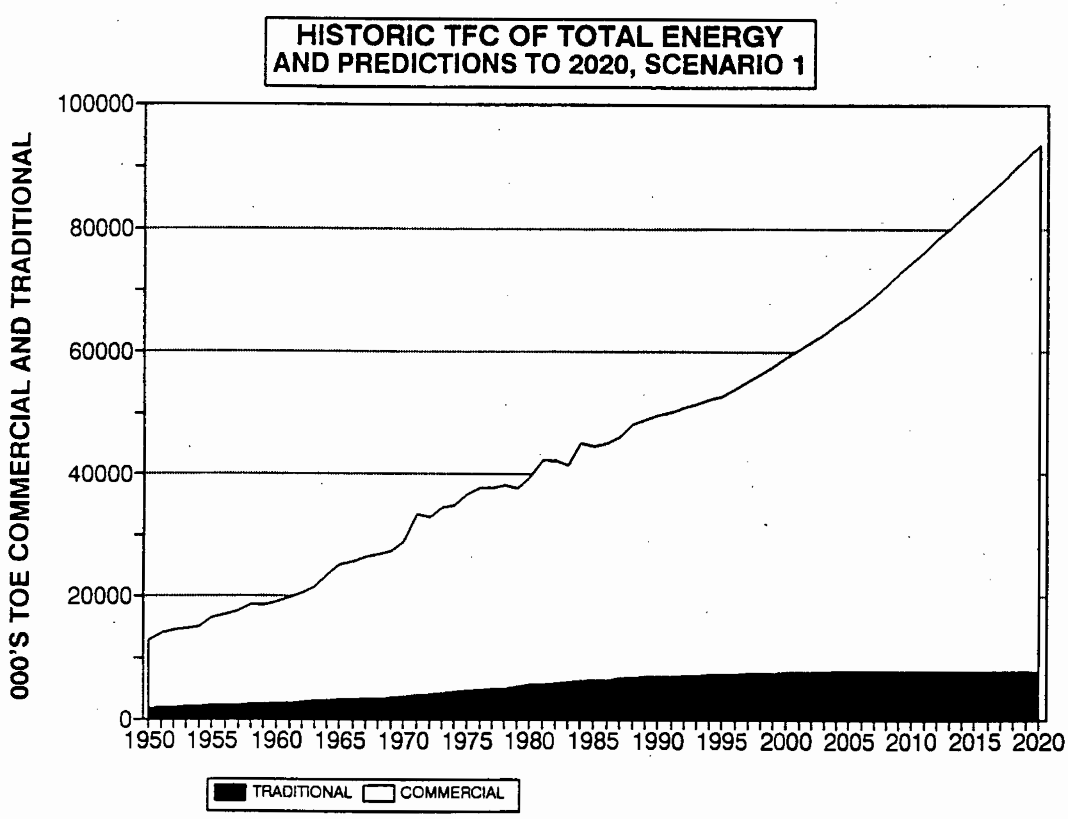


Figure L.3:

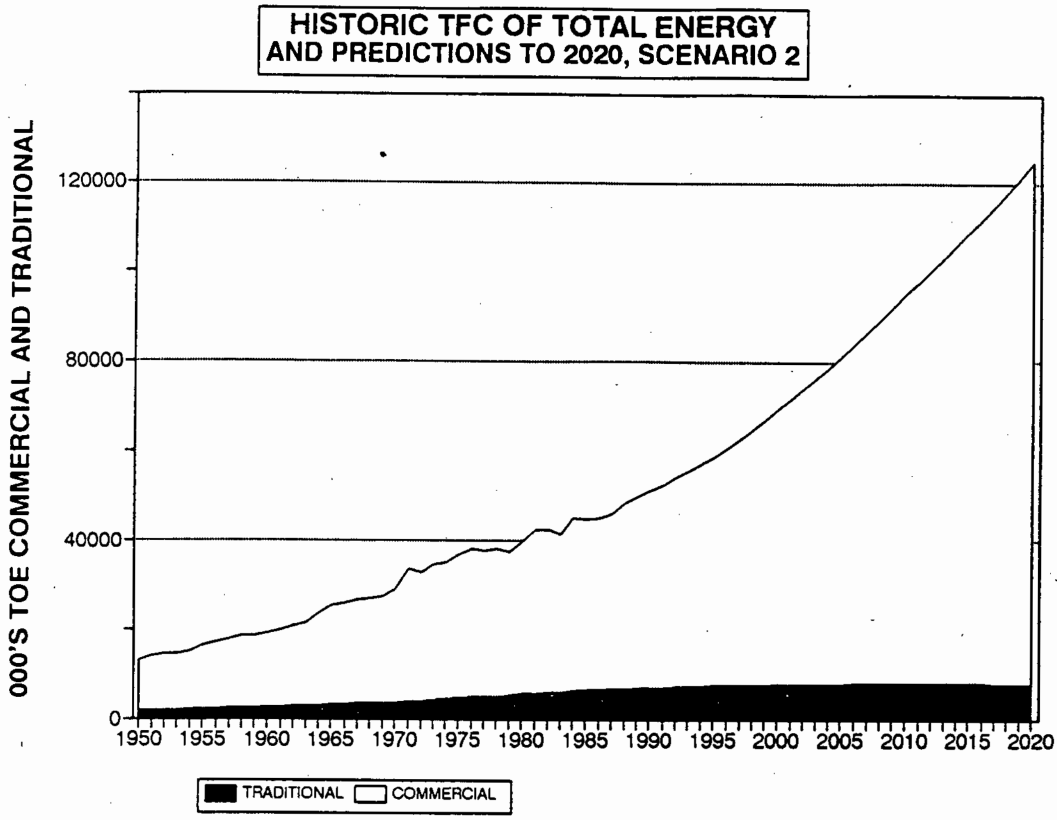
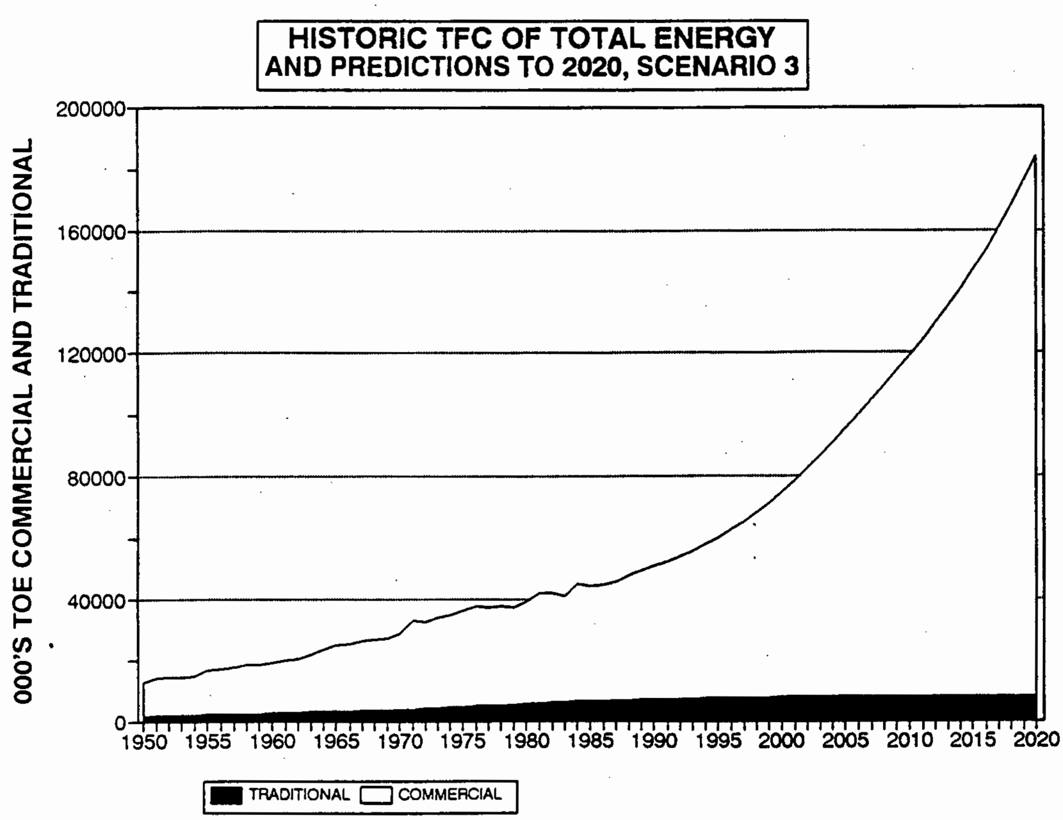


Figure L.4



APPENDIX M: GRAPHICAL PRESENTATION OF FORECAST TFC OF COMMERCIAL ENERGY In THE:

EASTERN AND SOUTHERN AFRICA REGION (Including South Africa)

Figure M.1:

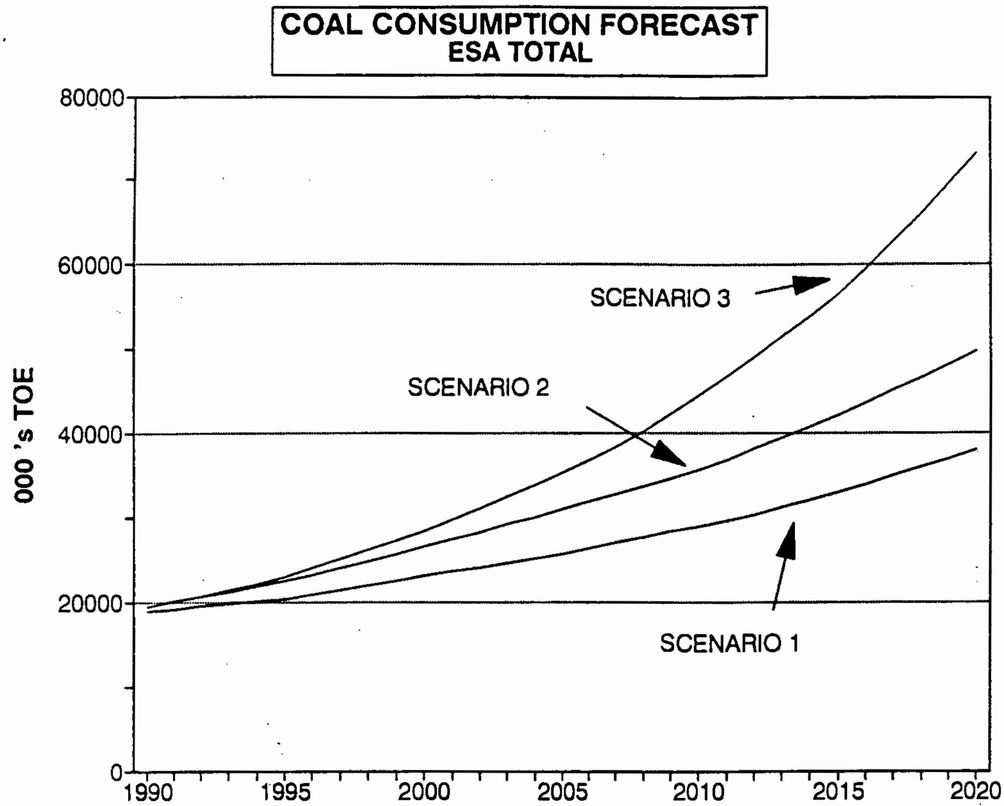


Figure M.2

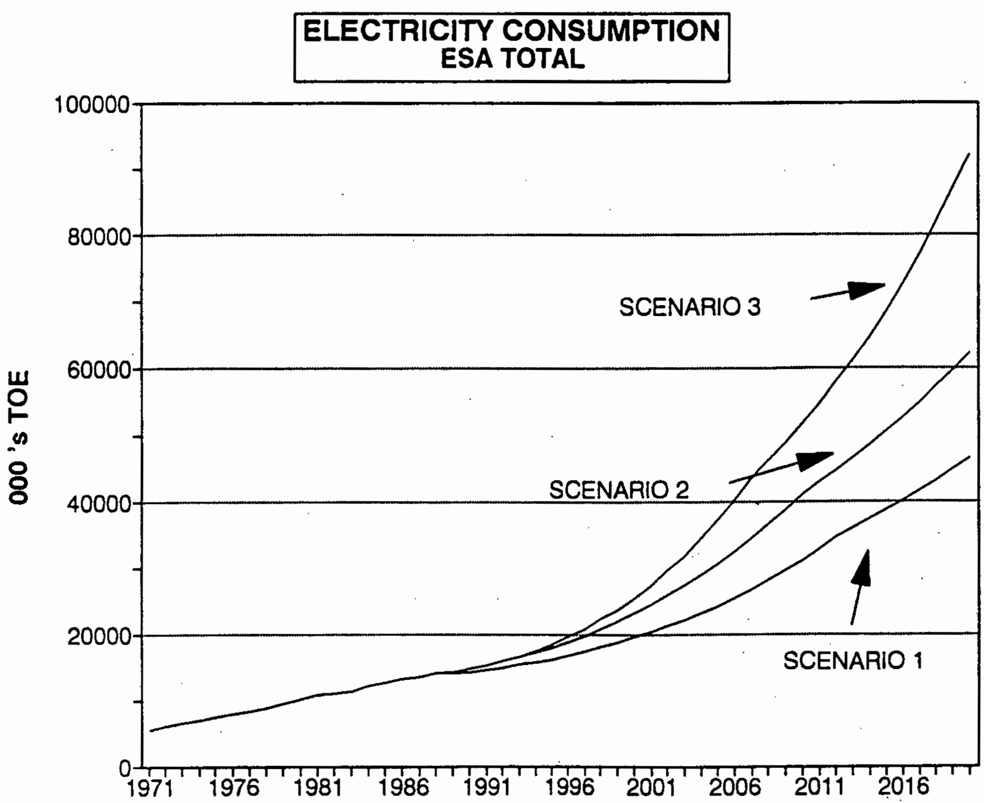


Figure M.3:

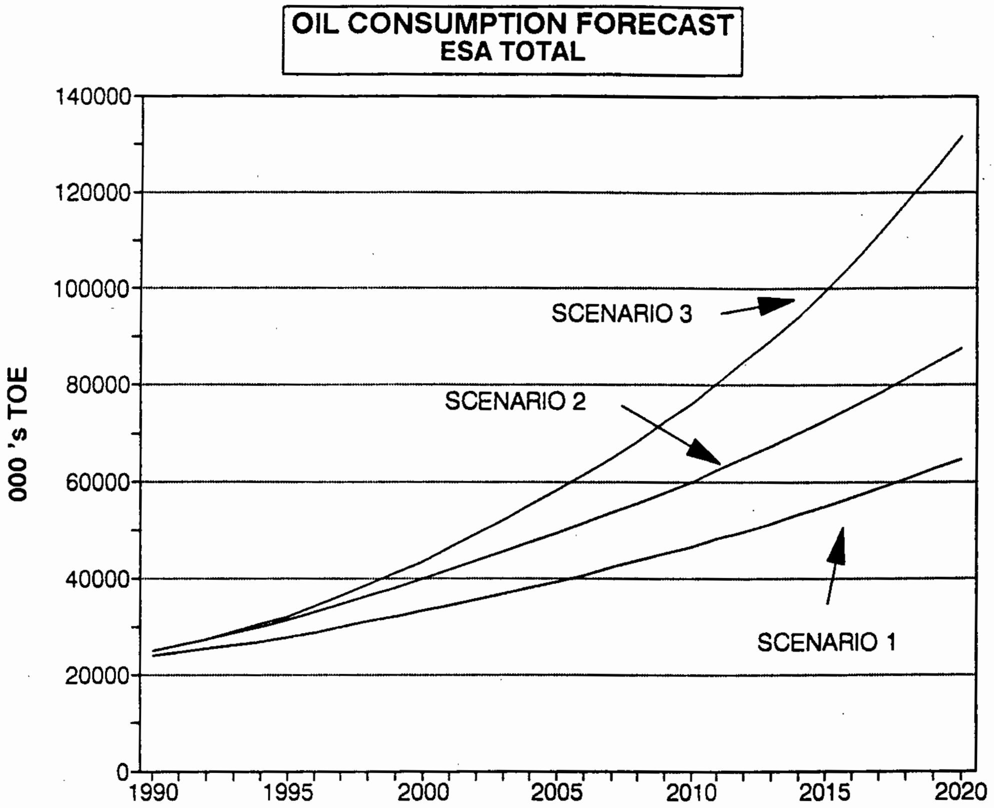


Figure M.4

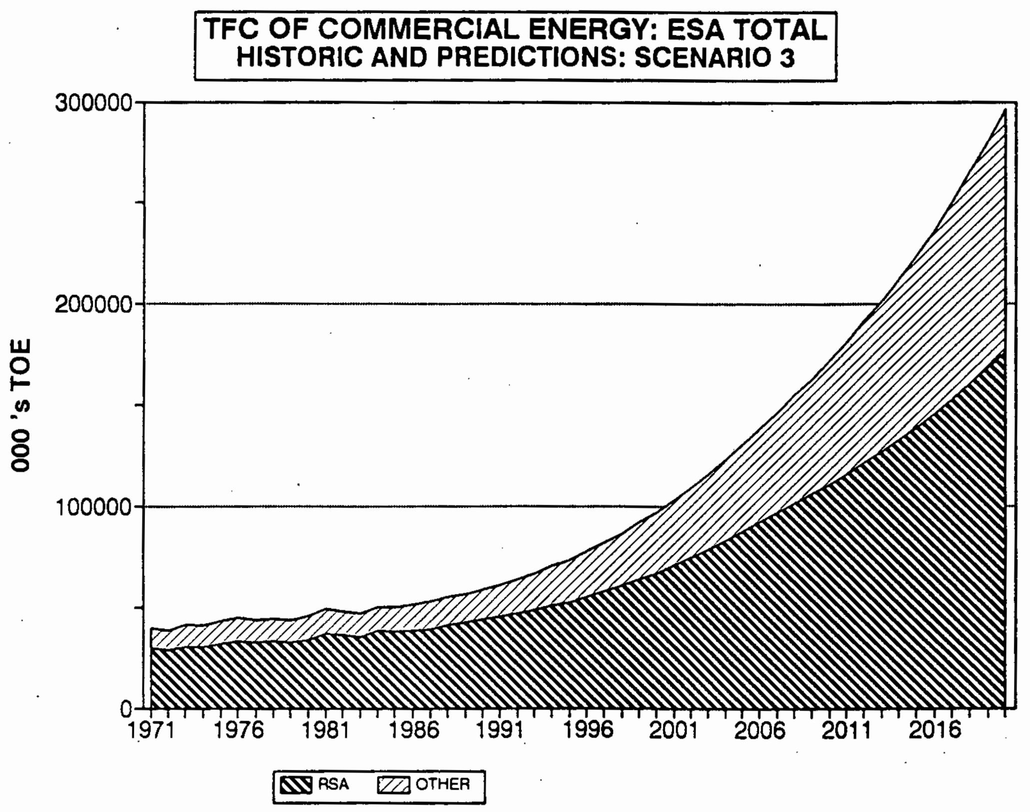


Figure M.5:

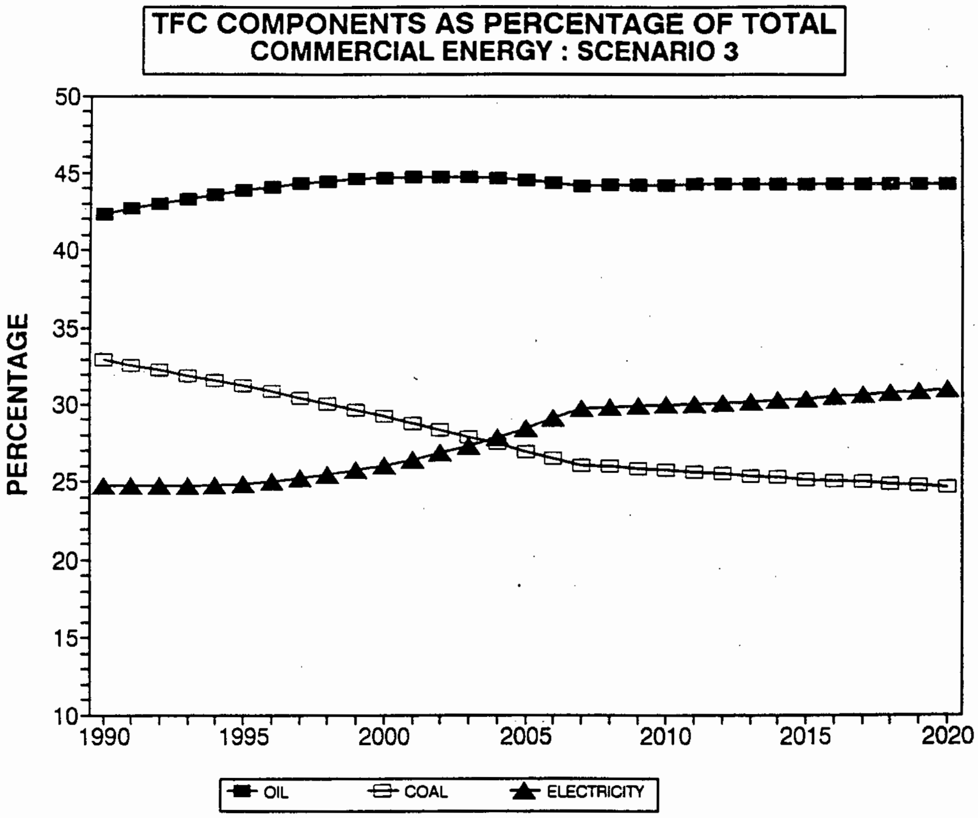
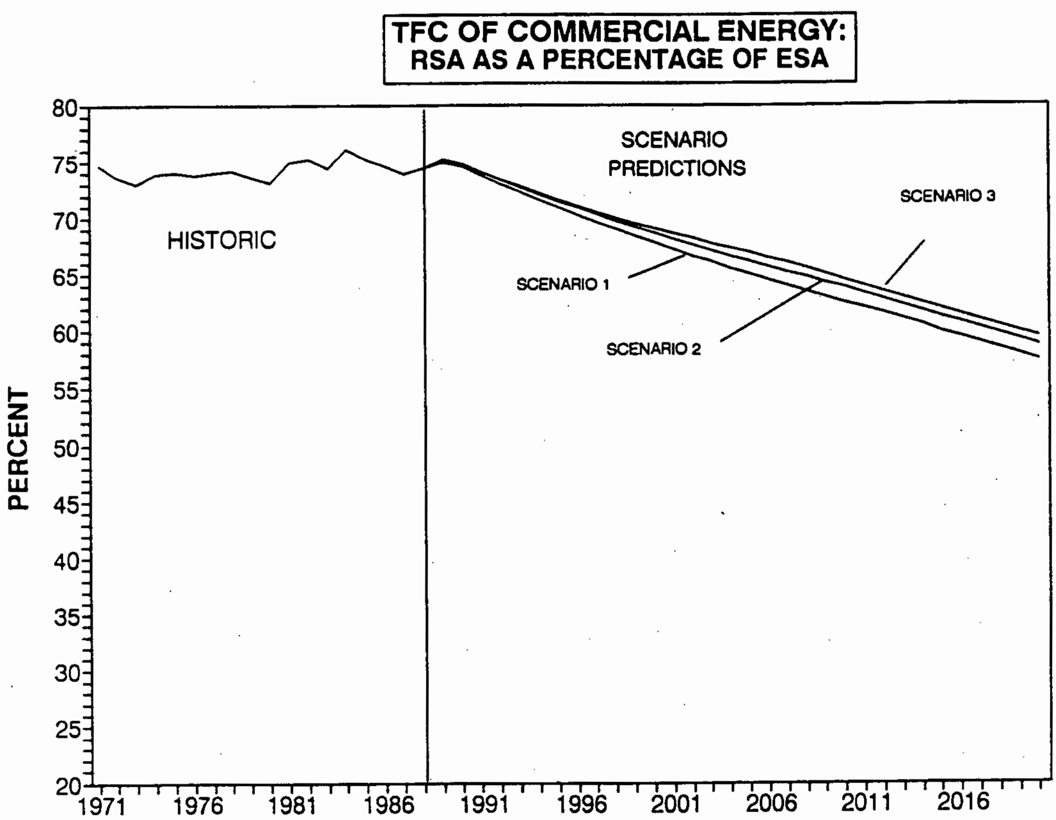


Figure M.6



APPENDIX N: GRAPHICAL PRESENTATION OF HISTORICAL AND FORECAST TFC OF ENERGY (TRADITIONAL & COMMERCIAL) IN THE:

EASTERN AND SOUTHERN AFRICA REGION
(Including South Africa)

Figure N.1:

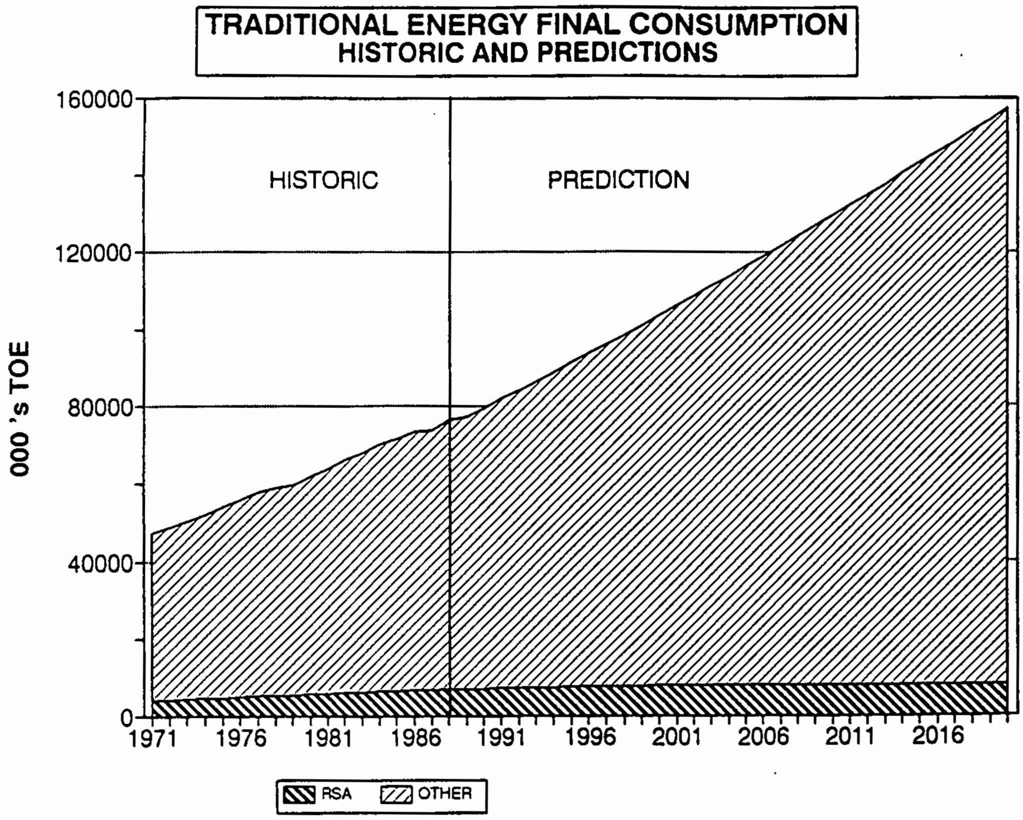


Figure N.2

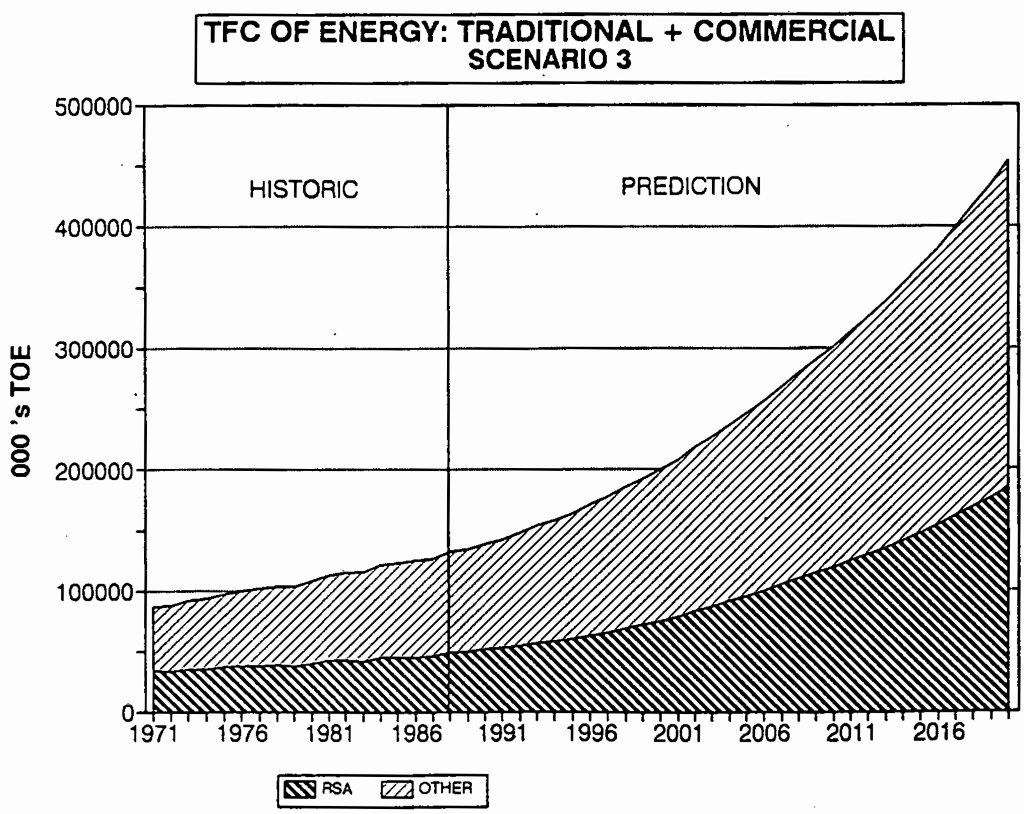


Figure N.3:

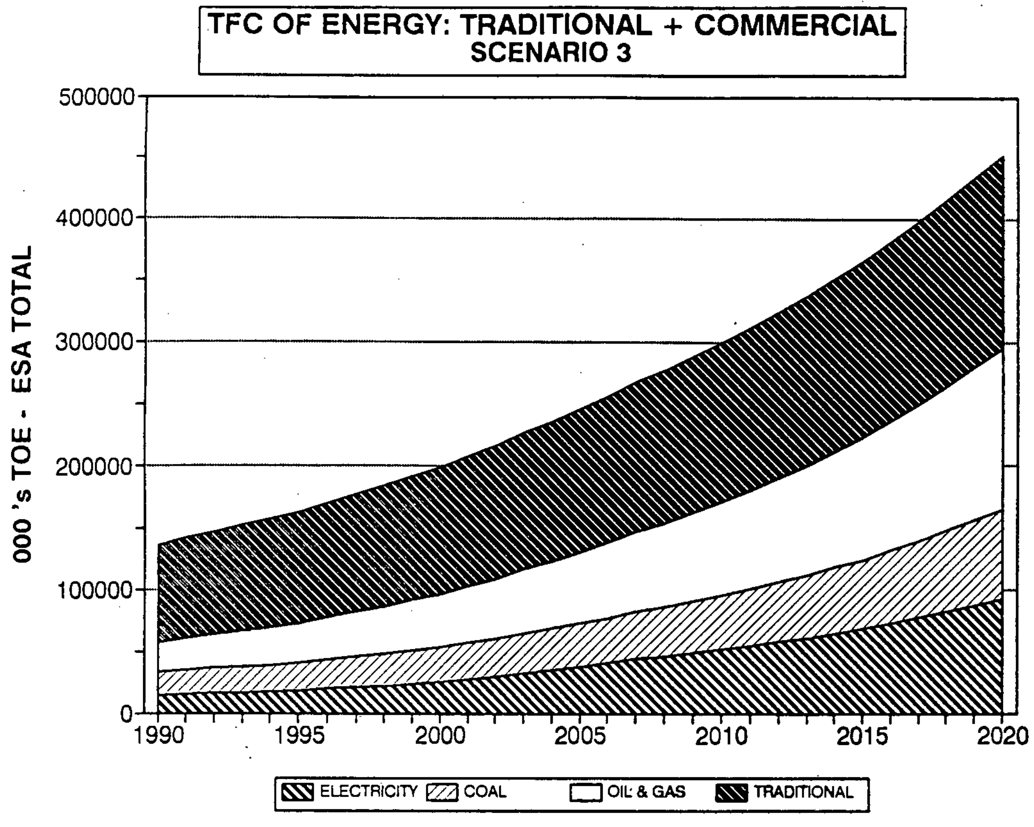


Figure N.4