

REPORT

OF THE

COMMISSION OF INQUIRY

INTO THE

SUPPLY OF ELECTRICITY

IN THE

REPUBLIC OF SOUTH AFRICA

1 OCTOBER 1984

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G.P.-S.

TO THE STATE PRESIDENT OF THE REPUBLIC OF SOUTH AFRICA

We, the undersigned,

W. J. DE VILLIERS



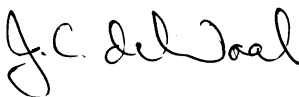
Chairman

J. W. L. DE VILLIERS



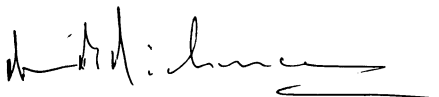
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Member

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Member

D. L. KEYS



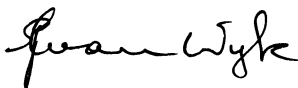
Member

L. F. RIVE



Member

A. J. VAN WYK



Member

J. WILKENS



Member

appointed by you as Chairman and Members of the Commission of Inquiry into the Supply of Electricity in the Republic of South Africa, have the honour to report to you as follows:

INDEX

	<i>Page</i>
INTRODUCTION	1
INVESTIGATION INTO THE TARIFF POLICY AND STRUCTURE FOR THE SUPPLY OF ELECTRICITY	1
INVESTIGATION INTO THE SUPPLY OF ELECTRICITY IN THE REPUBLIC OF SOUTH AFRICA	1
EVIDENCE, REPRESENTATIONS AND COMMENTS	2
EVIDENCE AND PRESENTATIONS	3
GATHERING OF OTHER INFORMATION	3
ANALYSIS OF TERMS OF REFERENCE AND PROCEDURE	3
SUMMARY OF FINDINGS AND CONCLUSIONS	3
CURRENT STRATEGIC POSTURE	3
EVALUATION OF PAST PERFORMANCE	5
EVALUATION OF PRESENT STRATEGY	14
RECOMMENDATIONS	15
MATTERS FALLING BEYOND THE SCOPE OF THIS STUDY OF ESCOM'S STRATEGY	18
EXPRESSION OF THANKS	18
THE COMPLETE STUDY OF ESCOM'S STRATEGY	19
METHOD OF INQUIRY	19
FRAMEWORK FOR THE INQUIRY	19
CURRENT STRATEGIC POSTURE OF ESCOM (PHASE 1)	21
DETERMINATION OF THE NATURE AND EXTENT OF THE ENTERPRISE (STEP 1)	21
INTRODUCTORY DESCRIPTION	21
THE CENTRAL GENERATING UNDERTAKING	23
ESCOM'S DISTRIBUTION UNDERTAKINGS	23
DETERMINATION OF ACTUAL PATTERN OF RESOURCE UTILISATION (STEP 2)	28
DETERMINATION OF BASIS OF COMPETITIVE ADVANTAGES (STEP 3)	30
DETERMINATION OF THE ACTUAL STRATEGIC CRITERIA OF OPTIONS (STEP 4)	32
EFFICIENCY OF KEY PERSONNEL	32
EVALUATION OF ESCOM'S PAST PERFORMANCE (PHASE 2)	34
DEFINING THE PAST PERFORMANCE OF THE UNDERTAKING (STEP 1)	34
BROAD BACKGROUND	34
TECHNICAL AND FINANCIAL PERFORMANCE OVER THE PAST 15 YEARS	34
ELECTRICITY SALES BY THE INTEGRATED ESCOM SYSTEM	36
ELECTRICITY SALES BY DISTRIBUTION UNDERTAKINGS	37
Rand and Orange Free State Undertaking	38
Natal Undertaking	38

	<i>Page</i>
Eastern Transvaal Undertaking.....	39
Cape Western Undertaking.....	40
Cape Northern Undertaking.....	40
Orange River Undertaking.....	41
Cape Eastern Undertaking	41
Border Undertaking	41
THE CENTRAL GENERATING UNDERTAKING	41
Plant in Escom's power stations.....	41
Performance of Escom's coal-fired power stations.....	46
THE NATURE AND EXTENT OF ESCOM'S SYSTEM MAXIMUM DEMAND CURVES	56
CAPITAL INVESTMENT IN THE VARIOUS UNDERTAKINGS	71
Capital investment in Escom as a whole	71
Capital investment in and programme for Escom's power stations	82
ANALYSIS OF THE CONSOLIDATED REVENUE AND EXPENDITURE ACCOUNTS FOR EACH OF THE YEARS FROM 1967 to 1982	98
THE INCREASE IN CERTAIN COST FACTORS AND PRODUCTIVITY PERFORMANCE DURING THE PERIOD 1967-1982	100
ESCOM BALANCE SHEETS FOR THE YEARS 1967-1982	103
Escom loans.....	107
The ratio of equity to total assets.....	109
Effect of Capital Development Fund on tariffs.....	109
Escom's capital/output ratios	117
EVALUATION OF PAST PERFORMANCE (STEP 2).....	121
THE PERIOD 1950-1974	121
THE PERIOD 1974-1982	121
THE COUNTRY'S LONG-TERM ELECTRICITY NEEDS.....	122
The post-war state of the world	123
The influence of the oil crisis on the econometric estimate of electricity consumption.....	125
Historical ratios disturbed by the oil crisis	127
Trends in the demand for electricity in the post-war period.....	130
Trends in the demand for electricity in the post-war period in South Africa and Australia	130
The South African case	134
The selling price of electricity	135
Trends in the South African economy and their influence on electricity consumption.....	137
The period 1946-1973 in the South African economy.....	137
The period 1973-1982	138
Structural changes and restrictive factors in the South African economy.....	140
The historical and future trend of the balance of payments	143
Future growth rate of the South African economy.....	147
Possible future conservation of electricity consumption.....	150
Trends in the growth of electricity sales in South Africa since the sixties and the impact of the energy crisis.....	154

	<i>Page</i>
The Escom long-term forecast	157
The implications of electricity growth rates used for planning.....	163
EVALUATION OF ESCOM'S EXPANSION PROGRAMME	163
Present power station capacity and planning until 1989	163
Increase in capital costs	177
Capital programme of the Central Generating Undertaking	178
The application of improved technology associated with the growth in demand	178
Thermal efficiency and availability	179
Improved high-voltage technique	180
Trends of prices per MW installed and available sent-out rating	180
Escom planning and current power station capacity and power stations to be commissioned before 1989	182
AN EVALUATION OF ESCOM'S PERFORMANCE IN RESPECT OF WORKING COSTS	183
Trends of capital-related costs.....	183
Trends of fuel costs	184
Trends of other expenditure	187
AN EVALUATION OF ESCOM'S GENERAL FINANCING	188
Internal financing	188
Change in the mix of Escom's borrowed capital.....	191
Capital-related costs and their effect on tariffs	191
Escom's financial capacity.....	193
Escom's claim to local capital resources	194
Extent of Escom's internal financing	196
Future potential tariff levels.....	197
Accounts and accounting systems.....	200
Escom's current net asset valuation	201
Determination of Escom's profitability	201
How efficient is Escom.....	201
Escom's reaction	202
EVALUATION OF THE CURRENT ELECTRICITY TARIFFS OF ESCOM	202
Present tariff structure.....	202
Tariffs as a means of achieving the lowest cost per kW.h.....	204
Effects of the broad constraints of the Electricity Act on tariffs	205
Suitability of the current tariff structure.....	208
Savings.....	209
ANALYSIS OF TRENDS AND PAST AND PRESENT BASES FOR SUCCESS IN THE INDUSTRY (STEP 3).....	211
EVALUATION TO DETERMINE WHETHER PAST BASIS OF SUCCESS IS STILL VALID (STEP 4)	212
POTENTIAL EFFECTIVENESS OF PRESENT STRATEGY FOR THE FUTURE (PHASE 3)...	214
EVALUATE POTENTIAL EFFECTIVENESS OF PRESENT STRATEGY FOR THE FUTURE (STEP 1)	214

	Page
ASSESS WHETHER STRATEGY IS CONSISTENT WITH REQUIREMENTS ARISING FROM THE ENVIRONMENT (STEP 2).....	217
REALISTIC ASSESSMENT OF BALANCE BETWEEN AVAILABLE RESOURCES AND REQUIREMENTS OF THE ENVIRONMENT (STEP 3).....	218
ASSESS WHETHER CURRENT STRATEGY IS CONSISTENT INTERNALLY (STEP 4).....	218
ASSESS WHETHER STRATEGY INVOLVES ACCEPTABLE DEGREE OF RISK (STEP 5)	218
DOES THE CURRENT STRATEGY HAVE A REALISTIC TIME PERSPECTIVE (STEP 6)	219
ASSESS WHETHER CURRENT STRATEGY IS FEASIBLE (STEP 7)	220
PLANNING OF FUTURE STRATEGY (PHASE 4)	221
ANALYSING THE ENVIRONMENT WITH EMPHASIS ON POTENTIAL FUTURE DEVELOPMENTS (STEP 1).....	221
CO-ORDINATION OF ACTIVITIES OF THE STATE AND ESCOM.....	221
ESCOM'S CONTROL STRUCTURE.....	221
The establishment of Escom	221
Review by Dr Van der Bijl in 1932	223
Changes during the period 1932-1982 which affect Escom	224
Suitability of the arm's length control system	224
Nationalised industries in the United Kingdom.....	225
Summary of proposals in the United Kingdom.....	226
The fate of the proposals in the United Kingdom	227
The control of the private sector corporations	228
The British system and structure	228
Systems and structures that developed in other countries	229
The two-tier board system.....	230
The evolution of management thinking	230
Analysis of responsibility for various decision-making processes required for Escom	231
Application of the two-tier board system to Escom and change of name	233
Board of Control of the Electricity Supply Corporation (Escor)	233
Composition of the Board of Control of Escor.....	233
Management Board of Escor.....	235
Implications of proposed control structure	235
Energy and electricity saving	236
Energy saving policy	237
Electricity saving policy	237
Tariff policy	237
Electricity price policy	238
THE ANALYSIS OF RESOURCES FOR FUTURE APPLICATION (STEP 2).....	238
FUTURE COMPETITIVE ADVANTAGE (STEP 3)	238
DEVELOPING STRATEGIC GUIDELINES FOR THE FUTURE (STEP 4).....	238
IDENTIFICATION OF POSSIBLE FUTURE PROJECTS (STEP 5)	239
Privatising	240

	<i>Page</i>
ESTABLISH FUTURE PERFORMANCE SPECIFICATIONS (STEP 6)	241
DEFINING THE SCOPE OF THE FUTURE STRATEGY (STEP 7)	241
PROCURING AND ALLOCATING RESOURCES (STEP 8)	241
MATTERS OUTSIDE THE SCOPE OF THE STRATEGY STUDY OF ESCOM	241
Local authorities	241
Electricity Control Board	242
Other sources of energy	242
Nuclear power	242

ANNEXURES

ANNEXURE A: CONSUMER PATTERNS IN DISTRIBUTION UNDERTAKINGS	243
Trends in different consumer sectors	243
Changes in market share of distribution undertakings	245
Differences between features of distribution undertakings	247
Number of consumers of Escom power in distribution undertakings	247
Length of transmission lines in distribution undertakings	247
Total working capital in distribution undertakings	248
Operating costs of the distribution undertakings	248
Operating costs per GW.h sold and per kilometre of network length	248
Total cost to consumers in cents per kW.h sold	249
Trends of electricity sales during period 1967-1982	249
Growth rates of bulk supply in distribution undertakings and years of exceptionally high growth rates	252
Growth rates of sales in industrial sector and years of exceptionally high growth rates	256
Growth rates of sales in mining sector and years of exceptionally high growth rates	256
Growth rates of sales in the traction sector and years of exceptionally high growth rates	256
Growth rate of bulk, retail and domestic sales and prices in c/kW.h	257
ANNEXURE B: ACTUARIAL VALUATION OF FINANCE	282
BIBLIOGRAPHY	284

TABLES

TABLE 1	Information on Escom's distribution undertakings	25
TABLE 2	Information on sales in certain sectors in different undertakings in 1982	27
TABLE 3	Integrated Escom system: Electricity sent out	35
TABLE 4	Average annual increase in the amount of electricity sent out	35
TABLE 5	Integrated Escom System: Electricity sales	36
TABLE 6	Average annual increase in amount of electricity sold by Escom and in the average selling price in cents/kW.h for different periods	36

ANNEXURE A

TABLE 7	7A1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Rand and Orange Free State Undertaking.....	258
	7A2 Data regarding consumption in the various sectors for the period 1967–1982. Rand and Orange Free State Undertaking.....	259
	7A3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1982. Rand and Orange Free State Undertaking	260
	7B1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Natal Undertaking	261
	7B2 Data regarding consumption in the various sectors for the period 1967–1982. Natal Undertaking	262
	7B3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1982. Natal Undertaking.....	263
	7C1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Eastern Transvaal Undertaking	264
	7C2 Data regarding consumption in the various sectors for the period 1967–1982. Eastern Transvaal Undertaking	265
	7C3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1982. Eastern Transvaal Undertaking.....	266
	7D1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Cape Western Undertaking	267
	7D2 Data regarding consumption in the various sectors for the period 1967–1982. Cape Western Undertaking	268
	7D3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1982. Cape Western Undertaking.....	269
	7E1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Cape Northern Undertaking	270
	7E2 Data regarding consumption in the various sectors for the period 1967–1982. Cape Northern Undertaking	271
	7E3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1982. Cape Northern Undertaking.....	272
	7F1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Orange River Undertaking	273
	7F2 Data regarding consumption in the various sectors for the period 1967–1982. Orange River Undertaking	274
	7F3 Data regarding bulk, retail and domestic consumption of electricity for the period 1968–1982. Orange River Undertaking.....	275
	7G1 Data regarding changes in the size of distribution undertakings for the period 1967–1982. Border Undertaking.....	276
	7G2 Data regarding consumption in the various sectors for the period 1967–1982. Border Undertaking.....	277
	7G3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1982. Border Undertaking	278
	7H1 Data regarding changes in the size of distribution undertakings for the period 1967–1980. Cape Eastern Undertaking.....	279
	7H2 Data regarding consumption in the various sectors for the period 1967–1980. Cape Eastern Undertaking.....	280
	7H3 Data regarding bulk, retail and domestic consumption of electricity for the period 1967–1980. Cape Eastern Undertaking	281
TABLE 8	The total consumption and annual growth of consumption in the traction, bulk supply, mining, industrial and domestic sectors	244

	<i>Page</i>
TABLE 9 Percentage of the total GW.h supplied by Escom and used by sectors, average annual growth rate of consumption for certain periods and years of high growth.....	245
TABLE 10 A comparison of the most important features of the distribution undertakings and the changes which took place between 1974 and 1982	246
TABLE 11 Working capital in R000 in the different distribution undertakings per GW.h sold in 1974 and 1982	248
TABLE 12 The total operating costs, excluding electricity purchased, per GW.h sold and per kilometre of network length for the different distribution undertakings in 1974 and 1982	249
TABLE 13 Total costs to consumers in cents per kW.h sold by the different undertakings in 1974 and 1982	249
TABLE 14 Years of exceptionally high growth rate of electricity consumption in certain undertakings	250
TABLE 15 Percentage increase of electricity sales in certain sectors for certain periods in distribution undertakings.....	251
TABLE 16 Years of exceptionally high growth rates of electricity consumption in certain sectors in distribution undertakings.....	253
TABLE 17 GW.h sales, average prices and average annual percentage growth of sales and prices for bulk, retail and domestic sales in the various distribution undertakings	255
TABLE 18 Principal plant installed in coal-fired power stations as at 31 December 1982.....	42
TABLE 19 Principal plant installed in other stations as at 31 December 1982.....	43
TABLE 20 Extension of Escom's generating capacity	44
TABLE 21 Power station operating statistics	47
TABLE 22 Average annual increase in total power output, thermal efficiency, coal cost, total power station capacity and the average load factor for coal-fired power stations during various periods	48
TABLE 23 Power station data	51
TABLE 24 General thermal efficiency and percentage availability of capacity for various power stations	53
TABLE 25 The effect of steam pressure, temperature and size of units on percentage thermal efficiency and availability	54
TABLE 26 Escom system's maximum weekly demand for the period 1980-1983	58
TABLE 27 An analysis of data about large power users, excluding municipalities.....	69
TABLE 28 Analysis of certain aspects of Escom's balance sheet	73
TABLE 29 Analysis of assets: R(000) per million kW.h sold and marginal R(000) per million kW.h sold.....	77
TABLE 30 Escom's total fixed assets in operation and under construction, fixed assets in operation and under construction in the Central Generating Undertaking and in each of the distribution undertakings as at 31 December of each year for the period 1972-1982	79
TABLE 31 Capital investment in coal-fired power stations in operation up to 31 December 1982.....	83

	<i>Page</i>
TABLE 32 Capital investment in gas-turbine, pumped-storage and hydro-stations in operation as at 31 December 1982	85
TABLE 33 Power station capacity installed in various years.....	90
TABLE 34 Estimated capital investment in power stations under construction at the time of commercial commissioning.....	91
TABLE 35 Information on power stations decommissioned since 1970	93
TABLE 36 Capital investment in certain coal-fired power stations when they were brought into commercial operation—R000	94
TABLE 37 Historical and estimated future capital cost per MW of capacity installed in coal-fired power stations, including Koeberg (Nuclear)	96
TABLE 38 Statement of Escom's revenue from electricity supplies.....	99
TABLE 39 Summary of Escom's consolidated revenue and expenditure account for the period 1967–1982.....	101
TABLE 40 Trends of cost escalation during the periods 1967–1974, 1974–1982 and 1967–1982.....	102
TABLE 41 Number of employees per MW of capacity and per kW.h of sales	102
TABLE 42 Average salaries and wages—period 1972–1982.....	103
TABLE 43 Recompiled balance sheet of Escom as at 31 December—Assets	104
TABLE 44 Recompiled balance sheet of Escom as at 31 December—Capital structure	106
TABLE 45 Foreign loans as a percentage of total loans raised each year.....	107
TABLE 46 Loan periods (expressed as percentage)—period to expiry of term	108
TABLE 47 Average life of all loans	108
TABLE 48 Capital Development Fund	109
TABLE 49 Ratio between equity and net book value of total assets	110
TABLE 50 Effect of Capital Development Fund on electricity tariffs	110
TABLE 51 Revenue retained	112
TABLE 52 Source and application of funds	113
TABLE 53 Application of tariff revenue retained.....	115
TABLE 54 Information on tariff revenue retained	118
TABLE 55 Capital/output ratio.....	120
TABLE 56 Margin between average annual growth rates of electricity consumption and the economy	131
TABLE 57 A number of important parameters with regard to exports for the period 1952–1982.....	145
TABLE 58 Growth in electricity consumption minus growth in economy of various countries for different periods	151
TABLE 59 Trends in electricity sales by Escom to sectors of the South African economy during the period 1967–1982	154
TABLE 60 Escom planning of present power station capacity and power stations that must be commissioned before 1990 and power stations decommissioned before 1990	165
TABLE 61 Total power station capacity, estimated peak demand and calculated excessive capacity	167

	<i>Page</i>
TABLE 62 Excess sent-out capacity available for different possible future cases, excess assigned sent-out capacity available.....	176
TABLE 63 Changes in Escom's income and expenditure accounts during the years 1973 and 1982	183
TABLE 64 Data of coal burnt in Escom power stations during period 1970–1982.....	186
TABLE 65 Increase in Capital Development Fund.....	189
TABLE 66 Average annual percentage increase in electricity unit prices	189
TABLE 67 Balance sheets of Escom as at 31 December 1973 and 31 December 1982...	189
TABLE 68 Change in mix of Escom's borrowed capital during the years 1973 and 1982	191
TABLE 69 Annual addition to Escom's fixed assets for period 1973–1982 with forecasts up to 1987	192
TABLE 70 Current values of Escom assets and liabilities	193
TABLE 71 Relative debt per MW installed of different electricity utilities at latest balance sheet date	194
TABLE 72 Escom's income cover to satisfy loan commitments	194
TABLE 73 Escom's capital expenditure as a percentage of gross domestic saving less depreciation	195
TABLE 74 Single income coverage for creditors: load growth 7 % per annum: interest rate 14 % per annum	199
TABLE 75 Single income coverage for creditors: load growth 5 % per annum: interest rate 14 % per annum	200
TABLE 76 Increase in debt per MW—installed between 1973 and 1983.....	200
TABLE 77 Escalated capital requirements for load growth at 7 % and 5 % per annum including interest during construction.....	216
TABLE 78 Estimated average electricity tariffs and annual rate of tariff increase for load growth rates of 7 % and 5 % per annum for Escom	216
TABLE 79 An analysis of the responsibility for decision-making processes required for Escom	232

GRAPHS

GRAPH 1 Percentage availability of groups of power stations, the effect of steam pressure and temperature and size of units on percentage availability	55
GRAPH 2 The correlation between the annual average percentage availability and the gross capacity factor	57
GRAPH 3 Weekly maximum demand 1980–1983	62
GRAPH 4 Escom integrated system—1982.....	63
GRAPH 5 Escom integrated system—1980.....	64
GRAPH 6 Escom integrated system—1981	65
GRAPH 7 Escom integrated system—1982.....	66
GRAPH 8 Escom integrated system—1983.....	67
GRAPH 9 Time-of-day tariff structure of Electricité de France	70
GRAPH 10 Escom system load duration graph for 1982.....	72
GRAPH 11 Escom's total capital expenditure 1983–1987	75

	<i>Page</i>
GRAPH 12 Total Escom capital expenditure 1983–1987	81
GRAPH 13 Typical coal-fired power station	87
GRAPH 14 Power station expansion programme: main activities from 1976 to 1988	88
GRAPH 15 Power station expansion programme: main activities from 1982–1994....	89
GRAPH 16 Capital cost per MW	97
GRAPH 17 Projections of peak demand in summer—comparison of annual 10 year forecasts (USA and adjacent)	126
GRAPH 18 Energy consumption/GDP ratios in various industrial countries	128
GRAPH 19 Average electricity prices for industrial, commercial and domestic consumer categories in Australia for 1970–1982 (at 1981 money values)	133
GRAPH 20 Average selling price of Escom electricity for the period 1960–1983	136
GRAPH 21 Growth pattern of gross domestic product.....	148
GRAPH 22 Gross domestic product—regression fittings	149
GRAPH 23 Trends with regard to electricity consumption and gross domestic product	153
GRAPH 24 Real GDP, total net energy and electric energy consumption in RSA since 1950	159
GRAPH 25 Comparison of actual versus forecasted electricity consumption in RSA with forecasts made at the end of various years.....	160
GRAPH 26 Performance of power stations	171
GRAPH 27 Escom's annual borrowings on a 5 % and 7 % growth rate basis	198

PART 1

1. INTRODUCTION

With the discovery of diamonds in South Africa leading to the switching on of the first electric street lights in Kimberley in 1882, electricity was first introduced into South Africa on a commercial basis. In South Africa, as elsewhere, various municipalities took the initiative in supplying electricity: Kimberley in 1890, Johannesburg in 1891, Pretoria in 1892, Cape Town in 1895, Durban in 1897, East London in 1899, Bloemfontein in 1900 and Port Elizabeth in 1906.

The discovery of gold on the Witwatersrand in 1886 and the developments in gold-mining methods precipitated the use of electricity on a more extensive scale, and the need for a more economical system of generating electricity lent strength to the idea of a central supplier of electricity. That concept eventually culminated in the establishment of the Victoria Falls Power Co. Ltd. (VFP) in 1906 (registered in Southern Rhodesia on 17 October). It was originally intended that the VFP should supply the mines and industries on the Witwatersrand with power generated at the Victoria Falls in Rhodesia. This scheme was, however, abandoned mainly for financial and technical reasons, and the VFP resorted to the use of coal-fired power stations for the supply of electricity. Thus commenced an era marked by the use of South Africa's coal as a source of energy, a process which continued on an ever-increasing scale after the establishment of Escom on 1 March 1923. Escom took over the VFP with effect from 1 July 1948, in terms of an agreement which heralded a period of growth during which Escom was established as a central supplier of electricity for South Africa, with a country-wide transmission grid. As will emerge from the report, the growth and development of Escom during the post-war period may be divided into two phases, namely the post-war period up to approximately 1972/3, and a second period up to approximately 1982/3.

2. INVESTIGATION INTO THE TARIFF POLICY AND TARIFF STRUCTURE FOR THE SUPPLY OF ELECTRICITY

The effect that the increase in electricity tariffs had had on the cost structure and competitiveness of the South African economy over a number of years prompted the Minister of Economic Affairs to request the Board of Trade and Industries on 7 March 1977 to inquire into and report on the suitability of the tariff policy and structure applicable to the supply of electricity in South Africa. This inquiry culminated in Report No. 1889 of the Board of Trade and Industries completed on 11 December 1978.

3. INVESTIGATION INTO THE SUPPLY OF ELECTRICITY IN THE REPUBLIC OF SOUTH AFRICA

The Commission of Inquiry into the supply of electricity in the Republic of South Africa was constituted as follows by Government Notice 1076 of 20 May 1983, read with Proclamation 79 of 1983 and published in *Government Gazette* 8718 of 20 May 1983:

"APPOINTMENT OF COMMISSION OF INQUIRY INTO THE SUPPLY OF ELECTRICITY IN THE REPUBLIC OF SOUTH AFRICA

It is hereby notified for general information that the State President has been pleased to appoint Dr Willem Johannes de Villiers a member and Chairman and the following persons members of a commission of inquiry into the supply of electricity in the Republic of South Africa:

Dr J. W. L. de Villiers.

Mr L. F. Rive.

Mr D. L. Keys.

Mr A. B. Dickman.

Mr A. J. van Wyk.

Mr J. Wilkens.

Mr J. C. de Waal.

The Commission's terms of reference are as follows:

To inquire into and report on all aspects of the supply of electricity in the Republic of South Africa with special reference to—

- (a) the responsibility and functions in regard to the supply of electricity of government, including local authorities, vis-à-vis the responsibility and functions of the private sector in this regard;

- (b) the principles applicable to the supply of electricity and policies in this regard;
- (c) the effectiveness of existing legislation relating to the supply of electricity;
- (d) the structure and functions of existing institutions involved in the supply of electricity in the Republic of South Africa;
- (e) the cost effectiveness of such institutions, including the policy followed in the acquisition of raw materials;
- (f) the impact of capital formation, price determination, methods of financing and the existing tariff structure on the financial policy of the country with special reference to inflation, economic growth, the creation of infrastructure and decentralisation;
- (g) the functions and responsibilities of members of the Electricity Supply Commission and of the Electricity Control Board; and
- (h) any other matter concerning the supply of electricity, including matters submitted for investigation to the Commission of Inquiry by the Electricity Supply Commission."

Adv. P. J. T. Oosthuizen, a member of Escom's Management who was appointed as Secretary of the Commission of Inquiry, was seconded by Escom to the Commission for the duration of the inquiry.

Messrs L. F. Rive and J. Wilkens were also members of the Electricity Supply Commission at the time of their appointment as members of the Commission of Inquiry.

Mr Rive resigned as member of the Electricity Supply Commission, while Mr J. Wilkens withdrew from participation in the affairs of the Electricity Supply Commission for the duration of the inquiry. By virtue of their business ties with the Electricity Supply Commission, Messrs D. L. Keys and J. C. de Waal declined to participate in those parts of the inquiry, weighing of evidence, discussions and findings relating to the procurement function of the Electricity Supply Commission.

4. EVIDENCE, REPRESENTATIONS AND COMMENTS

By Notice 548 of 1983, published in *Government Gazette* 8819 of 22 July 1983, the Commission of Inquiry invited interested persons and organisations to submit comments and/or representations to the Commission in connection with any matter falling within the Commission's terms of reference. Similar notices were published in Rapport and the Sunday Times of Sunday, 24 July 1983. The following organisations/institutions/persons made submissions to the Commission of Inquiry:

AECI Ltd.

Afrikaanse Handelsinstituut, Association of Chambers of Commerce of South Africa, The South African Federated Chamber of Industries, and Steel and Engineering Industries Federation of South Africa.

Association of Municipal Electricity Undertakings of South Africa, and The Institute of Municipal Treasurers and Accountants (SA).

Alusaf (Pty) Ltd.

Bankovs.

Distrikslandbou-unie van Amersfoort.

Dundee Chemical Co. Ltd.

Durban, City of.

Prof. R. K. Dutkiewicz, Director of Energy Research, University of Cape Town.

Electrical Contractors Association (SA).

Electricity Control Board.

Electricity Supply Commission.

Ferro Alloy Producers Association.

Cape Town, City of: Town Clerk and City Electrical Engineer.

Prof. W. D. Hamman, University of Stellenbosch Business Management School.

Mr O. C. Harrison, Tenants' Representative.

ISCOR.

Johannesburg, City of.

Chamber of Mines of SA.

Prof. B. Kantor, University of Cape Town.

Mr D. J. Malan, Member of the Electricity Supply Commission.

Municipality of Molteno.

Onderberg Boere-unie, Malelane.

Pietermaritzburg, City of.

Res Nova (Pty) Ltd.

Richards Bay Minerals.

Roodepoot, City of.

Dr P. J. Smit and Thabazimbi Distrikslandbou-unie.

Municipality of Sterkstroom.

Regional Development Advisory Committee: Eastern Cape Region (Region D).

S.A. Landbou-unie.

Technikon Pretoria.

Verenigde Munisipale Bestuur.

Vereniging van Munisipale Elektriesiteitsondernemings van Suid-Afrika.

Vorster, Van der Westhuizen and Partners, Consulting Engineers.

Dr J. L. Wallis, Department of Economics, Rhodes University.

Council for Scientific and Industrial Research.

Julius Yodaiken Associates, Consulting Electrical Engineers.

5. EVIDENCE AND PRESENTATIONS

With a few exceptions, evidence by the foregoing organisations/institutions/persons was also presented to the Commission of Inquiry orally, with explanations where necessary.

6. GATHERING OF OTHER INFORMATION

In addition to the preceding sources of information, the Commission of Inquiry also obtained information locally and abroad from the sources given in the bibliography. Escom lent its active co-operation, providing a great deal of information, some of which had been published previously and may be regarded as public knowledge.

7. ANALYSIS OF TERMS OF REFERENCE AND PROCEDURE

The Commission of Inquiry held its first meeting in Pretoria on Wednesday, 29 June 1983. After analysing its terms of reference and since Escom is the principal supplier of electricity consumed in South Africa, the Commission decided to confine its inquiry to an in-depth study of Escom's strategy. Mindful of the possible effects of its findings on monetary policy as well as on financial and other planning, the Commission resolved to complete its inquiry as speedily as possible. This consideration and the uncertainty about constitutional developments, precluded an in-depth investigation of certain matters, as will emerge from the Report.

8. SUMMARY OF FINDINGS AND CONCLUSIONS

8.1 Current strategic posture (pp. 21 to 33 of the Report).

Up to the mid-seventies, Escom progressed rapidly as the central electricity supply organisation and planner of future electricity requirements, enjoying the benefits of continuous growth in the demand for electricity and the application of improved technology. Since then, the unremitting high inflation rate and the high costs of financing, the decline in cost benefits of technological progress, the stabilising of the country's basic electricity infrastructure, the increasing expenditure on the prevention of environmental pollution, and the expected slump in the demand for electricity have combined to create problems that have had a radical effect on Escom's performance.

An analysis of Escom's consolidated revenue and expenditure account for each year from 1967 to 1982 reveals that the price of electricity per kilowatt hour increased at a relatively low average rate of 3,1 % per annum for the period 1967 to 1974, and thereafter at an average rate of 19,3 % per annum. Escom's total kilowatt hour sales increased by an average of 10,19 % per annum between 1967 and 1974, and thereafter by an average of 7,83 % per annum up to 1982.

The average annual load factor of the coal-fired power stations diminished from 65,9 % during the first five years of the sixties to 62,5 % for the period 1975–1980, and to 59,8 % for the period 1980 to 1982.

Escom improved the thermal efficiency of all its coal-fired power stations from 18,2 % in 1950 to 30,5 % in 1982, but the rate at which thermal efficiency could be improved has decreased since 1970. Although thermal efficiency was improved by an average of 0,9 % per annum during the seventies, this served to lower the average annual increase in the price of coal but only fractionally. During the period 1970–1974, the average annual increase in the price of coal was 6,6 %, escalating sharply to 19 % for the period 1974–1982.

The combined availability of all Escom's coal-fired power stations dropped from 82,3 % in 1973 to 73,1 % in 1982. An analysis indicates that, as steam pressure and temperature as well as the size of sets were increased, the average thermal efficiency increased from 18,5 % for the smaller sets with lower pressure and temperature, to 33,9 % for the 600 MW sets with higher pressure and temperature. However, at the same time, the availability of the various sets dropped from 87,1 % for the older lower-pressure sets to 66,8 % for the 600 MW high pressure sets, taking the results into account up to the end of 1982. If these trends were to continue, the level of availability of all the coal-fired power stations combined could drop to as low as 70 %. Low annual availability necessitates a higher gross rating factor to keep the probability of load losses within acceptable limits. The achievement of a total availability of 80 % in the future would make a considerable difference to Escom's required generating capacity. In the USA and West Germany, the problem of low availability of high-capacity sets has in fact been solved to a large extent by certain suppliers of electricity, so that they are now able to rely on high availability.

Escom's estimated capital expenditure for the supply of the country's future electricity needs amounts to R27 000 000 000 in current rand values for the period 1983–1987. (UNLESS OTHERWISE STATED, CURRENT RAND VALUES ARE QUOTED THROUGHOUT THIS SUMMARY AND THE REPORT.)

The figure quoted above includes works under construction as at 31 December 1982.

During the period 1967–1974, income from electricity sales increased by 13,6 % per annum, operating costs by 14,5 % per annum, loan charges by 12,6 % per annum and contributions to funds by 16,1 % per annum, although Escom's electricity sales during this period showed an annual increase of 10,2 %. However, during the ensuing period up to 1982, while electricity sales increased by an average of 7,8 % per annum, income from electricity sales increased by 28,6 % per annum, operating costs by 28,0 % per annum, loan charges by 25,6 % per annum and contributions to funds by 42,4 % per annum. As a result of this last increase, the tariff increase pattern characteristic of the period 1967–1974 was subsequently totally disrupted.

During the period 1967–1982, the installed power station capacity increased at a higher average annual growth rate than did electricity sales, while the average annual rate of increase in the total number of employees was lower than the growth rate of electricity sales. The decrease in the total number of employees per GW.h of electricity sold indicates that, in total terms, Escom's labour productivity improved by an average of 21 % during the period mentioned. Between 1972 and 1982, however, the labour productivity of power station employees declined by an average of 24 % notwithstanding the economies of scale.

Works under construction increased at an average growth rate of 40,9 % per annum during the period 1974 to 1982, from R323 200 000 in 1974 to R5 016 000 000 in 1982.

During the period 1974–1982, net borrowed capital increased by an average of 25,4 % per annum, outstanding loans by 25,3 % per annum, Escom stock held by Escom itself (in its funds) by 28,4 % per annum, and Escom stock held externally by 23,3 % per annum. Import financing facilities, which were introduced only later, increased at an average rate of 64,1 % per annum between 1974 and 1982, while the Capital Development Fund, which was established in 1972, grew at an average rate of 64,1 % during the period 1974–1982.

The average ratio of equity to total assets of Escom increased from 6,5 % in 1960 to 12,8 % in 1974, and, since 1974, has increased to 28 % in 1982. The marginal ratio increased from 16,6 % in 1974 to 30,1 % in 1977, and, after further increases, began to drop in 1981 to 30,8 % in 1982.

Allocations to the Capital Development Fund contributed 10,1 % to the electricity tariffs during 1975, and, following further increases (up to as much as 32,5 % during 1979), amounted to 29,1 % in 1982.

The contribution made by tariff income to capital expenditure rose from 22,0 % in 1975 to 48,6 % in 1979, before dropping to 38,1 % in 1982.

Because Escom is not a profit-making concern, the relative efficiency of application of capital may be determined by examining Escom's capital/output ratio. This is done by dividing the capital investment as at 31 December of a particular year by the total income for that year. However, owing to inflation and the increase in capital invested in works under construction, this approach in the Escom case does not provide a suitable norm.

8.2 Evaluation of past performance (pp. 34 to 213 of the Report).

During the period 1950-1974, the average growth rate of Escom's electricity sales was 8,81 % per annum, while the average growth rate of the selling price amounted to 3,87 % per annum. Escom's assigned sent-out rating increased at an average annual growth rate of 8,9 %, from 1 290 MW in 1950 to 10 002 MW in 1974. Escom's policy of providing an abundant supply of electricity cheaply and reliably where and when demanded was implemented very successfully during this period. Escom's share in the total national electricity sales rose from 77,1 % in 1967 to 85,9 % in 1974.

During the period 1974-1982, the average annual growth rate of Escom's electricity sales was 7,83 %, and the average annual growth rate of the selling price 19,3 %. The assigned sent-out rating increased at an average annual growth rate of 9,4 %, from 10 002 MW in 1974 to 20 523 MW in 1982. The principal factors that played a role in the rapidly rising selling price trend were the considerable increase in the price of coal, sharply escalating inflation and interest rates, wage increases, slower improvement in thermal efficiency combined with a decline in the availability of generating sets, a sharp increase in capital costs for new power stations, as well as larger contributions to the Capital Development Fund.

Escom's annual capital expenditure increased from R642 million in 1976 to R2 732 million in 1983, and a further increase is foreseen for a number of years to come.

Escom's share in the total electricity sales in South Africa rose to 93,6 % in 1982; this means that Escom dominates the electricity supply industry.

The basis of success over the period 1950 to 1974 and the limiting factors during the period 1974 to 1982 suggest that particular attention ought to be devoted to the country's long-term electricity requirements, the efficiency of Escom's generating capacity expansion programme, the application of technology, capital costs, operating costs, financing and electricity tariffs.

***Long-term electricity requirements* (pp. 122 to 163 of the Report).**

Escom's forecast of future electricity requirements has far-reaching implications in the event of either an inadequate generating capacity to meet actual demand or, conversely, the provision of superfluous capacity prematurely.

Estimates are an important prerequisite to planning, and in the electricity supply industry where design, procurement, establishment and commissioning may take from eight to twelve years, the forecast of electricity consumption is of cardinal importance.

Escom's forecast, which is based on the econometric approach, projects electricity consumption growth rates of 7,48 % in 1983, which will drop to 6,41 % in 2005 (October 1983 forecast), and 7 % in 1983, which will drop to 6 % in 2005 (May-June 1984 forecast). The Commission of Inquiry foresees electricity consumption growth rates as low as 5 %.

The difference between the capital expenditure based on the estimate of 7 % and that based on 5 % is considerable, and could amount to R105 000 million between 1983 and 2003.

Historical trends in the economy's growth rate and the increasing share of electricity in the energy consumption pattern are taken into account in the econometric method of forecasting long-term electricity requirements.

During the second half of the seventies, however, it was found in various countries that the econometric method of forecasting electricity loads had become unreliable. The reasons for this may be sought in the consequences of the oil crisis.

The oil crisis of 1973 precipitated a new era in the world economy, and radically influenced the electricity supply industry.

The world economy had been characterised during the sixties and seventies by high economic growth rates, high industrial growth rates, even an excessive growth in industrial capacity, diminishing real oil and electricity prices, and a one-to-one ratio between the growth rate of the economy and that of energy consumption, while electricity consumption had exhibited a higher growth rate than had the economy.

Relatively low inflation rates had prevailed, although these rates had begun to escalate more rapidly during the late sixties and early seventies.

High employment levels had been attained, and all these circumstances combined promoted a spirit of optimism, confidence in the future and expectations of a high standard of living.

Increases in the price of oil resulted in the oil crisis of 1973. Between 1973 and 1981, the price of oil increased tenfold, while the prices of other fuels and electricity increased fourfold.

The oil crisis of 1973 thus caused a *discontinuity* in the world's post-war economic growth pattern, in effect dividing it into two phases, and radically changed a number of circumstances and factors that determined and gauged the prosperity of the Western industrial countries.

During the period 1973–1981, the OECD countries fared as follows, in comparison with the post-war period up to 1973:

- ☆ Economic growth rates dropped to less than half, and industrial growth rates to a mere 36 % of what they had been during the preceding period.
- ☆ Unemployment rose sharply, to reach new record peaks.
- ☆ The inflation rates of most countries escalated sharply during the second half of the seventies and, in the case of certain countries were brought under control only during the eighties, after stringent monetary and fiscal measures and a strict energy policy had been implemented.
- ☆ World trade showed a sharp decline.
- ☆ The sharp increases in the price of oil and other energy resources served as strong incentives to more efficient utilisation and conservation of energy. Strict conservation measures were implemented in most countries.
- ☆ The energy policy, together with monetary and fiscal policies, became an integral part of the overall economic policy and helped various countries to cope fairly well during the crisis years.
- ☆ Between 1973 and 1982, energy consumption per unit of the total real gross domestic product decreased by 16 % in the OECD countries and by almost 23 % in America.
- ☆ While the ratio between the growth rates of energy consumption and the economy had been one-to-one prior to 1973, the OECD countries saw it drop to 0,1 to 1 in the subsequent period as a result of conservation measures.
- ☆ The price of electricity rose sharply in most countries.
- ☆ Historically, the growth rate of electricity consumption in the OECD countries has been approximately 2 % higher than that of the economic growth rate. Since the onset of the oil crisis, however, this margin has *narrowed* in most countries, and in certain countries even *disappeared*.

These changed circumstances disrupted the econometric basis for forecasting the long-term growth rate of electricity consumption, altered the "forecast-and-build" approach of the electricity supply industry and, in a large part of America, led to an *actual reduction* of 32 % in the 1974 load forecast for 1981, this is the equivalent of 200 power stations of 1 000 MW each, each costing \$3 000 million. New methods are now being employed in various cases for estimating long-term electricity requirements in the electricity supply industry.

Energy consumption in South Africa and Australia did not follow the same trend as that of the electricity supply industries of other countries, thanks to their ample and cheap coal and energy resources, and the consequent relatively low electricity prices which prevailed during the energy crisis.

Both these countries expanded their high energy intensive industries, which were established on internal raw materials, to a considerable degree, and turned the economic opportunities created by the energy crisis to their own advantage.

Before to the oil crisis, South African trends in the economic growth rate and the rate of increase in electricity sales had followed the same pattern as had those in the OECD countries and Australia, but they subsequently took a diametrically opposite course.

Oil prices did not have an immediate dramatic effect on electricity prices in South Africa, as had the shock increases of 1973 and 1974 in the OECD countries.

This fact, against the background of the low electricity prices prior to the oil crisis, also proved to be one of the effective strategic advantages experienced by South Africa in the early seventies, especially in the mineral and metal refining industries.

In the period preceding 1973, the real selling price of electricity in South Africa had decreased at a steady rate, but between 1975 and 1978 it rose sharply; thereafter it fell briefly, but since 1981 has again risen.

While electricity changed almost immediately from a particularly cheap to a much more expensive energy resource in most Western countries after 1973, the price of electricity began to rise sharply in South Africa only after 1976. In this respect, the effects of the energy crisis on the South African economy were temporarily delayed.

The South African economy is, however, closely linked to international long-term economic trends, and although the Republic was able to ward off the consequences of the oil crisis for a while, there are now strong indications that world circumstances will play a larger role in South Africa's economic prospects.

In the late sixties, low mining costs per ton of ore extracted, low electricity tariffs, relatively low transport costs and a low inflation rate, combined with a slow rate of increase in electricity tariffs, afforded South Africa a favourable competitive position on the world's mineral and metal market. During the late sixties and early seventies, the South African ferrous-alloys and smelting industries were greatly expanded, and the Richards Bay and Saldanha Bay harbours were constructed for the mass export of coal and iron-ore.

Although the oil crisis precipitated a totally new economic climate throughout the world, the following factors were *instrumental* in keeping South Africa's average annual economic growth rate at a level of 3,2 % during the period 1973–1982, as compared with 2,3 % in the OECD countries:

- ☆ The rise in the gold price, direct and through its secondary effects,
- ☆ the growing export of high energy content materials such as ferro-alloys, aluminium, steel and coal, which increased from 20 % of all exports, excluding gold, in 1973 to 40 % in 1982,
- ☆ the fact that there was no real growth in imports, mainly as a result of the import substitution policy and Sasol's growing influence.

The growth rate of approximately 1 % per annum higher than that of the OECD countries, achieved by South Africa between 1973 and 1982, was maintained notwithstanding that—

- ☆ the industrial growth rate of the OECD countries dropped to 2 % per annum and the growth rate of the Republic's exports to 1,9 % per annum during the period 1973–1982, and that
- ☆ South African exports as a percentage of the gross domestic product had declined since 1960 from approximately 35 % to approximately 30 % in 1973 and to 25 % in 1982.

Brisk consumer spending, arising from, *inter alia*, sharply increasing black wages and ready credit facilities, as well as high levels of government spending, contributed to the relatively high economic growth rate of approximately 3,2 % per annum for the period 1973–1982.

During this period, inflation rates were particularly high, electricity and railway tariffs, and mining costs per ton of ore extracted rose sharply, all combining to *change* South Africa's strong competitive position of the sixties and early seventies to a *relatively weaker position on the world market* in the early eighties.

While the Republic's inflation rate continued unabated at a level of more than 14 % per annum during 1981, 1982 and the major part of 1983, the inflation rates of South Africa's trade associates dropped to one half and one third of this figure.

Since 1980 the exchange rate of the rand to the dollar has declined sharply.

The years that succeeded 1973 were also characterised by a number of *structural changes*, which are expected to have an influence on the future South African economic growth rates:

- ☆ During the fifties and the sixties, foreign capital in the form of direct equity investments, flowed into the private sector, but to the public sectors during the seventies as loan capital.
- ☆ During the period 1977–1982, R2 897 million flowed out of the country: R5 178 million flowed out of the private sector and R2 281 million flowed into the public sector.
- ☆ Of the total net investment for the period 1971–1980,
 - 67,2 % was invested in public authorities and public corporations, of which
 - 22,8 % was invested in public corporations alone.

This investment also contributed to the percentage of the Republic's total fixed capital investment in the public corporations being increased from 4,0 % in 1955 to 6,9 % in 1970 and 14,8 % in 1982.

- ☆ The efficiency of application of additional capital for the period 1973–1982 was less than 60 % of that of approximately *the same amount* of additional capital over the preceding twenty-seven years. Converting an ill-advised or excessive capital investment into one which yields proper returns is difficult, and may take years; occasionally it cannot be rectified at all. It may therefore take years to improve a poor capital/output ratio.

When one takes into account the whole of the circumstances in the South African economy, the investment patterns, the inefficiency of application of capital and labour, and the complete change precipitated in the world economy by the energy crisis, the key question is whether South Africa has not now also reached a post-oil crisis long-term growth phase marked by a low economic growth rate of between 2,5 % and 3,5 % per annum, after exclusion of the cyclical fluctuations. This is the conclusion reached by the Commission of Inquiry.

When the effect of the economic growth rate on the growth rate of electricity sales is determined, the margin between these two growth rates becomes the key issue. Other countries have attained a fair measure of success in the saving of energy and, in particular, of electricity. The success or failure of these attempts at saving have had a considerable effect on the margin mentioned. If only a fair amount of success could be achieved with a savings campaign in comparison with that of other countries, South Africa should be able to narrow the margin to 1,5 %. If this could be achieved, it would appear that, in accordance with an economic growth rate of between 2,5 % and 3,5 % per annum, the average annual growth rate of electricity consumption could be established at between 4,0 % and 5,0 % per annum.

The average annual growth rate of electricity sent out in South Africa was 7,8 % for the period 1950 to 1970, while it was 8,54 % for the period 1967 to 1974 and 6,64 % for the period 1974 to 1982. Escom's market share of national sales increased from 77,1 % in 1967 to 85,9 % in 1974, and during the period 1974 to 1982 to 93,6 %.

When the possible increase in electricity consumption by municipalities, the possible rate of increase in the industrial sector's electricity consumption, the possible growth rate of electricity sales in the mining sector, including the gold mining industry, possible electricity consumption resulting from the export of coal as well as unrefined minerals and metals, and consumption arising from traction and domestic sales are taken into account, a growth rate for electricity sales of less than 6 % per annum for the rest of the century is foreshadowed. If a saving of 1 % is taken into account, however, the estimated growth rate decreases to 5 % per annum. The Commission of Inquiry does not agree with Escom's forecast of the growth rate of electricity consumption. The Commission of Inquiry has, furthermore, examined the reasons for the difference between its estimate and that of Escom, and is of the opinion that the fundamental influence of the oil crisis, which radically changed earlier trends, has rendered Escom's forecasting method, which is based on the statistics of the preceding 30 years, unreliable.

For this reason, the Commission of Inquiry requested Escom on the basis of information obtained for the 10 year period between 1973 and 1983, and with estimates for 1984 and 1985, to calculate its forecast in accordance with its own models. The results reveal that, if it is accepted that the energy crisis of 1973 caused a discontinuity in the world's economic growth patterns, and if trends subsequent to 1973 particularly are taken into consideration, a growth rate of electricity consumption of between 5 % and 6 % per annum could be expected. With reasonable savings in energy consumption, this growth rate may even be less than 5 %. This forecast differs considerably from that of Escom.

The accepted growth rate of electricity consumption, as determined by means of the forecasts, determines the objectives for Escom's expansion programme.

The efficiency of Escom's expansion programme (pp. 163–183 of the Report).

Escom plans to increase its installed capacity of 20 523 MW in 1982 to 34 953 MW in 1989; this means that new power stations with a combined sent-out capacity of 15 985 MW will have to be commissioned, and that power stations with a combined sent-out capacity of 1 555 MW will be decommissioned during that period. When evaluating Escom's expansion programme, the Commission of Inquiry took into consideration the total assigned sent-out capacity of power stations/peak demand on Escom's system, the availability of power stations, the number of large sets in operation, the heat value of the coal burnt and the average power station load factor, as well as different growth rates for peak demand.

The availability of Escom's coal-fired power stations was 84,9 % in 1975, but dropped sharply to 77,7 % in 1979, 73,1 % in 1982 and 69,9 % in 1983. Escom ascribes the drop in availability after 1975 to an exceptionally high growth in load, decreased availability of new large sets, delayed

commissioning of Cahora Bassa, Grootvlei, Kriel and the first sets of the Matla and Duvha power stations, a chronic shortage of trained personnel, the impracticability of carrying out planned maintenance programmes owing to small reserve margins, and the deterioration in the quality of coal. The low availability experienced in 1983 could, in particular, be ascribed to Umgeni and Ingagane power stations having been temporarily shut down because of the drought, while Camden's output was curtailed. Escom is taking steps to increase availability and intends achieving a system availability of 77 % by 1989. The Commission of Inquiry regards this as a programme that should be given the highest priority.

The importance of the growth rate of electricity consumption and of the availability of generating capacity is emphasised by the magnitude of the surplus capacity that would become available in future if present plans were realised.

Even if the growth rate of electricity consumption during the next decade should prove to be in accordance with Escom's 1983 estimate, a surplus generating capacity of 4 900 MW (16,3 %) at 77 % availability and 6 090 MW (21,1 %) at 80 % availability could be in operation by 1989, if the 1983 planned expansion programme (excluding Cahora Bassa) were carried out.

This surplus capacity would be increased further if old low thermal efficiency power stations remain in operation, to be used, if necessary, during peak load/periods.

If, however, the growth rate of the demand for electricity should be approximately 5 % per annum during the next decade, a surplus generating capacity of 8 900 MW (34,3 %) at 77 % availability and 10 030 MW (40,3 %) at 80 % availability could be in operation by 1989, if the 1983 planned expansion programme (excluding Cahora Bassa) were carried out. Once more, the surplus capacity will necessarily be higher if the old low thermal efficiency power stations remain in operation, to be used, if necessary, during peak load periods.

In 1983 it was estimated that the capital cost involved in establishing power stations plus facilities and transmission required for the creation of 9 732 MW generating capacity in the Central Generating Undertaking for the period 1983-1987 would amount to R20 036 000 000. It is evident that considerable capital expenditure would be deferred if a lower rate of consumption and a higher percentage availability could be achieved. In this connection it should be pointed out that Escom's total assets, both in commission and under construction, little more than *doubled* between 1967 and 1974, but increased *sixfold* between 1974 and 1982, a period which was, granted, one year longer than the preceding one. Between 1974 and 1982 the capital invested in fixed assets in commission increased by 19,5 % per annum, while capital invested in works under construction increased by 40,9 % per annum.

The works under construction, expressed as a percentage of assets in commission, increased from 17,3 % in 1974 to 64,0 % in 1982, when the value of works under construction amounted to R5 016 600 000, and that of fixed assets in operation R7 689 400 000.

The principal reasons for the growing capital investment are the exponential increase in sent-out capacity requirements and the sharply rising capital costs per MW of coal-fired power station generating capacity; these combined gave rise to Escom's funding problems. During the seventies, the nature and size of power stations in South Africa changed considerably. Anti-pollution requirements necessitated higher chimney stacks, more efficient precipitators and water purification systems while sets of ever-increasing size and the more advanced technology resulted in longer construction periods. Since the middle of the seventies higher technology, inflation, and costs of financing, long lead-times, changes in exchange rates, control of air pollution, security measures, premiums for the support of South African industries and premiums for the use of conference lines all contributed to the rising capital costs per MW.

As already mentioned, the improvement in thermal efficiency resulting from higher steam pressures and temperatures and increasingly larger sets was accompanied by a decrease in availability. Although the improvement in thermal efficiency brought about considerable savings in coal costs per MW, the question nevertheless arises whether the stage has not now been reached where a marginal increase in efficiency can be obtained only at the expense of an exponential increase in capital cost.

When one takes into account the substantial increases in real capital cost per MW of available sent-out capacity which took place since the commissioning of the 500 MW sets at Kriel Power Station, it would appear that Escom has reached the stage where the economies of scale will, in future, be able to make only a limited contribution, if any, to the curtailing of the capital cost per MW of generating sets.

Operating costs (pp. 183–188 of the Report).

Operating costs consist mainly of capital-related costs, fuel costs, and so-called other expenditure; of these the first two have shown average annual increases of 27,2 % and 29 % respectively from 1973 to 1982.

In this connection, it should be borne in mind that electricity sales in kW.h increased annually by an average of 8,3 % during the same period. The reasons underlying this sharp increase in capital-related costs will be discussed and evaluated in detail later.

It is interesting to note that the total percentage of open-cast mine coal burnt in Escom power stations increased from 1,10 % in 1970 to 38,15 % in 1982; the average cost per ton of coal supplied to Escom in 1982 was R11,69 for all coal, R14,53 for coal mined underground, and R7,08 for coal obtained from open-cast mines. In addition, it should be appreciated that the sharp increase of an average of 19,0 % per annum in the price of coal, which occurred after 1973, resulted from structural changes in the coal-mining industry, following on exceptionally low price increases during the periods 1960–1970 (1,08 % per annum) and 1970–1974 (6,6 % per annum).

The fact that open-cast mining, where practicable, is able to increase the amount of workable coal obtained from the same hectare reserve by up to three times, and that the present cost structure renders the price per ton of open-cast mine coal cheaper in many cases than coal mined underground, holds interesting possibilities for the future.

Other expenditure increased as follows between 1975 and 1982:

- ☆ Other station operating and maintenance costs by an average of 28,6 % per annum,
- ☆ distribution, operating and maintenance costs by 18,3 % per annum,
- ☆ general expenditure by 27 % per annum, and
- ☆ the total of other expenditure by 26,6 % per annum.

General financing (pp. 188 to 202 of the Report).

Escom receives no financial aid or subsidies from the Government, and Escom is clearly expected to be self-sufficient. The Electricity Act authorises Escom to raise loans, and to make contributions to its Capital Development Fund as well as to its Reserve Fund. The Government guarantees Escom's foreign loans. The Electricity Act also stipulates that Escom shall be run at neither a profit nor a loss.

After 1976, contributions to the Capital Development Fund were substantially increased when external financing was uncertain and capital expansion had to be maintained. The distribution of Escom's own funds in relation to borrowed funds as approximately 35 % and 65 % respectively of the total funds, while assets not yet commissioned increased from R244 million in 1973 (12 % of total assets) to R5 017 million in 1982 (35 % of total assets). Consequently, borrowed capital increased from 74 % of assets in commission in 1973 to 110 % in 1982. The capital cost of the first nuclear power station (Koeberg) constitutes an amount of R2 805 million out of the total figure of R5 017 million for works under construction.

Summed up, the construction of Koeberg nuclear power station, increased construction times for power stations, higher standards of technology, inflation, high interest rates, anti-pollution requirements and the purchase of fuel in advance contributed as much as 50% of the increase of R4 773 million in capital expenditure during the period 1973–1982 on works under construction which had not yet been commissioned, and which had therefore not yet contributed to Escom's income on 31 December 1982.

In 1973 the annual addition to fixed assets was R170 million, but this figure rose to R2 662 million in 1982, and it is estimated that fixed assets will increase by between R3 284 million and R5 042 million per annum over the next five years.

The contribution to the Capital Development Fund, expressed as a percentage of gross income from electricity sales, has already increased from 5,7 % in 1973 to 29,7 % in 1982, in consequence of the rising cost of capital expansion.

The problem of financing the capital programme and assets appearing in the balance sheet, but not yet in commission, is therefore not a short-term problem of a transient nature.

The consideration and evaluation of Escom's general financing were based on the assumption that the community would gain from the cheapest possible supply of electricity to consumers, but that this should not involve the Government in any costs, and should, at the most, stretch Escom's capabilities to the farthest *safe limits*, if necessary.

Both the actuarial and the arithmetical approaches employed to determine Escom's financial capabilities show that Escom is structurally sound in terms of current values, and that it offers a considerable degree of capital security to lenders and creditors. However, lenders attach value not only to capital security, but also to income security. Accordingly, the real test consists in ascertaining whether the current interest and redemption obligations are adequately covered by the current net cash income before interest, and whether this state of affairs may be expected to continue.

As far as this test is concerned, Escom's cover for 1982 and 1983, and the figures expected for 1984, have been adequate, albeit meagre.

In consequence of the reduced saving in the Republic, coinciding with an increase in Escom's requirements, Escom's relative claim to available savings became much more substantial, and its capital expenditure, expressed as a percentage of gross domestic saving less depreciation, reached 41,8 % in 1982 and 34,4 % in 1983.

Calculations show, however, that the pressure exercised on the market by Escom's requirements will decrease over the next six to ten years. The period preceding the resumed increase in pressure is expected to be the longest for the lowest corresponding growth rate of electricity consumption.

If this improvement materialises, Escom's negotiating power on this market should increase; this should in turn enable it to improve the conditions governing its loans. When favourable credit terms are available, financing by means of loans allows tariffs to be much lower than when Escom's capital has to be accumulated from tariffs, and this method of financing is therefore obviously to be preferred.

Under unfavourable conditions Escom should, however, be self-sufficient, and a certain degree of self-financing is consequently unavoidable; funds for such a contingency should therefore be accumulated in good time.

The forecast of future tariff levels, which the Commission based also on cover of income, takes the following facts into account:

- ★ The amount owed by Escom will increase initially and ultimately by more than 15 % per annum, falling to 12 % in the interim, and
- ★ tariffs will increase even more rapidly if inflation in capital expenditure is higher than 11,7 % per annum assumed for this calculation, and arrives at the conclusion that, *in all circumstances, a growing industry will necessitate tariffs which remain just below the inflation rate, provided that the construction rate of generating capacity is in harmony with consumption.* If this harmony is lacking, annual tariff increases will be higher than the inflation rate.

The reasons for this are contained in the following:

- ★ Since Escom's debt per MW increases by approximately 12 % per annum for the period ending 1990, and capital-related costs represent close to 50 % of total cost, a tariff increase of approximately 6 % per annum is necessary to cover merely the *unavoidable* increase in capital costs already incurred, and that such an increase is therefore essential.
- ★ In addition, cover must be provided for the increase in operating costs. If operating costs, which constitute the other 50 % of total cost, were to increase by—
 - 15 % per annum, the tariff increases would, *roughly speaking*, amount to 6 % + 7% %, that is 13½ % per annum, and if operating costs were to increase by
 - 10 % per annum, tariff increases would amount to 11 % per annum. This figure, which exceeds the inflation rate, may be attributed to the growth rates being out of harmony.

Escom's present electricity tariffs (pp. 202 to 210 of the Report).

The problem of determining the price of products of public utilities in general, and of electricity in particular, is a complex one. The Commission is aware of the theoretical arguments in favour of long-term marginal costing and the shortcomings of the traditional arithmetical approach to tariffs. However, the fact remains that marginal cost principles are not applied by South Africa's trading partners except to a degree in Britain and France, or by the greater majority of countries with which South Africa has to compete on the export market.

South Africa's dilemma over electricity prices is accentuated by the fact that "long-term marginal" prices are necessary to ensure saving, but that the employment of this method of determining the price of electricity will raise prices to such a degree that it will harm the energy-intensive industries and exports and (because of their strategic importance) also the economy, thus rendering this method unacceptable in the short term.

Legislative stipulations

Section 14 of the Electricity Act stipulates that the price of electricity shall include all costs connected with the generation and distribution of electricity, maintenance and administration, as well as provision for the repayment of interest and for other capital-related costs, and for contributions to the Capital Development and Reserve Funds. It furthermore stipulates that, as a general principle, electricity shall be supplied neither at a profit nor at a loss. Section 16 stipulates that separate statements shall be kept reflecting the expenditures of each undertaking, and that one group of consumers shall not subsidise another.

Present tariffs (pp. 202 to 203 of the Report).

Escom's tariffs are divided into four classes, namely those for large power users (Tariff A), small power users (Tariff B), domestic users, mainly within urban areas (Tariff C) and rural users (Tariff D). In certain cases, extension charges are levied over and above the particular tariff.

Tariffs may be used as an aid to obtaining the lowest average cost per kW.h, if such tariffs act as an incentive to consumers to restrict their demand during times of maximum load on the Escom system, to adapt their consumption so that it coincides, as far as possible, with valley periods, and to save electricity with a view to limiting the growth rate of the system and capital-related costs connected with works under construction but not yet in commission.

Capital-related costs which have to be redeemed from current tariffs are correlated to the maximum demand or peak load, which is reached for the period of an hour during the year and for which sufficient sent-out capacity must be available. The average capital-related cost per kW is therefore determined by the total capital cost of the generating capacity required to supply the maximum demand, and by the average utilisation of this capacity.

The system load factor measures the average utilisation of the sent-out capacity of the system. The integrated load factor for Escom's system during the period 1967-1983 ranged between the exceptionally high percentages of 75,1 % and 77,6 %, which rank amongst the highest in the world. Nevertheless, it would appear that three possibilities present themselves for further improving the system load factor or for maintaining it in future, namely—

- ☆ special tariffs for bulk consumers who agree to decrease their demand immediately at Escom's request, on a basis previously agreed upon,
- ☆ the switching off of domestic geysers during peak-load periods, and
- ☆ tariffs aimed at encouraging consumption during the valley periods in the evenings and over weekends.

A further possibility which merits consideration is the introduction in South Africa of a three-tier tariff structure for industrial, domestic and commercial consumers, as has been done in various countries on the basis of the utilisation of capital-related cost.

The effects of certain legislative restrictions (pp. 205 to 208 of the Report).

The general principle that electricity shall be generated at neither a profit nor a loss is applicable to each of Escom's distribution undertakings. In this connection the comparative trends of electricity prices are interesting.

The total cost to consumers, in cents per kilowatt hour, of electricity sold by the various undertakings, was as follows for the years 1972 and 1982:

Undertaking	Total cost to consumers in cents per kW.h		
	1972	1982	% Increase
Rand and OFS	0,5222	2,634	1
Natal	0,714	2,724	
Cape Eastern	0,536	2,763	
Cape Western	1,0948	3,614	2
Cape Northern	0,9059	3,860	
Orange River and Cape Eastern		3,477	
Border	1,2724	4,323	3

Before 1972, Escom's various undertakings operated independently of each other on separate accounts, but they are now interconnected to a national grid, and are supplied by the Central Generating Undertaking.

During the period 1972–1982 the three average tariff structures, as indicated above, prevailed.

In commentary submitted to the Commission of Inquiry, it was suggested that all references in the Electricity Act to separate undertakings within Escom be deleted, and that a tariff policy which comes as near as possible to supply at cost be accepted. Transmission costs up to certain reference points can then be established, so that for each consumer transmission cost will include his share of the cost up to the nearest reference point plus the additional cost between the reference point and the consumer. The principle of pooling certain costs may be retained, but only when the pooled items are of a similar nature.

The Commission of Inquiry supports this recommendation.

When the suitability of Escom's present tariff structures is considered, attention should also be given to the so-called extension charges and the principle of coal price adjustment.

Extension charges constitute a relatively small contribution to Escom's total income. For Escom as a whole, income from extension charges during 1982 amounted to R98,4 million, which constituted 3,7 % of the total income of R2 695, 4 million for that year. The percentage contributions of extension charges to the total income received from the consumer groups concerned during 1982 were as follows:

	%
Tariff A (large users)	3,4
Tariff B (urban small users)	6,7
Tariff C (urban domestic users)	1,1
Tariff D (rural small users)	13,5

Tariff A users constitute approximately 97 % of Escom's electricity sales, while the contribution of Tariff B users amounts to 0,6 %, that of Tariff C to 1,1 % and that of Tariff D to 1,3 %. If all extension charges had been levied on the same percentage contribution to income basis during 1982, large users (Tariff A) would have had to pay approximately 0,3 % more per kilowatt hour to ensure the same income for Escom.

Savings (pp. 209 to 210 of the Report).

In order to bring about savings in electricity as soon as possible and to the largest extent possible—

- ☆ Escom should annually (in January) publish the expected increases in the price of electricity for each of the following five years, together with previous predicted and actual figures, so that all consumers may know what to expect and consider these increases when making their own calculations and decisions,
- ☆ increases in the price of electricity should occur once a year only (in January), should include the coal price adjustment for the following year, and should be valid for the whole year,
- ☆ Escom should make every effort to persuade consumers to save electricity and, with a view to this, should discontinue its policy of providing an abundant supply of electricity,
- ☆ the existing seven distribution undertakings should be reduced to three at the most, in order to reduce administrative costs and eliminate inconsistencies between undertakings.
- ☆ Owing to changing circumstances
 - all references in the Electricity Act to separate undertakings, as well as to the principle that electricity shall be supplied neither at a profit nor at a loss, should be deleted,
 - unit cost should be determined in accordance with a small number of types and sizes of consumers, in order to distinguish, wherever applicable, between maximum demand and actual consumption,
 - unit cost of transmission to a reference point and unit cost of distribution from the reference point to the consumer should be calculated on the basis of cost per kilometre for different voltages and loading,
 - the principle of pooling could then be applied in accordance with the foregoing guide-lines, so that tariffs for each group of consumers could be built up from average pooled cost,
 - for this purpose, administrative and borrowing costs connected with rural supply could also possibly be divided into a few groups according to the density of consumption.

This approach will do away with the pooling of cost on a geographical basis.

Changed circumstances necessitate the development and imposition of new tariff structures. Though tariff structures were previously developed and implemented by Escom within the constraints of the Electricity Act, it has become evident that Escom will now have to be allowed sufficient flexibility to develop new structures which meet the requirements of load management and economic justification. In this connection it should be borne in mind that, in terms of the control structure recommended by the Commission of Inquiry, tariff structures will be established in consultation with consumers.

Analysis of trends and evaluation of performance (pp. 211 to 213 of the Report).

The continuous growth in the demand for electricity, the construction of large power stations on coal-fields, the interconnection and establishment of a national grid, and the exploitation of the economies of scale as well as the application of the latest improved technology established Escom as the predominant supplier of electricity.

Thanks to the exploitation of the economies of scale, together with the application of improved technology, the fixed assets in commission required per million kW.h sold increased merely from R28 010 in 1960 to R35 130 in 1974, despite the effects of inflation, and the fixed capital invested in works under construction constituted a mere 17,3 % of the total fixed assets in 1974.

Since the mid-seventies, however, the diverse factors mentioned earlier have contributed to the considerable increase in Escom's assets in commission per million kW.h sold, from R36 040 in 1975 to R166 780 in 1982.

An analysis of the application of improved technology to reduce cost reveals that, in contrast to the years in which exceptional progress was made in attaining the theoretical maximum thermal efficiency, only a marginal improvement is at present being achieved at high cost.

The period 1974–1982 (i.e. the years that followed the oil crisis) was characterised by changing economic circumstances, low economic growth rates, high inflation rates, high interest rates and, with special reference to Escom, a high annual growth rate in the selling price of electricity, rising coal prices and accelerating wage increases, especially from 1977 to 1982.

Works under construction, expressed as a percentage of fixed assets in commission, increased to 64,0 % in 1982 (17,3 % in 1973) and from R244 million in 1973 to R5 016,6 million in 1982.

The problem of financing the capital programme and assets appearing in the balance sheet but not yet in commission, which has arisen markedly since 1973, cannot be regarded as a short-term problem of a transient nature, because Escom is contemplating capital expenditure of between R3 284 million and R5 042 million per annum for the next five years.

Events since 1974 therefore serve to cast serious doubt on the viability of Escom's policy, with its declared objective of providing an abundant and reliable supply of electricity at cost price.

The developments in the world and in South Africa since 1973 have, on the contrary, emphasised the need for a policy of energy and electricity conservation.

8.3 The potential effectiveness of present strategy in the future (pp. 214 to 221 of the Report).

Escom's present strategy and policy have their origin mainly in the Electricity Act of 1922. As late as 1932, Escom had supplied only 30 % of South Africa's electricity, but by the end of 1982 this figure has risen to 93,6 % and Escom had virtually become a monopoly; it now also acts as the supplier and forecaster of future demand, as well as the planner of future electricity requirements and, in addition, as the largest capital investor in any industry in South Africa.

The magnitude of Escom's capital requirements accentuates the necessity for accurate load forecasts, but the responsibility for this task rests solely with Escom. This is an unsatisfactory state of affairs, as Escom will have to bear the blame for either an inadequate supply of electricity or for an excessive capacity. Once Escom has established the future demand for electricity, the necessary generating capacity and the capital requirements, it adapts its tariffs so as not only to cover operating and capital-related costs, but also to make a substantial contribution to future capital needs. The change in Escom's fundamental role, namely from that of a supplier of electricity to that of a monopolistic supplier and planner, occurred during a critical phase in the development of the electricity supply industry, and coincided with the most far-reaching economic change the world has experienced since the Second World War.

Escom is fundamentally directed towards providing an abundant supply of electricity, while circumstances arising after the oil crisis require Escom to have a share and to play a role in the determination, application and implementation of the country's energy and electricity policies, and to act within the framework of the priorities and limitations of the Government's strategy.

As far as energy and electricity policies are concerned, it has also become evident that in South Africa, as in most industrial countries, intensive efforts will have to be made to save energy and electricity.

If a reasonable measure of success is achieved in the attempts to save, the Commission of Inquiry is of the opinion that the average annual growth rate of electricity consumption will increase by 5 % per annum, instead of slightly higher than 7 % per annum until 1990, and thereafter at a lower growth rate, as foreseen by Escom. The present lead times for the construction and commissioning of power stations, which may be as long as eight years for the first and 14 years for the last sets, give rise to an extremely complex time perspective for the estimate of the increase in electricity consumption over long periods; this must serve as a basis for the expansion of generating capacity.

Since electricity growth rates are expected to be lower than planned, and existing contractual obligations were undertaken several years ago, owing to long lead times, new plans are being based on the last dates for which the contracts provide.

The comparative figures for the escalated capital requirements for load growths of 7 % and 5 % respectively (based on the maximum deferment of existing contracts) show that—

- ☆ the decrease in capital cost which could be attained over the first few years by deferring contracts, if provision were made for a load growth of 5 % instead of 7 %, is relatively small, amounting to R3 497 million for the period 1984–1988, but that
- ☆ after 1989, the annual saving in capital at a load growth of 5 % instead of 7 % would exceed R2 000 million per annum, and increase to R3 000 million per annum in 1993, R6 000 million in 1997 and almost R10 000 million in the year 2000, while the difference in the cumulative capital cost in the case of a load growth of 5 % instead of 7 % per annum would amount to—
 - R15 625 million in 1993,
 - R41 345 million in 1998, and
 - R105 745 million in 2003.

Escom's high electricity growth rate and construction strategies are directed towards the provision of an abundant and cheap supply of electricity. However, this strategy study shows clearly that, for national strategic reasons, Escom should—

- ☆ assume the leading role in a nation-wide programme aimed at energy and load conservation by the end consumer,
- ☆ make every effort to reduce its capital requirements by limiting the capital cost per MW, attaining higher availability and better utilisation of capital and restricting expansion,
- ☆ contain rising operating costs, especially by means of optimum exploitation of assigned coal-fields, and
- ☆ maintain relatively low electricity prices, in order to assure South Africa's energy-intensive industries of a competitive position on the world market.

In view of the importance of energy and electricity policies in the world economic circumstances following the oil crisis, it is evident that Escom's policy should be integrated with national objectives and policies.

8.4 Recommendations.

Page

Without detracting from the comprehensive recommendations contained in the report and the steps necessary for their implementation, the Commission of Inquiry makes the following recommendations:

- | | |
|--|---------------------------|
| (1) Recommendation: A TWO-TIER CONTROL STRUCTURE CONSISTING OF THE BOARD OF CONTROL OF THE ELECTRICITY SUPPLY CORPORATION (ESCOR) AND A MANAGEMENT BOARD, TO REPLACE THE PRESENT STRUCTURE. | 221–235 |
| <ul style="list-style-type: none"> ● Policies in respect of energy have, together with monetary and fiscal policies, necessarily become an integral part of the economic policy of the Republic. | 6–8
122–125
137–150 |
| <ul style="list-style-type: none"> ● Co-ordination of the activities of the Government and of Escor in the interests of South Africa in general and its economy in particular is of cardinal importance in determining Escor's strategy. | 15
218
221 |
| <ul style="list-style-type: none"> ● This structure provides for the inception of a new mechanism aimed at encouraging involvement of both the Government and consumers of electricity in accepting responsibility for determining strategy and policy, future growth rates in respect of consumption and consequently Escor's expansion programme, as well as their effect on electricity tariffs. | 233–235 |

	Page
● The need for joint responsibility in determining the growth rate in respect of load is sharply accentuated by the difference between the growth rate of 7 % which was forecast by Escom and that of 5 % which is foreseen by the Commission of Inquiry, and the implications of this difference in terms of cumulative capital expenditure up to the year 2003, namely R105 billion (in this report 1 billion = 1 thousand million).	16 122-163
● The change of name from Electricity Supply Commission to Electricity Supply Corporation is necessary for the reliable identification of the undertaking which is to accept corporative responsibility and answerability for the generation and supply of electricity.	233
(2) Recommendation: ESCOR SHOULD, IN FUTURE, ASSUME A LEADING ROLE IN THE CONSERVATION OF ENERGY AND ELECTRICITY WHILE PREVENTING PRICES FROM RISING TOO RAPIDLY AND THE GENERATION OF ELECTRICITY FROM MAKING EXCESSIVELY HIGH CAPITAL DEMANDS ON THE ECONOMY. ITS OBJECTIVE SHOULD BE THE MAXIMUM UTILISATION OF RESOURCES AND CAPITAL IN THE ECONOMY THROUGH THE OPTIMUM USE OF ENERGY AND ELECTRICITY.	16 236-237 8-9
● Changed economic circumstances necessitate a new approach in the electricity supply industry.	122-125 137-150
● The capital demands made on the economy by the generation of electricity should be curtailed and, in order to achieve this, the objective of providing an abundant supply of electricity at cost price wherever a demand exists in South Africa should be discarded.	217 194-195
● The efficient use of electricity, as well as the most efficient use of generating plant, could result in a more modest expansion programme in future.	174-177 236
(3) Recommendation:	
(a) MAXIMUM AVAILABILITY OF POWER STATIONS SHOULD BE ATTAINED, AND STANDARDISATION OF GENERATING PLANT SHOULD BE STRIVEN FOR, WITH A VIEW TO ACHIEVING OPTIMUM AVAILABILITY AND LIMITING CAPITAL COST PER ADDITIONAL MW.	10-11 54-56 169-177
(b) ESCOR SHOULD, BY MEANS OF FURTHER INVESTIGATION, DETERMINE WHETHER AND TO WHAT EXTENT THE LOCAL MANUFACTURE OF GENERATING PLANT IS JUSTIFIABLE. ESCOR'S INVESTIGATION SHOULD INCLUDE ITS PRESENT TENDER PROCEDURE AND SHOULD, INTER ALIA, COMPARE THE TENDER PRICES OF THE THREE LOWEST TENDERERS WITH THE PRICE AFTER COMPLETION OF EXISTING POWER STATIONS PER MW. THE POSSIBILITY OF PUBLISHING THE TENDER PRICES IN EACH CASE SHOULD ENJOY SERIOUS CONSIDERATION IN THE INVESTIGATION.	218-220
(c) ESCOR SHOULD SUBJECT STANDARDS RELATING TO WATER CONSERVATION, ANTI-POLLUTION AND SECURITY MEASURES TO A CRITICAL EXAMINATION, WITH A VIEW TO SAVINGS.	178-181
● The high standards in respect of the above have contributed substantially to the increases in Escom's capital cost per MW over the past number of years. It is essential that the extent of these additional costs be identified, evaluated and weighed up economically before the standards are determined and imposed.	
(4) Recommendation:	
(a) THE RISKS IMPLIED BY LOAD FORECASTS FOR ELECTRICITY CONSUMPTION WHICH MAY PRESENT ESTIMATES OF GROWTH WHICH COULD BE TOO HIGH OR TOO LOW, SHOULD BE REDUCED TO A MINIMUM.	161-163 216

- (b) (i) CLOSE CO-OPERATION SHOULD BE ELICITED FROM CONSUMERS WHEN ESTABLISHING FUTURE ELECTRICITY CONSUMPTION REQUIREMENTS, AND
- (ii) A POWER STATION CONSTRUCTION PROGRAMME SHOULD BE DEVELOPED WHICH IS BASED ON THE SIMULTANEOUS CONSTRUCTION OF MORE THAN ONE POWER STATION, BUT WHICH POSSESSES SUFFICIENT FLEXIBILITY IN RESPECT OF FOLLOW-UP SETS TO ALLOW THE ASSIMILATION OF CHANGES IN GROWTH RATE WHICH REQUIRE CONSTANT MONITORING, WITHOUT SUPPLYING AN EXCESS OF GENERATING CAPACITY.
- Since 1973, the econometric method of forecasting electricity consumption has become unreliable, as a result of the discontinuity in the world's economic growth pattern. 125-130
157-163
212-213
- (5) **Recommendation:** THE PRINCIPLE OF OPERATING NEITHER AT A PROFIT NOR AT LOSS MUST BE DISCARDED IN FAVOUR OF A SOUND ASSETS AND INCOME STRUCTURE COMPLYING WITH THE FOLLOWING REQUIREMENTS: 191-197
- (a) INCOME COVER OF AT LEAST 1,05 AND
- (b) THE MAINTENANCE OF A 3:2 ASSETS/LIABILITIES RATIO.
- It follows that Escor's tariff increases must in future be adequate to enable this recommendation to be implemented. 197-201
 - Escor's accounting system should also enable returns on its own capital to be easily identified in the accounts, and items deducted, for example depreciation and future capital expenditure, should be indicated as applications of such income and motivated separately. 200-202
- (6) **Recommendation:** ALTERED CIRCUMSTANCES NECESSITATE THE DISCARDING OF THE CONCEPT OF DIFFERENT UNDERTAKINGS WITHIN ESCOR AND THE MODIFICATION OF THE TARIFF STRUCTURE SO AS TO 202-210
- (a) DISTINGUISH BETWEEN MAXIMUM DEMAND AND ACTUAL CONSUMPTION WHEN ALLOCATING UNIT COST, WHERE APPLICABLE, 13-14
- (b) DETERMINE THE UNIT COST OF TRANSMISSION TO AN AGREED REFERENCE POINT, AND THAT OF DISTRIBUTION FROM THE REFERENCE POINT TO THE CONSUMER, ON THE BASIS OF THE COST PER KM FOR VARIOUS VOLTAGES AND LOADS, 13-14
- (c) ALLOW POOLING OF COSTS SO THAT TARIFFS FOR INDIVIDUAL GROUPS OF CONSUMERS MAY BE BUILT UP FROM MEAN POOLED COSTS. 13-14
- Though in the past, tariff structures were developed and implemented by Escor within the constraints of the Electricity Act, greater flexibility should in future be allowed, in order to create structures that satisfy load management requirements as well as economic demands. 205-209
- (7) **Recommendation:** THE ELECTRICITY ACT, No. 40 OF 1958, AS AMENDED, SHOULD BE SO AMENDED AS TO ENABLE THE FOREGOING RECOMMENDATIONS (AND AS SET OUT IN GREATER DETAIL IN THE COURSE OF THIS REPORT) TO BE IMPLEMENTED.

9. MATTERS FALLING BEYOND THE SCOPE OF THIS STUDY OF ESCOM'S STRATEGY

In the light of the provisions of its terms of reference, the Commission of Inquiry examined a variety of matters falling beyond the scope of this study of Escom's strategy, such as the supply/distribution of electricity by local authorities, the role of the Electricity Control Board and the possible exploitation of other energy resources.

In view of the present uncertainty, inter alia, about constitutional developments, the Commission does not feel qualified to make specific recommendations on the supply/distribution of electricity by local authorities.

However, the Commission is of the opinion that the utilisation of energy resources other than the conventional thermal, hydro-electric and nuclear power sources is not feasible or economical at this stage and does not merit further consideration.

The Commission of Inquiry appreciates the role played by the Electricity Control Board in the electricity supply industry in the past. However, it is of the opinion that, in view of its recommendations about the establishment of a new structure of control for Escom, many of the Electricity Control Board's present functions will become redundant, and that the remaining functions could be taken over by the Department of Mineral and Energy Affairs and the responsible Minister.

10. EXPRESSION OF THANKS

The Commission of Inquiry expresses its thanks and appreciation to the Electricity Supply Commission, its Management and all staff members who supplied information and assisted in the execution of many tasks that expedited the work of the Commission of Inquiry. The Commission of Inquiry also thanks the Electricity Control Board, government departments and their staff, as well as the organisations and their delegates, and members of the public, who submitted comments and information and who gave evidence before the Commission of Inquiry. The co-operation received was a great incentive to the Commission.

PART 2

THE COMPLETE STUDY OF ESCOM'S STRATEGY

METHOD OF INQUIRY

The method employed in this inquiry is based on the approach to strategic planning applied in the private sector to private enterprises. Strategic planning in the private sector is a broad, ever-changing programme of intended future corporate emphasis and resources development which responds to the competitive environment which it initiates, and in which the enterprise operates.

Although Escom was not established as a profit-making utility, the strategic planning approach is nevertheless applied. In this connection Peter Drucker's remark that the primary objective of an enterprise is not to manufacture a product or to make a profit, but to meet the needs of a client who has not yet been provided for, is interesting. He added that, if the latter task is carried out properly, profits would in fact be made.

The strategic planning process for private-sector enterprises basically consists of two parts:

- ☆ Strategic planning at *corporate* level which deals with the different concerns the enterprise has invested in, and
- ☆ strategic planning at *enterprise* level which deals with the question of how to compete at a *business level*.

In the case of Escom, which is a single-industry enterprise, the strategic planning pattern applied at enterprise level in the private sector is used as a guide-line.

This planning pattern is divided into four phases, namely—

- ☆ determining the current strategic posture,
- ☆ evaluating past performance,
- ☆ evaluating present strategy, and
- ☆ determining future strategy,

while each of these phases is subdivided into a number of relative steps.

STRATEGIC PLANNING OF ESCOM—A FRAMEWORK FOR THE INQUIRY

Strategic planning at enterprise level is above all applied to the eight strategic variables—product, marketing, distribution and promotion policy, competitive emphasis, price, financing and investment policy, and comprises the identification, analysis and rigorous evaluation of the following:

- ☆ The opportunities, threats and crucial success factors in the environment,
- ☆ the expectations and constraints, as well as the strengths and weaknesses of the enterprise, in order to identify
- ☆ the cardinal emphasis in the allocation of resources and the action to be taken to exploit the enterprise's competitive advantage optimally.

Identification, evaluation and planning of enterprise strategy involve the following four phases:

PHASE 1: Identification and description of Escom's current strategic posture

In short this step defines the strategy which determines *current* corporate behaviour in terms of the enterprise's *present* scope, *present* application of resources, *present* competitive advantage and *present* actual criteria of strategic options.

PHASE 2: Evaluating Escom's past performance

The description and evaluation of *past* performance, the determination of *past* tendencies of both the particular enterprise and the operation being carried out during this phase will give an indication of previous and present bases for success in the operation and will identify the previous competitive advantage.

PHASE 3: Evaluating Escom's present strategy

During this phase, the potential effectiveness of the *present* strategy for the *future* as well as the balance between the available resources and the present and *future* requirements of the environment are evaluated. *In short, will the present strategy really work?*

PHASE 4: Planning Escom's future strategy

Against the background of the preceding three phases the enterprise can now determine, for instance, the *crucial factors of success*, its *competitive advantage* and the required allocation of resources in order to exploit the competitive advantage in the future.

Each of these four phases involves a number of steps, described below:

PHASES AND STEPS OF STRATEGIC PLANNING AT BUSINESS LEVEL

PHASE 1	PHASE 2	PHASE 3	PHASE 4
CURRENT STRATEGIC POSTURE	EVALUATE PAST PERFORMANCE	EVALUATING PRESENT STRATEGY	PLANNING FUTURE STRATEGY
Step I: Determine the <i>present</i> scope.	Step I: Define the <i>past</i> performance of the enterprise.	Step I: Evaluate the <i>potential</i> effectiveness of the <i>present</i> strategy for the future.	Step I: Analyse the environment with emphasis on <i>potential</i> future developments.
Step II: Determine the <i>present</i> application of resources.	Step II: Evaluate <i>past</i> performance.	Step II: Assess whether the strategy is <i>consistent</i> with the environment in terms of present and developing conditions.	Step II: Analyse the resources for future application.
Step III: Determine <i>present</i> competitive advantage(s).	Step III: Analyse <i>tendencies</i> and <i>past</i> and <i>present</i> basis for success in the operation.	Step III: Realistically assess balance between available resources and <i>present</i> and <i>future</i> environment requirements.	Step III: Identify <i>future</i> competitive advantage of the enterprise.
Step IV: Determine the <i>present</i> actual strategic choice criteria.	Step IV: Identify the past competitive advantage of the enterprise.	Step IV: Assess whether strategy is <i>internally</i> consistent. Step V: Assess whether strategy involves an acceptable degree of risk. Step VI: Assess whether the strategy has an appropriate time horizon. Step VII: Assess whether the strategy is really workable.	Step IV: Develop <i>guide-lines</i> for the future. Step V: Identify possible <i>future</i> projects. Step VI: Establish <i>future</i> performance specifications. Step VII: Define the scope of future strategy. Step VIII: Procure and allocate resources.

CHAPTER 1

PHASE 1: THE CURRENT STRATEGIC POSTURE OF ESCOM

STEP 1: DETERMINATION OF THE NATURE AND EXTENT OF THE ENTERPRISE INTRODUCTORY DESCRIPTION

Escom was established in 1923 in terms of the Electricity Act of 1922 and has since then increasingly co-ordinated the supply of electricity at a national level so that Escom today supplies more than 93 % of the electricity consumed in South Africa and the independent homelands. Escom therefore supplies power in a geographical area approximately 1 000 000 km² in extent.

The remainder of more or less 7 % not supplied by Escom is generated by mines, industries and a number of municipalities which operate their own power stations, but generally also make bulk purchases from Escom to supplement their own generating capacity.

At the end of 1982 Escom operated 25 power stations having an installed capacity of approximately 21 000 MW and supplied power over an interconnected national network of 50 000 km high-voltage lines, from 33 kV to 400 kV, to almost the whole of South Africa.

By the end of 1982 Escom was an enterprise with assets totalling almost R14 700 million, a staff establishment of more than 58 800 employees and annual sales exceeding 96 000 GW.h, while its income in 1982 amounted to R2 695 million.

Escom expects that it will have to treble its present generating capacity by the year 2000. Although Escom is the sixth largest and undeniably the fastest growing electricity utility in the Western world, Escom ordered more generating plant in 1981 than did all the electricity utilities in the United States combined.

As already mentioned, Escom was established in terms of the Electricity Act, 1922 and although this Act was superseded in 1958, relatively few alterations were made and the following basic principles remained untouched:

- (1) The Commission comprising members appointed by the State President and entrusted with the task of ensuring that Escom plays its part in the South African economy to provide a cheap and abundant supply of electricity.
- (2) Neither at a profit nor at a loss [Section 14 (4)].
- (3) No financing by the State (Sections 10 to 16).
- (4) Accountability to the State (Sections 17 to 19).

Section 30 of the Act obligates Escom to supply electricity within its undertakings to every applicant who can pay for it, except in so far as its right to supply is restricted by its licence.

As a consequence of this Escom is also obligated to supply electricity in those national states that have not yet attained independence.

While Transkei, Bophuthatswana, Venda and Ciskei were still part of South Africa, the obligation to supply resulted in agreements being concluded with them in terms of which Escom would continue to supply electricity to those countries on their attaining independence. Escom also supplies electricity in bulk to Botswana, Lesotho, Swaziland, Zimbabwe and Mozambique, while electricity is purchased from Mozambique (Cahora Bassa).

The Act stipulates the manner in which Escom may finance its activities:

In this respect Escom should be self-sufficient and act accordingly. The Act also provides that Escom should show neither a profit nor a loss. This principle, like most of the other financial provisions, applies to every Escom undertaking separately so that profits may not be transferred from one undertaking to another. Escom's tariffs should cover expenditure, and expenditure includes contributions to the Reserve and Capital Development Funds. Capital expenditure is financed by way of loans. Even the so-called "internal financing" is possible only if Escom invests funds in its own loans.

The Capital Development Fund was established on 1 January 1972 in terms of section 13 of the Electricity Act to build up a reserve from income for financing capital development. The annual contributions to the Capital Development and Reserve Funds are regarded as cost items.

Two further provisions of the Electricity Act are firstly, that separate accounts should be kept for each undertaking and that electricity tariffs should correspond to the cost of electricity supply, and secondly that one group of consumers should not be subsidised by another.

Being a national and monopolistic electricity generating and supply undertaking, Escom was able over the years to—

- ☆ utilise the benefit of economies of scale,
- ☆ electrify the whole country systematically and economically, using the latest technology,
- ☆ establish an interconnected national network that would enable it to supply electricity in any part of the country in the future,
- ☆ erect large power stations on coal-fields, thus eliminating transport costs,
- ☆ make optimum use of the limited hydro-electric potential available.

In the process Escom as the central supply undertaking has become the planner for the supply of future electricity requirements.

Two further factors contributed to Escom's success in keeping electricity tariff increases in check in the past, viz—

- ☆ the continuous growth in the demand for electricity, which
- ☆ made possible the application of improved technology, especially in the commissioning of larger generating sets operating at higher steam pressures and temperatures, and higher voltage distribution networks.

Since the middle of the seventies a number of factors, which will be examined later in greater depth, came to the fore counteracting the success achieved under the previous policy up to that stage.

Over the past 30 years Escom's electricity sales have increased on average by 8,6 % per annum. Although the growth in electricity sales of 2,4 % in 1982 was the lowest in 35 years, Escom expects that it will recover and will in future increase up to the year 2000 at an average rate of between 6 % and 7 % per annum.

Escom does not have the profit-making incentive to promote electricity sales; the growth of sales is due mainly to the demands of the economy.

A problem that confronts Escom is that a temporary change in the growth rate should not affect its long-term programme for capital outlay. The long-term prospects have to be considered for capital outlay.

Escom considers it important that the financing objectives for the capital spending programme be pursued and that these should not be affected by fluctuations in the short-term growth rate of electricity sales.

Escom is endeavouring to pursue a policy of regular and even tariff adjustments because the economy is disturbed less by this approach than by irregular tariff adjustments. Apart from this Escom also makes tariff adjustments in accordance with the coal costs.

According to Escom the recent larger tariff increases can to a certain degree be ascribed to inadequate tariff increases in the past. Now there is also the problem of higher financing costs, additional security measures demanding great expenditure, steep rises in the cost of coal and the unreliability of Cahora Bassa giving rise to increased working costs. In spite of these problems Escom's tariffs have remained among the lowest in the world.

Escom's cost distribution in 1982 was as follows:

	%	%
GENERATING COSTS		41,49
Coal costs	21,53	
Railage on coal	2,03	
Other costs	5,12	
Maintenance	5,97	
Administration and General	6,84	
LOAN CHARGES		31,84
Interest:		
Generation		
Distribution	18,39	
Corporate Services	7,97	
Redemption:	-0,14	
Generation		
Distribution	4,73	
Corporate Services	0,86	
CONTRIBUTIONS TO FUNDS		17,29
Capital Development Fund		
Reserve Fund	16,35	
DISTRIBUTION COSTS	0,94	
Operation		7,99
Maintenance	0,11	
Administration and General	2,07	
CORPORATE MANAGEMENT	5,81	
ELECTRICITY PURCHASED		1,26
		0,13

Loan charges represent an important cost component. Little control is possible over interest charges and redemption costs, as these are market related. Escom is forced by continuous construction programmes aimed at satisfying the demands for electricity to seek capital during periods of high and low interest rates. The ideal would be to borrow more in times of low interest rates, and less when rates are high. Once Escom's internal financing has been placed on a sound basis it will be in a position to use internal financing as a means to defray high financing charges.

Contributions to the Capital Development and Reserve Funds represented 18 % of the total electricity costs during 1982. These contributions will be discussed later, but it should be noted that this figure represents a substantial decrease from the peak in 1980 when the contribution amounted to 25 % of total costs.

Fuel costs constitute another large cost component which Escom endeavours to control strictly. In the past this approach has on occasions compelled Escom to provide capital when coal companies were unable to do so at economical rates.

Since Escom's inception the generation, transmission and distribution of electricity has been undertaken in the different regional undertakings. Up to 31 December 1971 each of Escom's generating stations was assigned to a particular undertaking; meanwhile however, a number of transmission connections were built between generating stations and undertakings. These transmission connections formed an interconnected network that—

- ☆ is fed by the giant power stations on the coal-fields—while the limited hydro-electric potential and pumped-storage possibilities are utilised, and
- ☆ has made Escom the central authority for the planning of South Africa's electricity requirements.

The total Escom electricity generating and distribution set-up now comprises the following undertakings:

- ☆ The Central Generating Undertaking,
- ☆ Border, Natal, Cape Eastern, Cape Western, Cape Northern, Orange River and Rand and Orange Free State Undertakings.

THE CENTRAL GENERATING UNDERTAKING

In 1982 the Central Generating Undertaking operated twenty-five power stations. One hundred and thirty-eight turbo-generators were in operation in coal-fired power stations in that year.

In December 1982 Escom's installed capacity was 21 749 MW.

Transmission lines of the Central Generating Undertaking comprised the following on 31 December 1982—

- 1 030 km of 533 kV DC (monopolar),
- 7 279 km of 400 kV,
- 1 462 km of 275 kV,
- 108 km of 220 kV,
- 49 km of 165 kV to 132 kV,
- 57 km of 88 kV to 33 kV,
- 33 km of 22 kV and below,

an aggregate therefore of 8 988 km transmission lines, while 1 671 transformers having a capacity of 37 687 MVA were in operation in the undertaking.

On 31 December 1982 the valuation at cost of the fixed assets of the Central Generating Undertaking amounted to R5 739 046 000, which represented 74,6 % of Escom's fixed assets at that date.

ESCOM'S DISTRIBUTION UNDERTAKINGS

In Table 1 relevant information is given for the different distribution undertakings for 1982.

In 1982 electricity sales by—

- ☆ Rand and Orange Free State Undertaking were more than three times as much as those of the Natal and Eastern Transvaal Undertakings, which are of the same size, while those of

☆ Cape Western Undertaking were less than half the sales of the Natal and Eastern Transvaal Undertakings.

Although sales in Cape Northern Undertaking in 1982 were twice the sales in Orange River and Border Undertakings, sales in these three undertakings were still relatively limited, especially when compared with sales in the three largest undertakings.

The supply areas of the Rand and Orange Free State and Cape Northern Undertakings are of comparable size in terms of square kilometres, while Natal, Cape Western and Eastern Transvaal Undertakings have supply areas of the same size. The Orange River Undertaking supplies almost one and a half times the area of the Border Undertaking while the latter supplies almost half the area of the Cape Western Undertaking.

There are important differences in the nature and characteristics of the different undertakings, and also in the extent of the demand for electricity in accordance with consumer requirements.

The mix of consumers, for example whether sales are made predominantly to a small number of bulk users or to a large number of smaller users, affects the distribution costs of the undertaking. In this respect the column of figures in Table 1, which shows the number of consumers per GW.h sold and which varied between 14,13 for the Cape Western and 0,77 for the Rand and Orange Free State Undertakings in 1982, is informative and meaningful.

The network length in kilometres per GW.h sold is a good indicator of the order of differences of the regional density of the demand for electricity. This indicator varied between 4,41 for Border Undertaking and 0,80 for Rand and Orange Free State Undertaking in 1982.

TABLE 1
INFORMATION ON ESCOM'S DISTRIBUTION UNDERTAKINGS

Undertaking	GW.h sold	Supply area km ²	Number of consumers	Network km	Working capital R000	Working expenditure of undertaking R000	Quantity expressed per GW.h sold						Network of 22 kV and below as % of total network km	System annual load factor (sent out) %	Working expenditure of undertaking in R000 per km length of network
							Supply area km ²	Number of consumers	Network km	Working capital R000	Working expenditure R000	Number of transformers			
Rand & OFS.....	54 011	264 400	41 362	43 117	832 126	82 676	4,90	0,77	0,80	15,41	1,53	0,45	58,8	71,2	1,92
Natal.....	15 973	106 700	34 475	21 589	228 932	37 120	6,68	2,16	1,35	14,33	2,32	0,84	69,4	73,1	1,72
Eastern Tvl.....	14 053	93 500	13 320	22 158	297 744	31 436	6,65	0,95	1,58	21,19	2,24	0,83	75,5	71,8	1,42
Cape Western.....	7 015	116 800	99 153	20 308	258 533	39 516	16,65	14,13	2,89	36,85	5,63	2,22	80,7	71,9	1,95
Cape Northern.....	2 667	244 100	6 122	10 469	165 217	13 016	91,53	2,30	3,93	61,95	4,88	1,90	55,0	69,3	1,24
Orange River.....	1 382	146 800	2 112	4 292	49 294	7 686	106,22	1,53	3,11	35,67	5,56	1,03	63,7	71,9	1,79
Border.....	1 035	55 400	7 046	4 565	45 175	8 425	53,53	6,81	4,41	43,65	8,14	1,96	73,0	58,8	1,85
Total for seven distribution undertakings	96 136	1 027 700	203 590	126 498	1 877 021	219 875	10,64	2,12	1,32	19,52	2,29	0,76	67,4	75,3	1,74

Source: ESCOM.

Working costs per GW.h sold varied between R8 140 per GW.h for Border Undertaking and R1 530 for Rand and Orange Free State Undertaking in 1982. These differences in working costs per GW.h sold can, to a great extent, be attributed to the difference in network length in kilometres per GW.h sold.

The system load factor of a distribution undertaking has an important effect on the cost per unit electricity consumed. The higher the load factor the lower the cost per unit consumed, in kW.h for example, because of the high fixed costs associated with the generation and distribution of electricity. Although the load factors of Cape Northern, Rand and Orange Free State, Eastern Transvaal, Cape Western and Orange River Undertakings varied only between 69,3 % and 71,9 % in 1982, the load factor of the Natal Undertaking was 73,1 % and that of the Border Undertaking only 58,8 %.

The working capital per GW.h sold varied between R61 950 in the Cape Northern Undertaking and R14 330 in the Natal Undertaking in 1982. In this respect the Natal and Rand and Orange Free State Undertakings are comparable while the Cape Western and Orange River Undertakings are of the same order.

In Table 2 information is given of sales in certain sectors of the different undertakings during 1982.

In 1982—

- ☆ *bulk sales* represented 33,6 % of the total Escom sales. Of Escom's total *bulk sales* 47,9 % and 26,2 % were sold by the Rand and Orange Free State and Natal Undertakings respectively;
- ☆ *sales to industries* were 32,2 % of the total Escom sales. Of the total sales to industries 45,7 %, 28,4 % and 18,3 % were sold by the Rand and Orange Free State, Eastern Transvaal and Natal Undertakings respectively;
- ☆ *sales to the mining sector* were 28,5 % of the total Escom sales. Of the total sales to the mining sector 82,4 %, 10,7 % and 5,6 % were sold by the Rand and Orange Free State, Eastern Transvaal and Cape Northern Undertakings respectively;
- ☆ *electricity for traction* represented 4,54 % of the total Escom sales. Of the total sales to this sector 35,5 %, 30,5 %, 13,6 % and 12,6 % were sold by the Rand and Orange Free State, Natal, Cape Western and Cape Northern Undertakings respectively;
- ☆ *domestic sales* represented only 1 % of Escom's total sales. Of this 55,8 %, 22,4 % and 14,5 % were sold by the Escom distribution undertakings in the Western Cape, Orange Free State and Natal respectively to individual clients. It should be pointed out that bulk purchasers of electricity from Escom sell to domestic users.

TABLE 2

INFORMATION ON SALES IN CERTAIN SECTORS IN DIFFERENT UNDERTAKINGS IN 1982

Undertaking	GW.h sales by undertakings in 1982										Average prices in cents per kW.h in 1982					
	Traction		Bulk		Mining		Industrial		Domestic		Traction	Bulk sales	Mining ¹	Industrial	Domestic	Total
	GW.h	% of Escom system	GW.h	% of Escom system	GW.h	% of Escom system	GW.h	% of Escom system	GW.h	% of Escom system						
Rand & OFS.....	1 572,9	35,5	15 502,0	47,9	22 557,3	82,4	14 150,2	45,7	228,6	22,4	3,217	2,798	2,430	2,685	4,564	2,634
Natal.....	1 354,9	30,5	8 470,3	26,2	334,1	1,2	5 665,2	18,3	148,6	14,5	3,524	2,591	3,274	2,647	4,743	2,724
Eastern Transvaal	560,6	12,6	1 715,5	5,3	2 942,0	10,7	8 804,3	28,4	30,9	3,0	2,805	2,254	2,210	2,107	3,987	2,173
Cape Western.....	603,9	13,6	3 899,2	12,1	—	—	1 941,9	6,3	569,9	55,8	4,505	2,804	—	4,308	5,846	3,614
Cape Northern.....	343,6	7,7	531,4	1,6	1 538,7	5,6	246,8	0,8	6,8	0,7	4,562	3,446	3,645	5,059	5,887	3,860
Orange River plus Cape Eastern Border	—	—	1 325,7	4,1	—	—	53,6	0,2	4,0	0,4	—	3,310	—	7,356	9,248	3,477
	—	—	904,3	2,8	—	—	97,3	0,3	32,9	3,2	—	4,013	—	6,256	7,151	4,323
Total for Escom.....	4 435,9	4,54	32 348,4	33,6	27 372,1	28,5	30 959,3	32,2	1 021,7	1,0	3,650	2,808	2,541	2,825	5,418	2,804

Source: ESCOM.

As regards the average price in cents per kW.h in 1982 the following is evident:

- ☆ Escom's average price was 2,804 c/kW.h while the Eastern Transvaal Undertaking with 2,173 c/kW.h represented the lowest and the Border Undertaking with 4,323 c/kW.h the highest average price for the year.
- ☆ The lowest price of 2,107 c/kW.h was paid by industries in the supply area of the Eastern Transvaal Undertaking, while the highest price of 7,356 c/kW.h was also paid by the industrial sector, but in this instance in the Orange River and Cape Eastern Undertakings.
- ☆ 2,254 c/kW.h was paid by bulk users in the Eastern Transvaal area as opposed to 4,013 c/kW.h in the Border Undertaking.
- ☆ Almost all the selling prices per kW.h in the different sectors conformed to the following pattern:
 - *Lowest prices* in cents per kW.h were paid in the Eastern Transvaal Undertaking and in order of *rising* prices were the Rand and Orange Free State, Natal, Orange River, Cape Western, Cape Northern and Border Undertakings.

Phase 1

STEP 2: DETERMINATION OF ACTUAL PATTERN OF RESOURCE UTILISATION

From an analysis of the financial and accounting data the pattern of resource utilisation is evident and shows—

- ☆ how assets have been distributed among the different units and activities, this will also highlight the most important units,
- ☆ the distribution of discretionary funds, i.e. funds which become available every year,
- ☆ the cash flow of every unit or activity,
- ☆ where management wishes to lay the emphasis as demonstrated by the placement of high-level personnel.

On 31 December 1982 the position was as follows as regards Escom's assets:

(a) Total assets in operation and under construction.....	R14 698 300 000
(b) Total fixed assets in operation and under construction.....	R12 858 500 000
(c) Total fixed assets as a percentage of total assets	87,5%
(d) Total fixed assets in operation	R7 841 900 000
(e) Works under construction	R5 016 600 000
(f) Works under construction as a percentage of assets in operation.....	64,0%
(g) Net increase in total assets during year	R2 714 900 000
(h) Capital investment per million kW.h sold	R79 980 in 1982
(i) <i>Total fixed assets in operation less plant, equipment and furniture—</i> R152 500 000.....	R7 689 400 000
(j) <i>Fixed assets in operation</i> as at 31 December 1982, were apportioned at cost as follows:	
Central Generating Undertaking.....	R5 739 046 000
— percentage of fixed assets.....	74,6%
Rand and Orange Free State Undertaking	R832 126 000
— percentage of fixed assets.....	10,8%
Natal Undertaking.....	R228 932 000
— percentage of fixed assets.....	3,0%
Eastern Transvaal Undertaking.....	R297 744 000
— percentage of fixed assets.....	3,9%
Cape Western Undertaking.....	R258 533 000
— percentage of fixed assets.....	3,4%
Cape Northern Undertaking.....	R165 217 000
— percentage of fixed assets.....	2,1%
Orange River Undertaking.....	R49 294 000
— percentage of fixed assets.....	0,6%
Border Undertaking	R45 175 000
— percentage of fixed assets.....	0,6%
(k) Works under construction as at 31 December 1982.....	R5 016 580 000
This amount was apportioned as follows:	
Central Generating Undertaking.....	R4 611 092 000
— percentage of total works under construction	91,9%

Rand and Orange Free State Undertaking	R995 597 000
— percentage of total works under construction	2,0%
Natal Undertaking.....	R64 374 000
— percentage of total works under construction	0,6%
Eastern Transvaal Undertaking.....	R44 514 000
— percentage of total works under construction	0,9%
Cape Western Undertaking.....	R37 143 000
— percentage of total works under construction	0,7%
Cape Northern Undertaking.....	R33 028 000
— percentage of total works under construction	0,7%
Orange River Undertaking.....	R19 623 000
— percentage of total works under construction	0,4%
Border Undertaking	R6 876 000
— percentage of total works under construction	0,1%
Head Office.....	R100 333 000
— percentage of total works under construction	2,0%

As Escom is a non-profit making utility an alternative basis was used as a yardstick to compare the different distribution undertakings, i.e. that of the capital/output ratio and capital invested as at 31 December 1982 divided by the income for the year 1982. For the year ended 31 December 1982 the following capital/output ratios applied:

(a) Capital/output ratio on basis of total assets in operation less redemption funds, etc.	2,30
(b) Capital/output ratio for—	
— Rand and Orange Free State Undertaking.....	0,58
— Natal Undertaking	0,53
— Eastern Transvaal Undertaking	0,77
— Cape Western Undertaking	1,02
— Cape Northern Undertaking	1,60
— Orange River Undertaking	1,03
— Border Undertaking.....	1,01

Escom's capital/output ratio based on total assets in operation less redemption funds, etc. includes assets of the Central Generating Undertaking, while *only* the capital of the distribution undertakings and their total income from electricity sales were taken into consideration to determine the capital/output ratio for each undertaking.

The position, as indicated by the above figures, may be summarised as follows:

- ☆ Escom's *fixed assets* represented 87,5 % of its total assets as at 31 December 1982,
- ☆ *total fixed assets in operation* represented 60,9 % of Escom's total assets as at 31 December 1982, while
- ☆ works under construction were 64,0 % expressed as a percentage of assets in operation.

These figures give an indication of the huge capital programme undertaken by Escom to satisfy further requirements as determined by it. The book value, which does not include depreciation, of Escom's fixed assets in operation as at 31 December 1982, was R7 841 900 000, i.e. the fixed assets created since 1923, *but*, and this is *extremely important, works under construction*, i.e. not yet commissioned, had already required as much as R5 016 600 000 million at 31 December 1982.

Of the total fixed assets in operation as at 31 December 1982, 74,6 % was invested in the Central Generating Undertaking while 91,9 % of the capital invested in works under construction was also for that undertaking.

As regards the distribution undertakings—

- ☆ Rand and Orange Free State Undertaking with 10,8 % of the fixed assets and a capital/output ratio of 0,58 % was the major contributor towards cash flow, while the figures for the other undertakings were respectively:
- ☆ Natal Undertaking, 3,0 % of the assets and capital/output ratio of 0,53
- ☆ Eastern Transvaal Undertaking, 3,9 % of the assets and capital/output ratio of 0,77
- ☆ Cape Western Undertaking, 3,4 % of the assets and capital/output ratio of 1,02
- ☆ Cape Northern Undertaking, 2,1 % of assets and capital/output ratio of 1,60
- ☆ Orange River Undertaking, 0,6 % of assets and capital/output ratio of 1,03
- ☆ Border Undertaking, 0,6 % of assets and capital/output ratio of 1,01.

The high capital/output ratio of Cape Northern Undertaking in 1982 was partly attributable to large extensions and the present partial utilisation of capacity in the undertaking.

PHASE 1

STEP 3: DETERMINATION OF BASIS OF THE COMPETITIVE ADVANTAGES OF THE ENTERPRISE

In the private sector the competitive advantages of the enterprise are derived from a comparison of Step 1 (scope) and Step 2 (resources) with those of competitors. In the case of Escom, which is in fact a statutory monopoly, competitive advantage is out of the question in respect of other enterprises in South Africa. To form an idea of Escom's *efficiency* it—

- ☆ can be rated in terms of the efficient application of its policy, philosophy and strategy and their suitability for the future, and
- ☆ a comparison with other similar enterprises in other countries.

The policy, philosophy and strategy of Escom, their success in the past and their suitability for the future are outlined in a paper "Electricity Supply in South Africa—A Strategy for Electric Utilities" read at a conference on 24 and 25 January 1983 of the South African National Committee of the World Energy Conference (SANCWEC) by Mr Jan H. Smith, Chairman of Escom. A brief summary of the main aspects of the paper is necessary to put the policy, philosophy and strategy of Escom in perspective.

The Chairman of Escom made the following important points, *inter alia*:

- ☆ In the past the world has successfully applied the philosophy that the wheels of the more advanced economies should be oiled with cheap, reliable and abundant supplies of electricity.
- ☆ Electricity was not viewed as a commodity from which wealth should be created merely by generating and selling it, but rather by the application of it, for example to mining and industry. This approach gave rise to the concept of the electricity utility.
- ☆ The system worked well and electricity was accepted as the ideal source of energy because it was cheap, reliable, available in abundance and the only practical form of energy for high technology.
- ☆ These concepts have recently begun to fade because—
 - the costs of generating electricity are continuously increasing,
 - there are signs that the reliability of supply is being questioned due to insufficient generating capacity in certain countries, and that
 - the economic realities of the present and the long lead times in the commissioning of additional capacity may harm the concept of the availability of electricity in abundance.
- ☆ In South Africa the Government has indicated that too sharp an increase in the price of electricity may harm the economy, especially during a recession.
- ☆ Consumers of electricity hold the same view, but Escom argues that increases in the electricity price were justified because prices in this country were very low compared with those of other countries. However, Escom is fully aware that the solution to higher costs involves more than merely increasing tariffs.
- ☆ Reduction in the cost of electricity to a level where price increases are limited or avoided may create shortages of electricity. However, if action were not taken to limit price increases electricity may reach unpayable levels.
- ☆ With the long lead times required to create capacity, the wrong strategic decisions at this point in time simply cannot be afforded.

Against this background the Chairman formulated Escom's objective and policy as follows:

Escom's objective is to provide an abundant and reliable supply of electricity at cost wherever it can be used for the economic growth of South Africa. The policy aimed at achieving the above-mentioned objectives was to extend the existing generating and distribution capacity continuously and timeously to satisfy the demand and in the process to make use of the best technology available to the electricity supply industry.

The Chairman also stated that:

- ☆ This policy was implemented with particular success and that a cheap, reliable and abundant supply of electricity was made available where and whenever the demand for it arose. In the implementation of this policy Escom has erected some of the worlds largest and technically most advanced power stations.
- ☆ Notwithstanding a number of large price increases over the past few years, Escom's tariffs are still among the lowest in the world.
- ☆ The economic development of South Africa has never been held back by insufficient availability of electricity.
- ☆ As regards the policy of using advanced technology and continuously extending installed capacity, it is clear that this has paid substantial dividends.
- ☆ since the middle of the seventies the following factors have begun to counteract the success achieved by Escom's policy:
 - *Firstly*, the continuous high inflation and the high financing costs made their contribution to the increasing costs of electricity generation. In a highly capital-intensive industry and because such a high percentage of Escom's development is financed by loans, Escom's costs spiralled and the consumer had to accept increased costs. A 2 000 MW power station that cost approximately R250 million to construct in 1970 would cost almost R1 500 million today—a sixfold increase in just over ten years.
 - *Secondly*, the cost advantages of technological progress are no longer as significant as they were in the past. In this respect it would appear that electricity supply technology has reached a plateau.
 - *Thirdly*, another factor that contributes to costs is that South Africa's basic electricity infrastructure has been completed, so that the associated cost advantages have stabilised. As the network was completed and phased in, immediate cost advantages took effect and were instrumental in keeping costs in check, especially in respect of areas far from the coal-fields. The effects of further phasing-in are limited now that the network is almost complete.
 - *Fourthly*, increased attention to and requirements for security and the prevention of pollution of the environment in recent years have resulted in higher electricity costs.
 - *Fifthly, and possibly at the root of the problem of increased electricity charges, is the question of growth in the demand for electricity.* In the past the continuous growth in the demand for electricity was a factor contributing to cheaper electricity. Currently, with the high inflation rate and the benefits of economies of scale exhausted, the growth in the demand for electricity adds to the price of electricity. If the growth in the demand for electricity could be disregarded, it would be possible to lower the price. However, Escom's forecasts indicate that the demand for electricity will increase at an average compound annual growth rate of 7 % and will decline only towards the end of the century. *The question arises whether it is necessary to add a part of the financing charges of future electricity requirements to current electricity costs. At this stage it must be done.* The long lead times in the construction of new plant and the uncertainty of the world economy require that at least part of the financial provision be made by Escom itself.
- ☆ It is clear that the environment in which the electricity supply industry operates has changed in recent years. The Chairman doubted whether these changes were sufficient to give rise to a change in the objectives and policy but suggested that certain adjustments be made.
- ☆ Where in the past Escom pursued the policy of matching the installed capacity continuously and timeously with the electricity demand, Escom also endeavoured to utilise the best technology available in the electricity supply industry. The Chairman suggested that the policy in respect of the installed capacity should remain unchanged, but that *in future Escom should*

pursue its objective to a greater extent by the application of sound business principles within the framework of a monopoly based on the inputs of the public and private sectors. In this respect two matters would be of predominant importance, viz—

- the expected growth in the electricity demand, and
- the necessity to curb cost increases.

- ☆ Although the expected growth in demand is determined by the market, a long-term view has to be taken of the country's electricity requirements.
- ☆ In view of the long lead times in providing capacity Escom could be accused of gross neglect of duty should economic growth be restricted in the future because Escom had saved costs in the short term by not making sufficient provision for the future.
- ☆ The Chairman warned that in South Africa, with its high economic growth rate, the decision to limit capacity provision in order to save costs would be a high-risk decision involving a high degree of danger.
- ☆ Escom has *already* accepted the following strategies in order to adapt:
 - A management approach corresponding to an increasing extent with that of the private sector business enterprise,
 - it has established a sound economic basis for its expansion programme,
 - Escom makes use of technological progress and imposes economic constraints without lowering technical standards.
- ☆ Finally the Chairman of Escom made the statement that the electricity supply industry in South Africa—as in many other parts of the world—finds itself in a dilemma: how should increased costs be handled without making electricity a high-cost commodity or endangering the abundant availability of electricity.

PHASE 1

STEP 4: DETERMINATION OF THE ACTUAL STRATEGIC CRITERIA OF OPTIONS

The actual criteria of strategic options depend to a large extent on the personal values of the owner or managers who in fact determine(s) the options to be made. The following is a brief summary of Escom's top organisation structure:

Efficiency of key personnel

Escom's top management team which takes the decisions, comprises:

Position	Present incumbents	
	Qualifications	Years of Escom service
Senior General Manager	Pr Eng, BSc Eng (M & I) GCC(E)	34
General Manager (Services)	Pr Eng, BSc Eng, GCC(E) MBL	23
General Manager (Finance)	BCom, CA (SA), FCA, ACMA	8
General Manager (Operations)	Pr Eng, BSc Eng, CE, GCC(M)	35
General Manager (New Works)	Pr Eng, BSc B Eng, GCC(E)	27

From the above table it is clear that the engineering-technical discipline exercises an important, if not predominant, influence on the decision-making process. This could lead to technically exemplary results but to the detriment of economic considerations and relations with consumers and other persons on the economic scene in South Africa.

However, attention should also be paid to the second level of decision-making and/or counselling, in which the Management Committee, comprising the following, participates:

Position	Present incumbents	
	Qualifications	Years of Escom service
Senior General Manager	Pr Eng, BSc Eng (M & I) GCC(E)	34
General Manager (Services)	Pr Eng, BSc Eng, GCC(E) MBL	23
Production Assets Manager	Pr Eng, BSc Eng(E)	14
Personnel Manager	D Phil, MA (Soc)	8
General Manager (Finance)	BCom, CA (SA), FCA, ACMA	8
Assistant General Manager (Finance)	Pr Eng, BSc Eng, GCC(E), MBL	33
General Manager (Operations)	Pr Eng, BSc Eng, CE, GCC(M)	35
Assistant General Manager (Operations)	Pr Eng, BSc Hons Eng, BSc(E), GCC(E)	30
General Manager (New Works)	Pr Eng, BSc B Eng, GCC(E)	27
Assistant General Manager (New Works)	Pr Eng, BSc Eng, GCC(E & M)	27
Legal Manager	BA LLB	23

Once again it is clear from the foregoing that the engineering-technical background plays a predominant part in influencing the decision-making process. The ratio is eight to three and of the three non-technical members two have eight years of Eskom service each as opposed to an average of 27 years each for the technically orientated management members. The comments under paragraph one therefore also apply here.

The composition of management in the undertakings follows the same pattern, and the Eastern Transvaal Undertaking, which serves as an example, is constituted as follows:

Position	Present incumbents	
	Qualifications	Years of Eskom service
Manager	Pr Eng, BSc Eng (E), GCC (E)	36
Assistant Manager (Procurement and Control)	BSc Eng (E), GCC (E)	26
Assistant Manager (Distribution) (Engineering Services)	Pr Eng, BSc Eng	17
Assistant Manager (Generation) (Engineering Services)	Pr Eng, BSc Eng, GCC (E)	15

It follows that all probability the technical approach will affect decision-making.

Commission

The members of the Electricity Supply Commission on 31 July 1983 were:

Name	Qualifications	Occupation
Jan H. Smith	Pr Eng, MA (Oxon), BSc (Oxon.) BSc Eng	Chairman of Eskom and director of companies. Actuary and director of companies.
D. J. Malan	MA MSc FFA	Director of companies.
E. Pavitt	BSc (M & M)	Attorney and director of companies.
J. F. W. Haak	BA LLB	Stockbroker and director of companies.
R. Castle	—	Farmer and director of companies.
J. Wilkens	BCom	Director of companies. (Retired at own request on 1 August 1983.)
L. F. Rive	BA	

From the foregoing it is clear that there is a reasonable balance of occupational disciplines and background in the ranks of the Commission that should contribute to a good balance in decision-making.

Commission meetings are attended *ex officio* by the Secretary, the Legal Manager and the Senior General Manager. Members of Management are involved as required by discussion of their particular areas of responsibility. In consequence of the combination of management levels it can be expected that recommendations to the Commission will have a strong technical flavour.

CHAPTER 2

PHASE 2: EVALUATION OF ESCOM'S PAST PERFORMANCE

STEP 1: DEFINING THE PAST PERFORMANCE OF THE UNDERTAKING

BROAD BACKGROUND

During the past 30 years the consumption of electricity in South Africa has increased by a factor of 9, while Escom's share in the supply of power over the same period increased from just over 70 % to just over 93 %.

Escom's installed capacity was 227 MW in 1930, 742 MW in 1940 and just over 1 600 MW in 1953. Since 1953 this installed capacity was doubled in the eight years up to 1961, had to be doubled again during the following eight years up to 1969 and had once more to be doubled by 1977. According to Escom the indications are that South Africa's demand for electricity will reach double that of 1977 during the next few years.

In order to maintain this growth rate of the power supply, Escom's capital expenditure has increased as follows:

1923-1930.....	R15 million
1931-1940.....	R39 million
1941-1950.....	R115 million
1951-1960.....	R491 million
1961-1970.....	R1 493 million
1971-1980.....	R6 863 million
1981.....	R1 947 million
1982.....	R2 756 million and
1983-1987 forecast.....	R21 787 million

Up to the end of 1982 the total capital expenditure since the establishment of Escom amounted to R13 719 million. At the *growth rate of the past* and the present inflation rate, Escom's needs are expected to amount to R21 787 million during the period 1983-1987.

During the period 1967-1974 the average selling price of electricity supplied by Escom increased from 0,5467 to 0,6822 cents per kW.h sold, that is by 3,21 % a year cumulatively, and during the period 1974-1983 it increased from 0,6822 to 2,8038 cents per kW.h, that is by 19,32 % cumulatively a year.

During the fifties and sixties only a minor part of Escom's financial commitments were financed from internal sources. As a result of problems with the negotiation of loans on the foreign markets, due to the deteriorating political climate and the fact that foreign bankers regarded the domestic contribution to financing as insufficient, Escom had to undertake its own financing to some extent.

In terms of the 1971 amendment to the Electricity Act, Escom was authorised to establish a Capital Development Fund and maintain it from income received.

In the following pages Escom's technical and financial performance over the past fifteen years is examined.

TECHNICAL AND FINANCIAL PERFORMANCE OVER THE PAST FIFTEEN YEARS

ELECTRICITY SENT OUT

Table 3 indicates Escom's share in national electricity supply, electricity sent out from the Escom system, the peak demand and the load factor of this system.

TABLE 3

INTEGRATED ESCOM SYSTEM: ELECTRICITY SENT OUT

Calendar year	Escom's share in national electricity supply				Electricity sent out			
	Republic of SA total mill. kW.h sent out	Escom electricity sent out as % of total for Republic	Mill kW.h sent out from Escom power stations	Mill. kW.h purchased from other sources	Mill. kW.h own consumption	Mill kW.h sent out from Escom system	Peak demand on integrated Escom system MW	Integrated Escom system load factor %
1967.....	36 897	77,1	28 371	70	—	28 441	4 227	76,8
1968.....	39 761	77,6	30 843	8	—	30 851	4 658	75,4
1969.....	42 847	78,4	33 598	8	—	33 606	5 055	75,9
1970.....	47 456	77,7	37 321	7	—	37 328	5 622	75,8
1971.....	51 081	79,8	40 739	8	—	40 747	6 115	76,1
1972.....	55 298	80,4	44 475	10	—	44 485	6 630	76,4
1973.....	60 080	82,8	49 759	11	—	49 770	7 350	77,3
1974.....	*65 498	85,9	56 251	8	—	56 259	8 552	75,1
1975.....	69 883	88,1	61 498	35	—	61 533	9 185	76,5
1976.....	75 381	89,4	66 188	1 226	—	67 414	10 085	76,1
1977.....	79 354	89,8	67 050	4 241	27	71 264	10 735	75,8
1978.....	84 812	91,7	70 902	6 924	52	77 774	11 490	77,3
1979.....	92 614	92,8	75 643	10 394	58	85 979	12 855	76,4
1980.....	99 904	93,0	83 362	9 659	71	92 950	13 668	77,5
1981.....	106 135	93,9	97 824	2 601	712	99 713	14 674	77,6
1982.....	109 536	93,6	102 769	2 151	2 404	102 516	15 532	75,3

* Estimates based on limited information.

Source: ESCOM.

The total kW.h, expressed in millions, sent out by the Escom system includes electricity sales to neighbouring states, while the electricity sent out for consumption in the Republic of South Africa does *not* include electricity sales to neighbouring states.

The average annual increase in the amount of electricity sent out for consumption in the Republic of South Africa and by the Escom system for different periods of time are reflected in Table 4.

TABLE 4

AVERAGE ANNUAL INCREASE IN THE AMOUNT OF ELECTRICITY SENT OUT

Period	Average annual increase in percentage per annum	
	Republic of South Africa	Sent out by Escom system
1950-1970.....	7,87	8,41
1970-1982.....	7,22	8,78
1967-1974.....	8,54	10,19
1974-1982.....	6,64	7,81

Source: ESCOM.

The amount of electricity sent out for consumption in the Republic during the period—

- ☆ 1950-1970 increased by a *higher average growth rate*, namely 7,87 % per annum, than during the period,
- ☆ 1970-1982, when the average growth rate was 7,22 % per annum.

In contrast with these trends, the amount of electricity sent out by the Escom system during the period—

- ☆ 1950-1970 increased at a lower average growth rate, namely 8,41 % per annum, than during the period,
- ☆ 1970-1982, when the average growth rate was 8,78 % per annum.

During the period 1967-1974 the amount of electricity sent out for consumption in the Republic, as well as that sent out by the Escom system, *both* increased at high average annual rates, namely 8,54 % and 10,19 %, while the period 1974-1982 was characterised by lower growth rates in both instances, namely 6,64 % and 7,83 %.

The average annual increase in the amount of electricity sent out by the Escom system was, in each of the periods indicated above, higher than the average annual increase in the total amount sent out for consumption in the Republic. Escom's share in the total national sales increased initially from 77,1 % in 1967 to merely 77,7 % in 1970, but subsequently and rapidly to 85,9 % in 1974 and 93,9 % in 1982.

If Escom's share of the total national sales in 1982 had still been 85,9 %, i.e. on the 1974 national market share level, the average annual growth rate of electricity sent out by the Escom system for the period 1974–1982 would have been only 6,62 %.

The peak demand on the integrated Escom system increased from 4 227 MW in 1967 to 15 532 MW in 1982, that is by 267 %, while the load factor during this period varied around an average of 76,4 % but remained between a minimum of 75,1 % in 1974 and a maximum of 77,6 % in 1981.

ELECTRICITY SALES BY THE INTEGRATED ESCOM SYSTEM

In Table 5 electricity sales by the integrated Escom system, the percentage annual growth, the average selling price in cents/kW.h and the average annual increase in the average selling price are indicated for each year during the period 1967–1982.

TABLE 5
INTEGRATED ESCOM SYSTEM: ELECTRICITY SALES

Calendar year	Million kW.h sold by Escom	Annual growth percentage	Average selling price in cents/kW.h	Average annual increase in average selling price %
1967.....	26 657,1	8,6	0,5467	4,1
1968.....	28 885,0	8,4	0,5550	1,5
1969.....	31 505,6	9,1	0,5565	0,3
1970.....	34 890,6	10,7	0,5545	-0,4
1971.....	38 040,0	9,0	0,5572	4,1
1972.....	41 648,9	9,5	0,6108	5,8
1973.....	46 578,4	11,8	0,6484	6,2
1974.....	52 585,1	12,9	0,6822	5,2
1975.....	57 869,2	10,0	0,7950	16,5
1976.....	63 355,7	9,5	1,0360	30,3
1977.....	67 125,4	5,9	1,5353	48,2
1978.....	72 780,4	8,4	1,7887	16,5
1979.....	80 582,8	10,7	1,8980	6,1
1980.....	87 539,3	8,6	2,0242	6,6
1981.....	93 844,0	7,2	2,2811	12,7
1982.....	96 135,9	2,4	2,8038	22,9

Source: ESCOM.

The annual growth rate in kW.h, expressed in millions, sold by Escom during the period 1967–1982 varied between the low growth of 2,4 % in 1982 and the highest annual growth of 12,9 % in 1974. These annual growth rates for sales by Escom, namely 10,7 %, 9,0 %, 9,5 %, 11,8 %, 12,9 %, 10,0 % and 9,5 % respectively for the years 1970 to 1976, are probably unique in the history of electricity sales.

The annual increase in the selling price of electricity varied from a decline of 0,4 % in 1970 to an increase of 48,2 % in 1977. The annual increase in the selling price of 16,5 %, 30,3 %, 48,2 % and 16,5 % for the years 1975, 1976, 1977 and 1978 respectively was also exceptional, except for the years 1981 and 1982, when it was 12,7 % and 22,9 %.

In Table 6 the average annual increase in the amount of electricity sold by Escom and in the average selling price is indicated for different periods.

TABLE 6
AVERAGE ANNUAL INCREASE IN AMOUNT OF ELECTRICITY SOLD BY ESCOM AND IN THE AVERAGE SELLING PRICE IN CENTS/KW.h FOR DIFFERENT PERIODS

Period	Average annual increase in percentage per annum	
	In amount of electricity sold by Escom	In selling price
1950–1960.....	8,82	6,36
1960–1970.....	8,04	0,88
1970–1980.....	9,64	13,82
1967–1974.....	10,19	3,21
1974–1982.....	7,83	19,32

Source: ESCOM.

After the selling price of electricity supplied by Escom had increased by an average of 6,36 % per annum during the fifties, the period 1960–1970 was characterised by an average increase of a mere 0,88 % per annum. The average increase during the period 1967–1974 was still only 3,21 % per annum but this figure increased to 19,32 % per annum for the period 1974 to 1982.

ELECTRICITY SALES BY DISTRIBUTION UNDERTAKINGS

Escom's electricity sales are handled by the distribution undertakings.

Over the years the boundaries of Escom's undertakings were extended in consonance with the growth of the Escom system. These boundaries were originally defined as strips along railway lines and circles where towns were situated. The present system whereby areas are defined by farm boundaries was adopted later. The boundaries of the different undertakings were consequently defined subjectively, mainly for historical reasons.

As the factors used in determining tariffs may differ from one undertaking to another, it may well happen that different tariffs apply on opposite sides of a boundary between two undertakings.

The difference in tariffs that apply in different undertakings is a complex subject which will not be examined at this stage.

With the formation of the Central Generating Undertaking on 1 January 1972 some assets in the other undertakings were transferred to that undertaking and the supply areas reclassified. Although most of the information for the period 1967-1982 is provided, it is nevertheless realistic to analyse certain trends in the distribution undertakings for the period 1972-1982.

During the period of 1972-1982 *total electricity sales* by Escom's distribution undertakings increased by 130,8 % for instance, from 41 648,8 GW.h sold in 1972 to 96 136,0 GW.h sold in 1982.

In Annexure A electricity consumption patterns are analysed, identifying years of exceptionally high consumption growth rates for Escom as a whole and for the different distribution undertakings with regard to the different sectors. Identification of the causes of these trends is also necessary.

This information is not only valuable in analysing past trends, but also useful in forecasting future consumption patterns.

This analysis due to its extensiveness is set out in the Annexure. To simplify future reference, the table numbers in the Annexure have been combined with those in the report.

Summary of important facts in connection with the growth of Escom's electricity sales during the period 1967-1982

The *bulk sales* sector achieved growth rates of 14,2 %, 15,6 %, 18,9 %, 21,7 % and 16,3 % respectively in the years 1971, 1972, 1973, 1974 and 1975 and a growth rate of 14,64 % during the period 1967-1974.

Sales to *industries* achieved growth rates of 15,2 %, 12,1 %, 14,6 %, 14,8 %, 12,1 %, 12,4 % and 13,6 % respectively in the years 1969, 1970, 1971, 1972, 1974, 1975, 1978 and 1979 and a growth rate of 13,27 % during the period 1967-1974.

Sales to the *mining* sector achieved growth rates of 10,3 % and 15,8 % respectively in the years 1970 and 1978 and a growth rate of 6,55 % during the period 1974-1982.

Sales for *traction* achieved growth rates of 11,4 %, 12,5 % and 10,7 % respectively in the years 1968, 1969 and 1980 and a growth rate of 7,62 % during the period 1967-1974.

Before the growth rate of electricity sales to the foregoing sectors in the different distribution undertakings is considered, it is necessary to have an insight into the market share of each undertaking to be able to evaluate the relative importance of percentages in the different undertakings.

The Rand and Orange Free State Undertaking with 56,2 %, the Natal Undertaking with 16,6 % and the Eastern Transvaal Undertaking with 14,6 % of the total Escom sales in 1982 together supplied 87,4 % of the total electricity sold by all undertakings during that year. In 1982 the Cape Western, Cape Northern, Orange River, Cape Eastern and Border Undertakings supplied 7,3 %, 2,8 %, 1,4 % and 1,1 % respectively of Escom sales.

The average annual Escom growth rate of 14,64 % for *bulk supply* during the period 1967-1974 was due *mainly* to growth rates of 14,7 % in the Rand and Orange Free State, 9,76 % in the Natal, 24,68 % in the Cape Eastern and 26,53 % in the Cape Western Undertakings during this period.

The average annual Escom growth rate of 13,27 % for electricity sales in the *industrial* sector during the period 1967-1974 was due *mainly* to growth rates of 10,72 % in the Rand and Orange Free State, 23,26 % in the Natal, 15,64 % in the Eastern Transvaal and 10,54 % in the Cape Western Undertakings during this period.

The average annual Escom growth rate of 6,55 % for electricity sales in the *mining* sector during the period 1974-1982 was due *mainly* to growth rates of 6,08 % in the Rand and Orange Free State, 7,42 % in the Natal, 7,08 % in the Eastern Transvaal and 15,33 % in the Cape Northern Undertakings during this period.

The average annual Escom growth rate of 7,62 % for sales of electricity for *traction* during the period 1967–1974 was due *mainly* to growth rates of 5,02 % in the Rand and Orange Free State, 9,80 % in the Natal, 4,90 % in the Eastern Transvaal, 4,19 % in the Cape Western and 13,90 % in the Cape Northern Undertakings during this period.

As the analysis in Annexure A indicates that the high annual growth rates of electricity consumption occurring in certain years and in certain sectors in different distribution undertakings may be non-recurrent, further attention was devoted to this aspect.

In this connection it must firstly be pointed out that annual growth rates for electricity sales by Escom were exceptionally high, particularly during the years 1970 to 1976—the years during which Escom's market share increased considerably.

Secondly, the high annual growth rate of electricity consumption in the different distribution undertakings, which may indicate non-recurrent high growth rates, should be investigated.

In this connection it is important to note that electricity sales increased by 36 255,6 GW.h in the Rand and Orange Free State, 12 252,4 GW.h in the Natal, 11 223,7 GW.h in the Eastern Transvaal and 5 481,8 GW.h in the Cape Western Undertakings during the period 1967–1982. These four undertakings were consequently responsible for 93,9 % of the increase in consumption during this period and therefore deserve special attention, in the order indicated above.

Possible non-recurrent high growth rates in the different undertakings are therefore discussed below:

☆ **Rand and Orange Free State Undertaking**

In 1970 electricity sales in this undertaking increased by 2 075 GW.h or 10,26 % above the sales for the previous year. This increased growth rate in the undertaking during 1970 was due mainly to increased sales to the mining sector, which increased by 1 129,5 GW.h during that year. In 1970 the growth of sales to the mining sector was 10,25 %, which was almost twice the average annual increase in sales of 5,51 % to this sector for the period 1967–1982.

During 1973 electricity sales increased by 2 730 GW.h or 10,83 %. The growth of sales to the mining sector was 1 125,2 GW.h during that year, this constituted a growth of 9 % above that of the previous year. Bulk sales during that year grew by 982 GW.h, which represented an increase of 20,55 % above that for the previous year, as against an average annual increase of 12,47 % during the period 1967–1982 in this sector. The reason for the high growth rate of bulk sales in 1973 was that sales more than trebled in Bloemfontein (which was connected during the previous year), Johannesburg and Pretoria municipalities. These municipalities operate their own power stations and purchase only part of their requirements from Escom. Because Escom has to meet the additional annual demand, growth in this category of sales is exceptionally high, especially in the initial stages. The 1973 growth rate in total bulk sales was more than 20 %, as against an average annual growth of 12,44 % during the period 1968–1982.

In 1974 electricity sales increased by 3 209 GW.h or 11,49 %. The growth rate of sales in 1974 was again due to a considerable increase (20,6 %) in bulk sales as a result of sales to the three major municipalities. Industrial sales, which increased by 17,8 % above that for the previous year, also contributed appreciably to the total growth.

The abnormal growth in industrial sales was due to increased sales to Metalloys, which installed new furnaces at Meyerton during this period, to ISCOR, which was developing its factory at Vanderbijlpark, and to AE & CI. Of the total growth of 11,48 % Metalloys alone was responsible for more than 1 % while ISCOR and AE & CI together were responsible for 0,9 %.

In 1976 electricity sales increased by 3 321 GW.h or 9,79 %. In 1976 the increase in bulk sales was still high; sales to Johannesburg Municipality alone were responsible for 1,2 % of the total growth. Industrial growth was reasonable—ISCOR was for instance responsible for almost 1 % of the total growth and growth of sales to the mining sector, though not exceptional, was above average.

The above average growth of 3 933 GW.h or 9,37 % in 1979 was due mainly to industrial sales. Sales to Metalloys alone were responsible for 1,2 % of the total growth and sales to AE & CI for more than 0,5 %. Growth in bulk sales to the mining sector during this year, though not exceptional, was also slightly above average.

☆ **Natal Undertaking**

In the Natal Undertaking the annual growth rate of electricity sales exceeded 9 % in 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1978 and 1979.

Durban Corporation is Escom's major consumer in the bulk category and as such dominated

sales by the Natal Undertaking. Particularly during the years 1969 to 1973 the growth in sales by this undertaking was to a great extent determined by the sales to Durban. In 1969 and 1970 the total growth was 12,5 % and 9,5 % respectively, sales to Durban alone being responsible for 5,6 % and 3,7 %.

In 1971 sales were 19,7 % higher than in 1970 and Durban Corporation again played an important part in this, because this consumer was responsible for 4,8 % of the growth. The main reason for the exceptional increase in sales was however the establishment of Alusaf's factory, which was responsible for 9,8 % of the growth during that year.

In 1972 the total growth rate declined to 14,26 %, which was, however, still exceptional. Durban Corporation and Alusaf again played a major part. They were responsible for 5,3 % and 5,8 % respectively of the total growth.

In 1973 the growth rate levelled out to 9,3 %. Sales to Durban during that year were still high compared with those in the previous year—the Corporation being responsible for 4,7 % of the total growth—but sales to Alusaf levelled out and were responsible for only 0,3 % of the total growth. During that year ISCOR commenced with activities in Newcastle while Feralloys and Holland Electro Chemical Company increased their consumption, so that these three consumers were responsible for approximately 0,6 % of the total growth.

The growth of 12,1 % in sales in 1974 was due mainly to industrial sales, Alusaf and ISCOR playing leading parts with 4,8 % and 1,0 % respectively of the total growth.

In 1978 the Richards Bay iron and titanium plant was connected and it was mainly this consumer that was responsible for the exceptional sales during 1978 and 1979. This plant alone was responsible for 4,8 % and 2,5 % respectively of the total growth in the years 1978 and 1979, and due to this consumer, the growth rate during 1978 would have been higher than that of 1979, if the increase in sales to Durban and other industrial consumers had not been abnormally low in 1978.

☆ **Eastern Transvaal Undertaking**

In the Eastern Transvaal Undertaking the annual growth rate of electricity sales failed to exceed the 9 % notch only in 1971, 1974 and 1982.

The Eastern Transvaal Undertaking serves a mineral rich area that was characterised by rapid industrial development during the period 1968–1982. In order to serve these industries electricity sales increased annually by an average of more than 11 % and, as already mentioned, there were only three calendar years, namely 1971, 1974 and 1982, when this increase was less than 9 %.

Unfortunately no detailed figures are available of sales to individual consumers prior to 1972. In 1973 Ferrometals was responsible for 4,2 % of a total growth of 16,5 % while bulk sales increased by more than 50 % to contribute almost 4 % to the total growth. Sales to smaller industries increased considerably and contributed almost 5 % to the total.

In 1975 the increase in sales was again high and during that year Highveld Steel and Vanadium and Ferrometals especially made important contributions. These consumers were responsible for 3 % and 3,7 % respectively of the total growth of 11,3 %. Sales to smaller industries were also important and contributed 2,6 % to the total.

The increase in sales in 1976 was lower than that of the previous year. Sales to the large industrial consumers showed a reasonable but not dramatic increase, except for those to Transalloys, which increased by 25,6 % to contribute 0,9 % of the total growth of 10,47 %. Sales to the smaller industrial consumers increased by an average of 23,6 % to contribute 4,2 % to the total.

In 1977 industrial sales again improved rapidly. The special factors that contributed to this were the new chromium plant at Tubatsi, which was commissioned late in 1976, an exceptional increase in consumption by Highveld Steel and Vanadium and the commissioning of the Consolidated Metallurgical Industries' plant. These three consumers together were responsible for 8,5 % of the total growth of 12,9 %. In addition it was also a good year for sales to the mining sector.

In 1978 the increase in sales to Highveld Steel and Vanadium, Tubatsi and Consolidated Metallurgical Industries was less dramatic but sales to other major and minor industries improved. In addition sales to Sasol increased substantially.

1979 was a particularly good year. Sales to industrial consumers were responsible for 11,1 % of the total and were made up as follows:

	<i>Contribution to total growth (%)</i>
Sasol.....	1,3
Highveld Steel.....	0,4
Tubatsi.....	1,2
Ferrometals.....	2,4
Palmiet Chrome.....	1,4
Rand Carbide.....	0,4
Transalloys.....	1,4
Consolidated Metallurgical Industries.....	0,9
Other.....	1,7
Total.....	11,1

These major industries which chiefly supply world markets felt the recession in the world economy in the years 1980, 1981 and 1982. In 1980 there was a levelling off in consumption and in 1981 and 1982 a decrease in consumption by most of the consumers.

An exception to this rule was Sasol, which supplies a relatively stable domestic market and which was responsible in 1980 and 1981 for 6,6 % and 11,1 % of the total growth of 10,2 % and 13,2 % respectively. In 1982 many major industries reduced their consumption; Sasol purchased only 5,2 % more electricity than in the previous year and sales for the undertaking as a whole were 3,6 % lower than those of the previous year.

★ *Cape Western Undertaking*

In 1967, 1969, 1970, 1971, 1972, 1973, 1974, 1975 and 1980 the annual growth rates of electricity sales in the Cape Western Undertaking exceeded the 9 % mark.

Sales by the Cape Western Undertaking during the period 1968–1982 were dominated by bulk sales to the Municipality of Cape Town. The average annual growth during this period was 11,0 % and there were only six years during which the growth did not exceed 9 %. Sales to industries, mostly small industries, also contributed considerably to the overall growth in sales, though a great deal less than did bulk sales.

Like Johannesburg, Pretoria and Bloemfontein, Cape Town operates its own power stations and provides a partial supply. As Escom has to supply the additional energy that is required annually, the growth in sales to this consumer was high, especially in the earlier stages. The exceptionally high growth rate experienced in 1974/1975 was due to assistance rendered to the Cape Town Municipality in order to reduce generation in its Table Bay power station, which was burning crude oil at that time. The abnormal growth in other bulk sales during 1973 was due to the extension of the undertaking's systems to connect Sutherland and Vredendal in the north and Oudtshoorn, Mossel Bay, George, Knysna and Plettenberg Bay in the south. The following year Albertinia, Riversdale, Stil Bay and Heidelberg were also connected.

★ *Cape Northern Undertaking*

In the Cape Northern Undertaking electricity sales increased from 519,9 GW.h in 1972 to 2 667,4 GW.h in 1982. In this undertaking the annual growth rate of electricity sales failed to exceed the 9 % notch only in 1969, 1970, 1980, 1981 and 1982.

The undertaking serves a mineral rich area which largely supplies an export market. This market was brisk up to the beginning of the eighties. In addition a major extension of the undertaking's distribution system was taken into service during 1978, which had a marked effect on sales. The growth rate of sales was consequently high and during the period 1968 to 1982 the average was 11,3 % a year. In nine of the 14 years it exceeded 9 %. The major consumer category of the undertaking is the mining sector.

Unfortunately no figures are available for sales before 1972. Sales to this sector reflect the fluctuations in the demand for the different minerals. As mining also produces heavy minerals, such as iron ore, manganese and lime, which have to be transported by rail, sales for traction are also related to mining operations.

The exceptionally high growth rate during 1972 and 1973 was due mainly to the development of Prieska Copper Mines' mine but was also influenced by the beginning of mining activities at Sishen.

In 1973 bulk sales also increased considerably when Upington was connected.

In 1977 growth was attributable mainly to increased activity at the Sishen mine. Sales to "other" mining groups also increased during that year and probably represented sales to the manganese industry.

In 1978 the distribution system to the Atlantic coast was taken into service and additional loads, among others those of Consolidated Diamond Mines at Oranjemund and the O'Kiep copper mine at Springbok, were responsible for the exceptionally high growth rate. The high growth rate continued into 1979. In that year the Sishen-Saldanha railway line was electrified, and this led to an exceptional growth in sales for traction.

After 1979 the market for minerals started levelling out and consequently the growth rate declined. In 1982 sales were lower than those of the previous year.

☆ **Orange River Undertaking**

An application for the establishment of the Orange River Undertaking was submitted to the Electricity Control Board in December 1966 and the undertaking began its activities in 1967 by building a system connecting the towns of Rouxville, Smithfield and Zastron to Aliwal North. The increase in bulk sales during the first few years, up to 1973, was due to the connection of small municipalities. In 1973 Port Elizabeth Municipality was connected and from that date this consumer dominated the undertaking's sales.

For these reasons the undertaking showed a considerable growth rate, especially in the initial years, as can be expected of any young undertaking. The average annual growth rate during the period 1968–1982, though not a very meaningful figure in the circumstances, was very high and the first time the growth rate failed to reach 9 % was in 1977.

The growth in sales by the undertaking is determined mainly by the demand of Port Elizabeth Municipality.

Industrial sales increased fairly rapidly until 1973, but declined later. The reason for this was that many of the sales were to contractors involved in the Orange River project. With the systematic completion of this project there was a gradual decline in sales to the industrial sector.

☆ **Cape Eastern Undertaking**

Before its incorporation into the Orange River Undertaking in 1981, this undertaking served the valley of the Sondags and Gamtoos Rivers as well as Kareedouw on the banks of the Krom River. These were rural supplies. Industries in the area are based on agriculture and forestry, e.g. fruit-packing and the treatment of wooden poles.

Bulk supplies were provided to Kirkwood in the Sondags River Valley (from as early as 1968) and to Humansdorp which was connected in 1977.

Domestic supplies were provided mainly to consumers in Hankey, Patensie and Kareedouw where Escom was responsible for the distribution. The increase in sales reflects mainly the development of the undertaking's distribution system.

☆ **Border Undertaking**

In the Border Undertaking the annual growth rates of electricity sales exceeded the 9 % notch in 1970, 1971, 1972, 1973, 1974, 1976 and 1980.

The Border Undertaking serves an area where there are no mining activities. So far there have been no electrified railways and industries are small and use little electricity. The major consumers are the bulk buyers and in this category sales to the Municipality of East London predominate. The average growth rate during the period 1968–1982 was just over 9 % and there were six years during which the growth rate exceeded this figure. The high growth rate and bulk sales were due not only to sales to the East London Municipality (whose average annual growth rate was 6,2 %) but also to a number of other municipalities which were connected during that period, e.g. Queenstown and Umtata in 1975.

THE CENTRAL GENERATING UNDERTAKING

Plant in Escom's power stations

The Central Generating Undertaking has a number of coal-fired, gas turbine, hydro-electric and pumped-storage stations in service, the plant having been installed as indicated in Tables 18 and 19.

During the period 1950–1970 coal-fired power stations supplied between 99,9 % and 100 % of Escom's power annually, but since 1970 this percentage decreased gradually to 97,5 % in 1982. Up to 1982 power output by coal-fired power stations was predominant in the Escom system.

Of the 138 turbo-generators in operation in Escom's coal-fired power stations in December 1982, 86 were in service before 1967 and 52 were commissioned since the beginning of that year.

In 1967 Escom had twenty-one 60 MW and seven 100 MW sets, which were at that time the sets with the highest rating, in service in coal-fired power stations. Since then only another two 60 MW and another three 100 MW sets were commissioned.

The extension of Escom's generating capacity since 1967 is shown in Table 20.

In 1967 Escom commissioned four 200 MW sets at Camden Power Station. During the period 1967-1977 a total of twenty-four 200 MW sets were commissioned at Camden, Grootvlei and Hendrina Power Stations.

The first 350 MW set was commissioned at Arnot Power Station in 1971. In total six 350 MW sets have been commissioned, all at Arnot. The last of these sets was commissioned at Arnot in 1975.

TABLE 18
PRINCIPAL PLANT INSTALLED IN COAL-FIRED POWER STATIONS AS AT 31 DECEMBER 1982

Power station	Installed rating		*Station capacity Assigned sent-out-rating MW	Boilers		Main turbo-generators		Steam conditions at by turbine-inlet	
	Boilers kg/s	Generators MW		Number	Maximum continuous rating each kg/s	Number	Normal rating each MW	Pressure MPa (abs)	Temperature °C
Coal fired power stations									
Arnot	1 998,6	2 100	1 980	6	333,1	6	350	15,9/3,98	510/510
Camden.....	1 814,4	1 600	1 520	8	226,8	8	200	10,3	538
Colenso	90,8	50	70	4	22,7	2	25	2,0	385
	50,4	30		2	25,2	1	30	2,0	385
	141,2	80		6		3			
Duvha.....	2 028,0	2 400	2 300	4	507,0	4	600	16,1/3,55	535/535
Grootvlei	1 071,0	1 200	1 130	5	214,2	6	200	10,3	538
	230,6			1	230,6			10,3	538
	1 301,6	1 200		6		6			
Hendrina	2 142,0	2 000	1 900	10	214,2	10	200	10,3	538
Hex River	100,8	60	111	4	25,2	3	20	4,2	427
	69,2	60		2	34,6	2	30	4,2	482
	170,0	120		6		5			
Highveld.....	554,4	480	412	8	69,3	8	60	6,3	482
Ingagane.....	567,0	500	465	5	113,4	5	100	8,4	510
Klip	544,8	396	325	24	22,7	12	33	2,5	390
		**28							
	544,8	424		24		12			
Komati	567,0	500	906	5	113,4	5	100	8,4	510
	566,8	500		4	141,7	4	125	8,4	510
	1 133,8	1 000		9		9			
Kriel.....	2 640,0	3 000	2 850	6	440,0	6	500	16,0/3,17	510/510
Matla	2 541,0	3 000	2 875	5	508,2	5	600	16,1/3,68	535/535
Salt River.....	328,0	120	228	10	32,8	4	30	4,2	482
		120				2	60	4,2	482
	328,0	240		10		6			
Taibos.....	584,0	480	440	8	73,1	8	60	4,2	441
Umgeni	181,6	120	222	8	22,7	4	30	4,2	454
	164,0	120		5	32,8	2	60	4,2	454
	345,6	240		13		6			

Power station	Installed rating		*Station capacity	Boilers		Main turbo-generators		Steam conditions at by turbine-inlet	
	Boilers kg/s	Generators MW		Number	Maximum continuous rating each kg/s	Number	Normal rating each MW	Pressure MPa (abs)	Temperature °C
Vaal.....	430,2	297 ***21	270	18	23,9	9	33	2,5	427
	430,2	318		18		9			
Vierfontein	503,5	360	336	19	26,5	12	30	4,2	441
West Bank.....	85,6	45	80	4	21,4 26,5	3	15 20	2,9 2,9	427 427
	53,0	40		2		2			
	138,6	85		6		5			
Wilge.....	62,8	60 180	221	4	15,7 50,4 73,1	2 3	30 60	4,2 4,2	454 454
	201,6			4					
	73,1			1					
	337,5	240		9		5			
Total, coal-fired power stations.....	20 244,2	19 867	18 641	186		138			

* Difference between installed and sent-out rating indicates the power station's internal consumption.

** Four 7 MW house sets installed at Klip.

*** Three 7 MW house sets installed at Vaal.

Source: ESCOM.

TABLE 19

PRINCIPAL PLANT INSTALLED IN OTHER STATIONS AS AT 31 DECEMBER 1982

Power Station	Installed rating		*Station capacity	Boilers		Main turbo-generators		Steam conditions at turbine-inlet	
	Boilers kg/s	Generators MW	Assigned sent-out rating MW	Number	Maximum continuous rating each kg/s	Number	Normal rating each MW	Pressure MPa (abs)	Temperature °C
Gas-turbine Stations									
Acacia.....		171	171			3	57		
Port Rex.....		171	171			3	57		
Total, gas-turbine stations		342	342			6			
Hydro-electric stations									
Hendrik Verwoerd.....		320	320			4	80		
Vanderkloof.....		220	220			2	110		
Total, hydro-stations		540	540			6			
Pumped-storage station									
Drakensberg		1 000	1 000			4	250		
Total, pumped-storage station		1 000	1 000			4			
Total, all Eskom	20 244,2	21 749	20 523	186		154			

Other power sources

Fire capacity available
to Eskom MW

Cahora Bassa

1 373

* Difference between installed and sent-out rating reflects the power station's internal consumption.

Source: ESCOM.

TABLE 20

EXTENSION OF ESCOM'S GENERATING CAPACITY (FIGURES IN MW)

Year	Size of sets of MW							Number of sets	Total capacity	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW
	20	60	100	200	350	500	600														
1967	1	2	1	4				8	1 040	West Bank	1 × 20	Salt Rivier	2 × 60	Ingagane	1 × 100	Camden	4 × 200				
1968			1	2				3	500					Ingagane	1 × 100	Camden	2 × 200				
1969	1		1	4				6	920	West Bank	1 × 20			Ingagane	1 × 100	Camden Groot-vlei	2 × 200 2 × 200				
1970				3				3	600							Hen-drina Groot-vlei	2 × 200 1 × 200				
1971				3	2			5	1 300							Hen-drina Groot-vlei	2 × 200 1 × 200	Arnot	2 × 350		
1972				1	1			2	550							Hen-drina	1 × 200	Arnot	1 × 350		
1973				2	1			3	750							Hen-drina Groot-vlei	1 × 200 1 × 200	Arnot	1 × 350		
1974				1	1			2	550							Hen-drina	1 × 200	Arnot	1 × 350		

Year	Size of sets of MW							Number of sets	Total capacity	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW	Power Station	Set MW
	20	60	100	200	350	500	600														
1975				1	1			2	550		Hen-drina	1 × 200	Arnot	1 × 350							
1976				2		1		3	900							Hen-drina	1 × 200			Kriel	1 × 500
1977				1		1		2	700							Groot-vlei	1 × 200			Kriel	1 × 500
1978						2		2	1 000											Kriel	2 × 500
1979						2	1	3	1 600											Kriel	2 × 500
1980							4	4	2 400												Matla Duvha 2 × 600
1981							2	2	1 200												Duvha Matla 1 × 600
1982							2	2	1 200												Duvha Matla 1 × 600
Total in Service December 1982	5	23	10	24	6	6	9	138	19 918												
Commissioned during 1967–1982	—	2	3	24	6	6	9	52	15 760												

Source: ESCOM.

The first 500 MW set was commissioned at Kriel Power Station in 1976, and the last of a total of six sets having this rating was commissioned in 1979. All Escom's 500 MW sets were installed at Kriel Power Station.

The first 600 MW set was commissioned at Matla Power Station in 1979 and nine sets of that capacity were subsequently commissioned at Matla and Duhva Power Stations up to the end of 1982.

While Escom's coal-fired generating capacity at the beginning of 1967 was 4 158 MW and the sets with the highest capacity were *seven* of 100 MW each—

- ☆ *twenty-four 200 MW* sets with a combined capacity of 4 800 MW were commissioned during the period 1967–1977,
- ☆ *six 350 MW* sets with a combined capacity of 2 100 MW during the period 1971–1975,
- ☆ *six 500 MW* sets with a combined capacity of 3 000 MW during the period 1976–1979, and a further
- ☆ *nine 600 MW* sets with a combined capacity of 5 400 MW during the period 1979–1982.

The rapid increase in generating capacity entailed not only an increase in the size of sets from 100 MW to 600 MW during the period 1967–1982, but also a considerable increase in steam pressures and temperatures at the turbo-generator inlets. During the past few decades Escom also switched from the steam range system to the unit system.

Performance of Escom's coal-fired power stations

In Table 21 information is provided of coal consumed, coal costs, total power station output in million kW.h sent out by coal-fired power stations, and also for all power stations for every year during the period 1967–1982. In addition coal-fired power station output as a percentage of the total, the assigned total sent-out rating and the average power station load factor are also given for each of the years mentioned above.

The heat content of coal burnt between 1950 and 1975 did not vary much from year to year and remained at an average of 22,54 MJ/kg during this period. The heat content of coal burnt since 1975, however, decreased to an average of 21,49 MJ/kg for the period 1976–1982.

The average annual increase in—

- ☆ total power output by coal-fired power stations,
- ☆ overall thermal efficiency,

TABLE 21
POWER STATION OPERATING STATISTICS

Calendar year	Coal-fired power stations						Total power station output million kW.h sent out			Total power station capacity (assigned sent-out rating MW)	Peak demand on integrated Escom system rating MW	Assigned sent-out rating + Peak Escom system demand %	Average power station load factor sent-out basis %
	Thousands of tons	Coal consumed			Coal costs		Coal-fired power stations	Total power station output	Coal-fired power station output as % of total				
		Average heat content MJ/kg	Average heat rate MJ/kW.h sent-out	Overall thermal efficiency % sent-out basis	Costs average rand/ton	Cents/kW.h sent-out							
1950.....	6 323,4	22,72	19,74	18,2	0,84	0,0729	7,276	7,287	99,8	1,290	**1 182	109,1	64,7
1951.....	6 662,9	22,72	19,43	18,5	0,98	0,0840	7,797	7,806	99,9	1,361	**1 212	112,3	66,1
1952.....	7 113,4	22,75	19,68	18,3	1,20	0,1037	8,220	8,227	99,9	1,454	**1 265	114,9	66,9
1953.....	7 393,9	23,08	19,32	18,6	1,33	0,1116	8,838	8,845	99,9	1,635	**1 394	117,3	65,5
1954.....	8 024,9	23,06	18,56	19,4	1,41	0,1136	9,971	9,977	99,9	1,846	**1 570	117,6	66,4
1955.....	8 999,7	22,89	18,04	20,0	1,52	0,1201	11,419	9,977	99,9	1,846	**1 806	102,2	66,4
1956.....	9 688,5	22,96	17,56	20,5	1,62	0,1236	12,663	12,670	99,9	2,498	**2 001	124,8	61,2
1957.....	10 220,6	22,79	17,09	21,1	1,59	0,1266	13,634	13,640	99,9	2,555	**2 151	118,8	61,1
1958.....	10 784,1	22,73	16,89	21,3	1,77	0,1312	14,511	14,516	99,9	2,748	**2 249	122,2	62,0
1959.....	11 548,7	22,44	16,43	21,9	1,82	0,1329	15,774	15,777	99,9	2,983	**2 429	122,8	62,6
1960.....	12 512,6	22,52	16,28	22,1	2,03	0,1466	17,306	17,308	99,9	3,091	**2 605	110,7	65,2
1961.....	13 194,9	22,39	16,17	22,3	2,10	0,1516	18,282	18,284	99,9	3,226	**2 733	118,0	66,2
1962.....	13 955,5	22,22	15,98	22,5	2,09	0,1507	19,409	19,404	99,9	3,406	**2 925	116,4	65,8
1963.....	14 721,1	22,15	15,68	23,0	2,11	0,1492	20,789	20,793	99,9	3,788	**3 183	119,0	65,7
1964.....	15 654,7	22,15	15,33	23,5	2,07	0,1430	22,634	22,639	99,9	4,077	**3 460	117,8	65,2
1965.....	16 726,7	22,39	15,23	23,6	2,09	0,1423	24,583	24,583	100,0	4,181	**3 669	113,9	67,4
1966.....	16 982,3	22,20	14,79	24,4	2,23	0,1486	25,504	25,504	100,0	4,377	3 906	112,05	67,1
1967.....	18 307,7	22,44	14,47	24,9	2,30	0,1482	28,371	28,371	100,0	5,328	4 227	126,0	66,8
1968.....	19 133,9	22,63	14,03	25,6	2,33	0,1446	30,843	30,843	100,0	5,800	4 658	124,5	62,9
1969.....	19 982,9	22,73	13,52	26,6	2,37	0,1412	33,598	33,598	100,0	6,441	5 055	127,4	62,1
1970.....	21 630,6	22,97	13,32	27,0	2,26	0,1308	37,321	37,321	100,0	7,060	5 622	125,6	62,9
1971.....	23 416,2	23,30	13,42	26,8	2,25	0,1297	40,645	40,739	99,7	8,373	6 115	136,9	61,3
1972.....	24 952,8	22,89	13,07	27,5	2,25	0,1285	43,662	44,475	98,1	9,849	6 630	148,6	59,6
1973.....	27 907,9	22,47	12,65	28,5	2,39	0,1348	49,570	49,759	99,5	9,482	7 350	129,0	62,5
1974.....	30 891,4	22,42	12,56	28,7	2,92	0,1637	55,141	56,251	98,0	10,002	8 552	117,0	66,3
1975.....	34 231,7	22,21	12,59	28,6	4,05	0,2295	60,400	61,498	98,2	10,552	9 185	114,9	68,6
1976.....	37 251,4	21,87	12,66	28,4	5,39	0,3122	64,309	66,188	97,2	11,688	10 085	115,9	66,8
1977.....	37 505,6	21,87	12,55	28,7	6,22	0,3582	65,114	67,050	97,1	12,756	10 735	118,8	61,9
1978.....	39 589,5	21,61	12,44	28,9	6,67	0,3824	69,004	70,902	97,3	13,595	11 490	118,3	60,7
1979.....	43 264,9	21,22	12,33	29,2	6,96	0,4045	74,485	75,643	98,4	15,056	12 855	117,1	60,9
1980.....	46 755,0	21,34	12,16	29,6	8,12	0,4614	82,345	83,362	98,7	17,339	13 668	126,9	57,8
1981.....	53 903,7	21,25	12,01	30,0	9,71	0,5473	95,675	97,824	97,8	18,989	14 474	131,2	62,2
1982.....	55 198,4	21,39	11,82	30,5	11,75	0,6471	100,217	102,769	97,5	20,523	15 532	132,1	59,3

* As at 31 December 1982.

** Source: ESCOM.

- ☆ coal costs in rand/ton,
- ☆ coal costs in cents per kW.h sent out,
- ☆ total power station capacity,
- ☆ the peak demand on Escom's integrated system and the

change in the average power station load factor for different periods is shown in Table 22.

The average annual increase in the power output of all power stations was 9,1 % in the fifties, 8,0 % in the sixties, and 8,2 % in the seventies. During the period 1970–1974 the average annual growth rate was 10,3 % as against 7,8 % for the period 1974–1982. It is therefore obvious that *the exceptionally high annual growth rate of 10,3 % in the output of all coal-fired Escom power stations during the period 1970–1974 was approximately 2 % higher than that during the sixties and the rest of the seventies.*

The average annual increase in power station capacity, compared with the average annual growth in output, was 9,1 % as against 9,1 % in the fifties, 8,0 % as against 8,6 % in the sixties, and 9,4 % as against 8,2 % in the seventies.

Although the annual power output increased by 1 277 % during the period 1950–1982, the assigned power station rating increased by 1 490 % during the same period.

The average annual increase in the coal price in rand per ton was 9,2 % in the fifties, 1,08 % in the sixties and 13,6 % in the seventies. During the period 1970–1974 the average annual increase in the coal price was 6,6 % as against 19,0 % for the period 1974–1982. The annual average percentage increase in the coal price was obviously very low during the sixties and this low increase was maintained up to 1974. The average price, which was R2,03 per ton in 1960, increased during the next 15 years to the 1974 price of a mere R2,92 per ton. The annual average percentage increase in the coal price has shown a steep upward trend since 1974 and reached an average increase of 19,0 % per annum for the period 1974–1982.

The average annual increase in coal costs in cents/kW.h was 7,2 % in the fifties, –1,1 % in the sixties, and 13,4 % in the seventies. During the period 1970–1974 the average annual increase in the coal cost in cents/kW.h was 5,8 % while it was 18,7 % for the period 1974–1982.

Thermal efficiency has shown a continuous annual improvement, from 18,2 % in 1950 to 28,7 % in 1974 and 30,5 % in 1982. This improvement of 67,5 % over the entire period was an achievement indeed and has contributed considerably towards limiting coal costs, in cents per kW.h sent out, notwithstanding the rising coal price in rand per ton during this period.

The average annual improvement in the thermal efficiency of the coal-fired power stations was 2,0 % in the fifties, 2 % in the sixties, and 0,9 % in the seventies. During the period 1970–1974 the average annual improvement was 1,5 %, while it was 0,9 % in the period 1974–1982. *It is clear that the rate at which the thermal efficiency of coal-fired power stations could be improved, has decreased since 1970. This trend has become more marked since 1974.*

TABLE 22

AVERAGE ANNUAL INCREASE IN TOTAL POWER OUTPUT, THERMAL EFFICIENCY, COAL COST, TOTAL POWER STATION CAPACITY AND THE AVERAGE LOAD FACTOR FOR COAL-FIRED POWER STATIONS DURING VARIOUS PERIODS

Period	Average annual growth in power output of coal-fired power stations	Average annual increase in power station capacity	Average annual increase in coal price R per ton	Average annual improvement in thermal efficiency	Average annual increase in coal cost in cents per kW.h sent-out	Average power station load factor
	%	%	%	%	%	%
1950–1955.....	—	—	—	—	—	65,9
1955–1960.....	—	—	—	—	—	63,0
1950–1960.....	9,1	9,1	9,2	2,0	7,2	—
1960–1965.....	—	—	—	—	—	65,9
1956–1970.....	—	—	—	—	—	64,9
1960–1970.....	8,0	8,6	1,08	2,0	–1,1	—
1970–1975.....	—	—	—	—	—	64,5
1975–1980.....	—	—	—	—	—	62,5
1970–1980.....	8,2	9,4	13,6	0,9	13,4	—
1970–1974.....	10,3	9,1	6,6	1,5	5,8	—
1974–1982.....	7,8	9,4	19,0	0,8	18,7	—
1980–1982.....	—	—	—	—	—	59,9

Source: ESCOM.

During the fifties the improvement in the thermal efficiency by 2 % a year increased the average annual coal costs, calculated in cents per kW.h, by only 7,2 % a year, although the coal costs, in rand per ton, increased by an average of 9,2 % a year during the same period. In this connection an extraordinary feature of the sixties was that the general thermal efficiency had improved by an average of 2 % a year while the coal price in rand per ton increased by an average of only 1,08 % a year so that the average coal costs in cents per kW.h decreased by 1,1 % a year. Although the thermal efficiency was indeed improved by an average of 0,9 % a year during the seventies, it assisted only in reducing the annual average coal price increase, in rands per ton, from 13,6 % to 13,4 %, in terms of the coal costs per kW.h sent out.

In Table 21, the column that shows the assigned sent-out rating divided by the peak Escom system demand indicates the quantity by which the sent-out rating exceeded the peak Escom system demand, provided the generating capacity was available at the time of the peak demand.

During the period 1950–1966 the assigned rating, as a percentage of the peak demand, varied between 109,1 % and 122,8 %, with ± 117 % to 118 % as the normal figure. With the exception of a few years, namely 1974–1979, when the figure was below 120 %, and even as low as 114,9 % in 1975, the assigned rating exceeded 120 % and varied between 124,5 % and 148,6 %. This percentage was 126,9 %, 131,2 % and 132,1 % in 1980, 1981 and 1982 respectively.

The mean annual load factor of the coal-fired power stations decreased from 65,9 % in the first five years of the fifties and sixties to 62,5 % in the period 1975–1980 and to 59,8 % during the period 1980–1982.

In view of the predominant part coal-fired stations play in the Escom system, their efficiency has been investigated further.

Table 23 provides the data in respect of the assigned sent-out rating, nominal capacity of each generator in MW, steam conditions, power station availability during the period 1973–1982, as well as general thermal efficiency and the total station factor for each year during the period 1967–1982.

The figures indicate that the availability of all of Escom's coal-fired power stations combined dropped from 82,3 % in 1973 to 73,1 % in 1982, while the five-yearly average availability of all the coal-fired power stations dropped from 82,1 % for the period 1973–1977 to 74,9 % for 1978–1982.

Only in the case of Colenso, Vierfontein and Taaibos did the percentage availability for the period 1978–1982 reach a higher level than that for the period 1973–1977.

The arithmetical average availability of the *seventeen power stations in operation for the full ten years (1973–1982)* was 85,9 % for the period 1973–1977, while it was only 80,2 % for the years 1978–1982. If Colenso, Vierfontein and Taaibos were not taken into consideration, i.e. if the performance of only the other *14 power stations* that were in service for both of the five-year periods were evaluated, the percentage availability for the period 1973–1977 would be considerably higher than that for the period 1978–1982.

POWER STATION DATA

% availability—Total for all coal-fired power stations	82,3	83,6	84,9	82,1	77,5	76,6	77,7	73,6	73,3	73,1	82,1	74,9	79,7
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Station load factor = $\frac{\text{kW.h sent-out} \times 100}{\text{assigned sent-out rating (MW)} \times \text{hours in year}}$

$$\text{Station load factor} = \frac{\text{kW.h sent-out} \times 100}{\text{assigned sent-out rating (MW)} \times \text{hours in year}}$$

The average percentage general annual thermal efficiency for any particular power station has not varied much during the past 15 years. Among individual power stations the general annual thermal efficiency varied between 17,8 %, in the case of Colenso Power Station, and 34,2 % in the case of Kriel Power Station.

The average annual station factor varied from an average of 23,9 % for Hex River, to 80,8 % for Wilge.

Table 24 gives the capacity of the main turbo-generators, the steam pressure and temperature, the average general thermal efficiency, and the average percentage annual availability in ascending order of technical efficiency for all Escom's coal-fired power stations.

An analysis of Table 25 indicates that, as steam pressure and temperature and the size of the sets were increased, the average thermal efficiency increased from 23,5 % for a pressure of 4,2 MPa (abs), temperatures between 441° and 482 °C, and sets of 20, 30 and 60 MW to a thermal efficiency of 33,9 % for a pressure of 16,1/3,68 MPa (abs) and the temperature of 535/535 °C and sets of 600 MW, but that the availability of the various sets dropped from 87,1 % for the older, smaller, low-pressure sets to 66,8 % for 600 MW high-pressure sets.

It may be argued that by the end of 1982 availability figures had been established for only seven years for Kriel, four years for Matla, and three years for Duvha and that *these periods* are too short to serve as a valid basis for conclusions.

On the other hand it is clear, from the figures in Table 25 and the curve in Graph 1 that the percentage availability for groups of power stations has dropped, from 87,1 % for those with smaller, low pressure and temperature sets, to 84,1 % for 100 MW sets, 78,1 % for 200 MW sets and to 72,2 % for 350 MW sets. These results are based on figures assembled over periods of 10 years.

Although figures for shorter periods only are available for Kriel, Matla and Duvha Power Stations, these figures clearly follow the trends indicated by the other figures covering periods of ten years.

The *low average availability* of 67,3 % for the 500 MW and 600 MW sets at Kriel, Matla and Duvha Power Stations, which was achieved over the recent period, and which corresponds to the trends in Graph 1, is a cause for concern.

The new coal-fired sets that are to be commissioned during the next few years will also be large, high pressure and temperature sets of the Matla and Duvha type, and will contribute a relatively large percentage of the total Escom generating capacity in the future. If present trends of availability continue the total for all coal-fired power stations may sink even to the level of 70 %.

TABLE 24

GENERAL THERMAL EFFICIENCY AND PERCENTAGE AVAILABILITY OF CAPACITY FOR VARIOUS POWER STATIONS

Power Station	Capacity of Main Turbo-generators in MW	Steam pressure and temperature		General thermal efficiency %	Percentage availability taken over one year		
		MPa (abs)	°C		Best	Poorest	Average over period
Colenso	25/30	2,0	385	17,8	91,7	74,1	80,5
Klip	33	2,5	390	18,5	95,0	70,1	86,0
Vaal	33	2,5	427	19,8	95,8	79,6	87,6
Vierfontein	30	4,2	441	21,6	96,5	76,8	88,6
West Bank	15/20	2,9	427	21,9	98,3	72,4	84,9
Umgeni	30/60	4,2	454	21,9	93,8	77,6	85,7
Hex River	20/30	4,2	427/482	22,8	95,7	68,9	88,5
Wilge	30/60	4,2	454	24,0	97,1	60,0	84,5
Taibos	60	4,2	441	25,0	91,2	83,6	87,1
Salt River	30/60	4,2	482	25,8	97,0	74,4	88,0
Highveld	60	6,3	482	27,1	94,0	79,5	85,7
Komati	100/125	8,4	510	27,7	88,5	61,4	75,0
Ingagane	100	8,4	510	28,7	94,7	76,4	84,1
Camden	200	10,3	538	30,7	82,1	70,0	75,1
Hendrina	200	10,3	538	31,5	86,8	77,9	81,8
Grootvlei	200	10,3	538	31,6	83,4	62,2	77,5
Arnot	350	15,9/3,98	510/510	33,4	82,1	65,0	72,2
Kriel	500	16,0/3,17	510/510	34,2	81,6	57,7	69,1
Duvha	600	16,1/3,55	535/535	33,8	78,2	55,8	71,0
Matla	600	16,1/3,68	535/535	33,9	71,2	45,9	61,7

Source: ESCOM.

TABLE 25

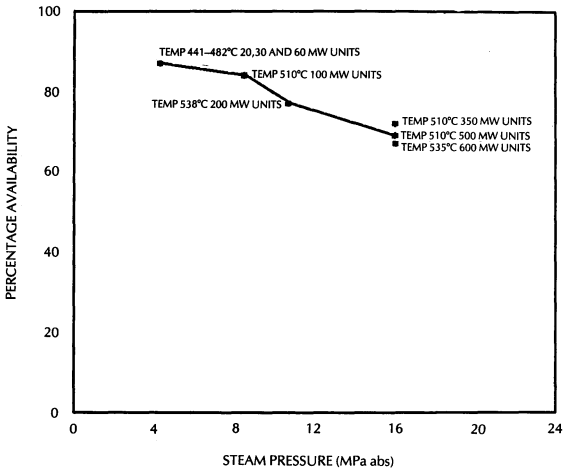
THE EFFECT OF STEAM PRESSURE, TEMPERATURE AND SIZE OF UNITS ON PERCENTAGE THERMAL EFFICIENCY AND AVAILABILITY

Steam pressure and temperature at turbine inlet		Power Station	Number and size of units in MW	Thermal efficiency %	Average thermal efficiency % *	% Availability	
MPa (abs)	°C					For individual power stations	For group of power stations *
4,2 MPa (abs)	441 to 482	Vierfontein	12 × 30	21,6	23,5	88,6	87,1
		Umgeni	4 + 2 × 30/60	21,9		85,7	
		Hex River	3 + 2 × 20/30	22,8		88,5	
		Wilge	2 + 3 × 30/60	24,0		84,5	
		Taaibos	8 × 60	25,0		87,1	
		Salt River	4 + 2 × 30/60	25,8		88,0	
8,4	510	Ingagane	5 × 100	28,7		84,1	84,1
10,3	538	Camden	8 × 200	30,7	31,3	75,1	78,1
		Hendrina	10 × 200	31,5		81,8	
		Grootvlei	6 × 200	31,6		77,5	
15,9/3,98	510/510	Arnot	6 × 350	33,4	33,4	72,2	72,2
16,0/3,17	510/510	Kriel	6 × 500	34,2	34,2	69,1	69,1
16,1/3,55	535/535	Duvha	4 × 600	33,8	33,9	71,0	66,8
16,1/3,68	535/535	Matla	5 × 600	33,9		61,7	

Source: ESCOM.

GRAPH I

PERCENTAGE AVAILABILITY OF GROUPS OF POWER STATIONS. THE EFFECT OF STEAM PRESSURE AND TEMPERATURE, AND SIZE OF UNITS ON PERCENTAGE AVAILABILITY



With the low annual average availability a higher gross capacity factor is required to limit the probability of load loss to less than six days a year. The correlation between the annual average percentage availability and the gross capacity factor is indicated in Graph 2.

For an average annual availability of 70 % a gross capacity margin of 37,6 % is required. For an availability of 75 % the margin is 27,8 % and for an availability of 80 % it is 18,9 %.

If a total availability of 80 % can be achieved in future it will make a considerable difference to Escom's required generating capacity. The difference between 70 % and 80 % availability for Escom's coal-fired power stations can make a *difference of 15,7 % in the required generating capacity*. In other words, for a maximum load of say 25 000 MW, a capacity of 34 400 MW will be required at 70 % availability and a capacity of 29 725 MW at 80 % availability, or 4 675 MW less installed capacity.

It is clearly essential that the availability of Escom's large generating sets be increased. During recent years there have been strong indications, as reported in "Engineering Assessment of an Advanced Pulverised-Coal-Power Plant" of the Electric Power Research Institute and in the latest editions of "VGB Kraftwerktechnik", that the problem of low availability of high capacity sets is being overcome in America and Germany and that high-level availability is being achieved.

THE NATURE AND EXTENT OF ESCOM'S SYSTEM MAXIMUM DEMAND CURVES

The nature, form and extent of a system's maximum demand curves determine, among other things—

- ☆ the maximum generating capacity required by the system,
- ☆ the possibilities of demand management to shift the peaks and level out the demand, thereby reducing the required generating capacity and utilising it more efficiently, and
- ☆ has an important influence on the average electricity tariffs and also on individual tariffs which were designed to obtain a more even demand curve.

Table 26 gives the extent, time and day of the Escom system's maximum demand for each week during the period 1980–1983.

The figures in this table indicate the following:

- ☆ In 197 of the 208 weeks in that period, that is in 94,7 % of the weeks, the weekly maximum demand occurred at 09h00 in the morning.

GRAPH 2

THE CORRELATION BETWEEN THE ANNUAL AVERAGE PERCENTAGE AVAILABILITY AND THE GROSS CAPACITY FACTOR

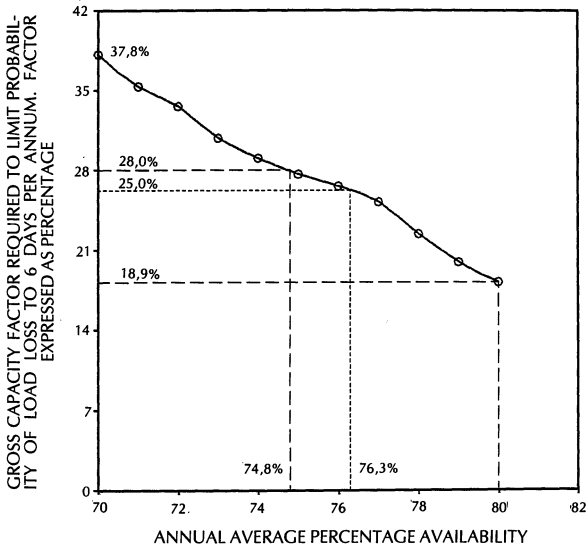


TABLE 26
ESCOM SYSTEM'S MAXIMUM WEEKLY DEMAND FOR THE PERIOD 1980-1983

1980					1981				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h	Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
5/1/80	10 851,0	09h00	4/1/80	1 517 223,0	3/1/81	11 298,0	09h00	29/12/80	1 608 615,0
12/1/80	11 305,0	09h00	11/1/80	1 624 604,0	10/1/81	12 081,0	09h00	9/1/81	1 723 203,0
19/1/80	11 653,0	09h00	18/1/80	1 670 187,0	17/1/81	12 468,0	10h00	16/1/81	1 787 505,0
26/1/80	11 593,0	09h00	24/1/80	1 694 171,0	24/1/81	12 499,0	09h00	20/1/81	1 826 451,0
2/2/80	11 878,0	09h00	1/2/80	1 706 561,0	31/1/81	12 356,0	09h00	30/1/81	1 803 143,0
9/2/80	11 698,0	09h00	3/2/80	1 701 706,0	7/2/81	12 642,0	09h00	6/2/81	1 802 500,0
16/2/80	12 109,0	09h00	15/2/80	1 721 468,0	14/2/81	12 420,0	10h00	13/2/81	1 814 406,0
23/2/80	11 895,0	09h00	19/2/80	1 743 457,0	21/2/81	12 604,0	09h00	20/2/81	1 820 752,0
1/3/80	11 954,0	09h00	27/2/80	1 742 217,0	28/2/81	12 567,0	09h00	25/2/81	1 823 491,0
8/3/80	11 979,0	09h00	7/3/80	1 735 202,0	7/3/81	12 903,0	09h00	6/3/81	1 838 198,0
15/3/80	11 916,0	09h00	14/3/80	1 726 139,0	14/3/81	12 798,0	09h00	13/3/81	1 857 476,0
22/3/80	12 106,0	09h00	21/3/80	1 739 314,0	21/3/81	12 720,0	09h00	18/3/81	1 850 530,0
29/3/80	12 116,0	09h00	28/3/80	1 760 170,0	28/3/81	12 902,0	09h00	27/3/81	1 858 347,0
5/4/80	12 102,0	09h00	2/4/80	1 675 033,0	4/4/81	12 729,0	09h00	3/4/81	1 842 815,0
12/4/80	12 217,0	09h00	11/4/80	1 720 550,0	11/4/81	12 825,0	09h00	10/4/81	1 838 484,0
19/4/80	12 488,0	09h00	18/4/80	1 785 378,0	18/4/81	12 704,0	09h00	16/4/81	1 744 123,0
26/4/80	12 496,0	09h00	25/4/80	1 800 928,0	25/4/81	13 107,0	09h00	24/4/81	1 797 626,0
3/5/80	12 505,0	09h00	2/5/80	1 800 342,0	2/5/81	13 397,0	09h00	1/5/81	1 911 383,0
10/5/80	12 933,0	09h00	9/5/80	1 823 249,0	9/5/81	13 458,0	09h00	8/5/81	1 928 639,0
17/5/80	12 145,0	09h00	14/5/80	1 786 493,0	16/5/81	13 691,0	09h00	15/5/81	1 947 692,0
24/5/80	12 894,0	09h00	23/5/80	1 837 639,0	23/5/81	13 671,0	09h00	22/5/81	1 979 327,0
31/5/80	13 089,0	09h00	28/5/80	1 842 600,0	30/5/81	13 680,0	09h00	27/5/81	1 930 842,0
7/6/80	12 904,0	19h00	4/6/80	1 848 713,0	6/6/81	14 043,0	11h00	5/6/81	1 967 320,0
14/6/80	13 347,0	09h00	13/6/80	1 887 631,0	13/6/81	14 674,0	09h00	12/6/81	2 076 317,0
21/6/80	13 572,0	09h00	20/6/80	1 921 954,0	20/6/81	14 609,0	09h00	19/6/81	2 086 218,0
28/6/80	13 423,0	09h00	24/6/80	1 922 611,0	27/6/81	14 534,0	09h00	26/6/81	2 064 539,0
5/7/80	13 685,0	09h00	4/7/80	1 930 745,0	4/7/81	14 443,0	09h00	2/7/81	2 057 590,0
12/7/80	13 575,0	09h00	11/7/80	1 929 112,0	11/7/81	14 551,0	19h00	8/7/81	2 068 614,0
19/7/80	13 717,0	09h00	18/7/80	1 936 868,0	18/7/81	14 391,0	09h00	15/7/81	2 047 647,0
26/7/80	13 447,0	09h00	25/7/80	1 905 132,0	25/7/81	14 152,0	09h00	24/7/81	2 019 950,0
2/8/80	13 204,0	09h00	29/7/80	1 879 288,0	1/8/81	14 094,0	09h00	31/7/81	2 009 055,0
9/8/80	13 336,0	09h00	8/8/80	1 863 359,0	8/8/81	14 277,0	09h00	7/8/81	2 018 007,0
16/8/80	13 470,0	09h00	15/8/80	1 884 449,0	15/8/81	14 132,0	09h00	14/8/81	2 005 946,0
23/8/80	12 996,0	09h00	22/8/80	1 851 817,0	22/8/81	14 533,0	19h00	19/8/81	2 078 124,0
30/8/80	13 138,0	09h00	29/8/80	1 844 136,0	29/8/81	14 260,0	09h00	28/8/81	2 053 423,0
6/9/80	12 705,0	08h00	5/9/80	1 793 812,0	5/9/81	14 569,0	09h00	3/9/81	2 083 554,0
13/9/80	12 832,0	19h00	9/9/80	1 832 140,0	12/9/81	14 279,0	09h00	10/9/81	2 029 639,0
20/9/80	12 860,0	09h00	19/9/80	1 812 550,0	19/9/81	13 732,0	09h00	15/9/81	1 989 541,0
27/9/80	12 983,0	09h00	26/9/80	1 855 808,0	26/9/81	13 640,0	09h00	25/9/81	1 972 901,0

1980				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
4/10/80.....	12 660,0	09h00	29/9/80	1 824 850,0
11/10/80.....	12 372,0	09h00	9/10/80	1 773 666,0
18/10/80.....	12 545,0	09h00	17/10/80	1 785 158,0
25/10/80.....	12 864,0	09h00	24/10/80	1 823 043,0
1/11/80.....	12 555,0	09h00	31/10/80	1 790 330,0
8/11/80.....	12 334,0	09h00	4/11/80	1 786 878,0
15/11/80.....	12 384,0	09h00	14/11/80	1 796 493,0
22/11/80.....	12 321,0	09h00	21/11/80	1 790 509,0
29/11/80.....	12 479,0	09h00	28/11/80	1 786 118,0
6/12/80.....	12 337,0	09h00	5/12/80	1 784 141,0
13/12/80.....	12 167,0	09h00	12/12/80	1 770 702,0
20/12/80.....	11 650,0	09h00	18/12/80	1 761 930,0
27/12/80.....	11 486,0	09h00	23/12/80	1 529 075,0
Year to date	13 717,0	09h00	18/7/80	92 967 649,0

1982				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
2/1/82.....	11 839,0	09h00	29/12/81	1 702 574,0
9/1/82.....	12 879,0	09h00	8/1/82	1 838 813,0
16/1/82.....	13 046,0	09h00	15/1/82	1 900 319,0
23/1/82.....	13 427,0	09h00	22/1/82	1 939 166,0
30/1/82.....	13 400,0	09h00	28/1/82	1 933 594,0
6/2/82.....	13 616,0	09h00	5/2/82	1 944 311,0
13/2/82.....	13 486,0	09h00	12/2/82	1 948 881,0
20/2/82.....	13 393,0	09h00	16/2/82	1 940 929,0
27/2/82.....	13 590,0	09h00	26/2/82	1 937 794,0
6/3/82.....	13 811,0	09h00	5/3/82	1 947 997,0
13/3/82.....	13 693,0	09h00	12/3/82	1 937 106,0
20/3/82.....	13 714,0	09h00	19/3/82	1 962 562,0
27/3/82.....	13 843,0	09h00	26/3/82	1 982 086,0
3/4/82.....	13 745,0	09h00	2/4/82	1 978 594,0
10/4/82.....	13 505,0	09h00	8/4/82	1 854 059,0
17/4/82.....	13 732,0	09h00	16/4/82	1 921 827,0
24/4/82.....	14 029,0	09h00	23/4/82	2 019 110,0
1/5/82.....	14 347,0	09h00	30/4/82	2 016 381,0
8/5/82.....	14 062,0	09h00	7/5/82	2 005 104,0
15/5/82.....	13 987,0	19h00	12/5/82	2 003 757,0
22/5/82.....	14 114,0	09h00	19/5/82	1 962 328,0
29/5/82.....	14 498,0	09h00	28/5/82	2 015 744,0
5/6/82.....	14 306,0	09h00	3/6/82	1 968 963,0
12/6/82.....	15 029,0	09h00	11/6/82	2 097 759,0
19/6/82.....	15 453,0	09h00	18/6/82	2 148 652,0
26/6/82.....	15 084,0	09h00	25/6/82	2 138 450,0
3/7/82.....	15 532,0	10h00	2/7/82	2 128 200,0
10/7/82.....	15 091,0	09h00	8/7/82	2 135 073,0
17/7/82.....	15 219,0	09h00	16/7/82	2 109 933,0

1981				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
3/10/81.....	13 464,0	09h00	2/10/81	1 945 214,0
10/10/81.....	13 395,0	09h00	9/10/81	1 938 448,0
17/10/81.....	13 383,0	09h00	14/10/81	1 931 310,0
24/10/81.....	13 542,0	09h00	23/10/81	1 950 846,0
31/10/81.....	13 257,0	09h00	26/10/81	1 912 718,0
7/11/81.....	13 023,0	09h00	6/11/81	1 896 301,0
14/11/81.....	13 263,0	09h00	13/11/81	1 919 288,0
21/11/81.....	13 467,0	09h00	20/11/81	1 932 005,0
28/11/81.....	13 354,0	09h00	27/11/81	1 935 846,0
5/12/81.....	13 115,0	09h00	4/12/81	1 891 224,0
12/12/81.....	12 970,0	09h00	10/12/81	1 890 063,0
19/12/81.....	12 502,0	09h00	17/12/81	1 799 348,0
26/12/81.....	12 408,0	09h00	23/12/81	1 677 073,0
Year to date	14 674,0	09h00	12/6/81	99 583 617,0

1983				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
1/1/83.....	11 842,0	09h00	28/12/82	1 664 644,0
8/1/83.....	12 912,0	09h00	7/1/83	1 794 570,0
15/1/83.....	13 431,0	09h00	14/1/83	1 887 520,0
22/1/83.....	13 733,0	09h00	21/1/83	1 932 529,0
29/1/83.....	13 649,0	09h00	28/1/83	1 926 360,0
5/2/83.....	13 662,0	09h00	4/2/83	1 920 174,0
12/2/83.....	13 671,0	09h00	11/2/83	1 928 381,0
19/2/83.....	13 784,0	10h00	18/2/83	1 949 056,0
26/2/83.....	13 648,0	09h00	25/2/83	1 923 903,0
5/3/83.....	13 548,0	09h00	1/3/83	1 942 832,0
12/3/83.....	13 836,0	09h00	11/3/83	1 951 390,0
19/3/83.....	13 903,0	09h00	18/3/83	1 970 737,0
26/3/83.....	13 773,0	09h00	25/3/83	1 971 580,0
2/4/83.....	13 937,0	09h00	30/3/83	1 864 151,0
9/4/83.....	13 966,0	09h00	8/4/83	1 874 838,0
16/4/83.....	14 209,0	09h00	15/4/83	1 889 908,0
23/4/83.....	14 027,0	09h00	20/4/83	1 997 625,0
30/4/83.....	14 210,0	09h00	29/4/83	2 002 628,0
7/5/83.....	13 993,0	09h00	5/5/83	1 986 220,0
14/5/83.....	13 992,0	09h00	1/5/83	1 964 916,0
21/5/83.....	14 474,0	19h00	16/5/83	2 056 360,0
28/5/83.....	14 735,0	09h00	27/5/83	2 084 248,0
4/6/83.....	14 927,0	09h00	3/6/83	2 023 987,0
11/6/83.....	14 952,0	09h00	10/6/83	2 100 042,0
18/6/83.....	15 162,0	09h00	17/6/83	2 146 925,0
25/6/83.....	15 274,0	09h00	24/6/83	2 143 990,0
2/7/83.....	15 582,0	09h00	1/7/83	2 152 853,0
9/7/83.....	15 515,0	09h00	7/7/83	2 142 345,0
16/7/83.....	15 082,0	09h00	13/7/83	2 102 476,0

1982				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
24/7/82.....	14 951,0	09h00	21/7/82	2 102 390,0
31/7/82.....	15 116,0	09h00	30/7/82	2 092 201,0
7/8/82.....	14 920,0	09h00	6/8/82	2 056 294,0
14/8/82.....	14 696,0	09h00	13/8/82	2 081 905,0
21/8/82.....	14 456,0	09h00	20/8/82	2 043 442,0
28/8/82.....	14 727,0	09h00	27/8/82	2 054 412,0
4/9/82.....	14 419,0	09h00	3/9/82	2 003 109,0
11/9/82.....	14 107,0	09h00	7/9/82	1 975 721,0
18/9/82.....	14 073,0	09h00	17/9/82	1 949 046,0
25/9/82.....	13 946,0	09h00	24/9/82	1 950 982,0
2/10/82.....	13 726,0	09h00	1/10/82	1 934 275,0
9/10/82.....	13 819,0	09h00	7/10/82	1 955 802,0
16/10/82.....	13 767,0	09h00	15/10/82	1 953 770,0
23/10/82.....	13 863,0	09h00	22/10/82	1 941 652,0
30/10/82.....	13 751,0	09h00	28/10/82	1 932 783,0
13/11/82.....	13 648,0	09h00	12/11/82	1 915 369,0
20/11/82.....	13 891,0	09h00	19/11/82	1 951 772,0
27/11/82.....	13 722,0	09h00	24/11/82	1 947 079,0
4/12/82.....	13 545,0	09h00	3/12/82	1 901 404,0
11/12/82.....	13 294,0	09h00	8/12/82	1 888 098,0
18/12/82.....	13 174,0	09h00	15/12/82	1 786 125,0
25/12/82.....	12 671,0	09h00	22/12/82	1 724 255,0
Year to date	15 532,0	10h00	2/7/82	100 561 952,0

1983				
Week ending	Maximum kW.h	Reached at	Day of week	Total kW.h
23/7/83.....	14 972,0	09h00	22/7/83	2 109 054,0
30/7/83.....	15 285,0	09h00	29/7/83	2 146 093,0
6/8/83.....	14 987,0	09h00	6/8/83	2 105 323,0
13/8/83.....	15 639,0	09h00	10/8/83	2 195 079,0
20/8/83.....	15 595,0	09h00	19/8/83	2 129 281,0
27/8/83.....	15 253,0	09h00	24/8/83	2 145 673,0
3/9/83.....	14 799,0	09h00	30/8/83	2 099 494,0
10/9/83.....	14 606,0	09h00	9/9/83	2 070 704,0
17/9/83.....	14 588,0	09h00	16/9/83	2 068 542,0
24/9/83.....	14 773,0	09h00	23/9/83	2 075 157,0
1/10/83.....	14 421,0	09h00	27/9/83	2 061 859,0
8/10/83.....	14 486,0	09h00	7/10/83	2 080 572,0
15/10/83.....	14 533,0	09h00	13/10/83	2 085 316,0
22/10/83.....	14 658,0	09h00	21/10/83	2 105 224,0
29/10/83.....	14 610,0	08h00	28/10/83	2 091 407,0
5/11/83.....	14 803,0	09h00	4/11/83	2 110 906,0
12/11/83.....	14 660,0	09h00	11/11/83	2 080 161,0
19/11/83.....	14 724,0	09h00	18/11/83	2 103 147,0
26/11/83.....	14 396,0	09h00	25/11/83	2 088 547,0
3/12/83.....	14 563,0	09h00	2/12/83	2 069 052,0
10/12/83.....	14 199,0	09h00	7/12/83	2 043 665,0
17/12/83.....	13 931,0	09h00	13/12/83	1 923 080,0
24/12/83.....	13 458,0	09h00	22/12/83	1 896 234,0
Year to date	15 639,0	09h00	10/8/83	105 280 758,0

☆ During—

- two weeks each in 1980 and 1981, as well as one week in 1982 and one in 1983, the maximum system demand occurred at 19h00,
- two weeks in 1981 as well as one week in 1982 and one in 1983 it occurred at 10h00, and during
- one week in 1981 it occurred at 11h00.

☆ The maximum system demand for the respective years, as well as the hour and date when it occurred, were as follows:

- 13 717 MW at 09h00 on 18 June 1980,
- 14 674 MW at 09h00 on 12 June 1981,
- 15 532 MW at 10h00 on 2 July 1982 and
- 15 639 MW at 09h00 on 10 August 1983.

The weekly maximum demand curve 1980–1983 in Graph 3 indicates that—

- ☆ the weekly demand increased between 1980 and 1982, but the 1983 value remained almost the same as that for 1982, and that
- ☆ the extent of the weekly maximum demand was considerably higher during the winter months of May, June, July and August than during the summer months.

Graph 4 shows demand curves for the Escom system during the week of maximum demand, an average week during winter and an average week during summer, and these indicate—

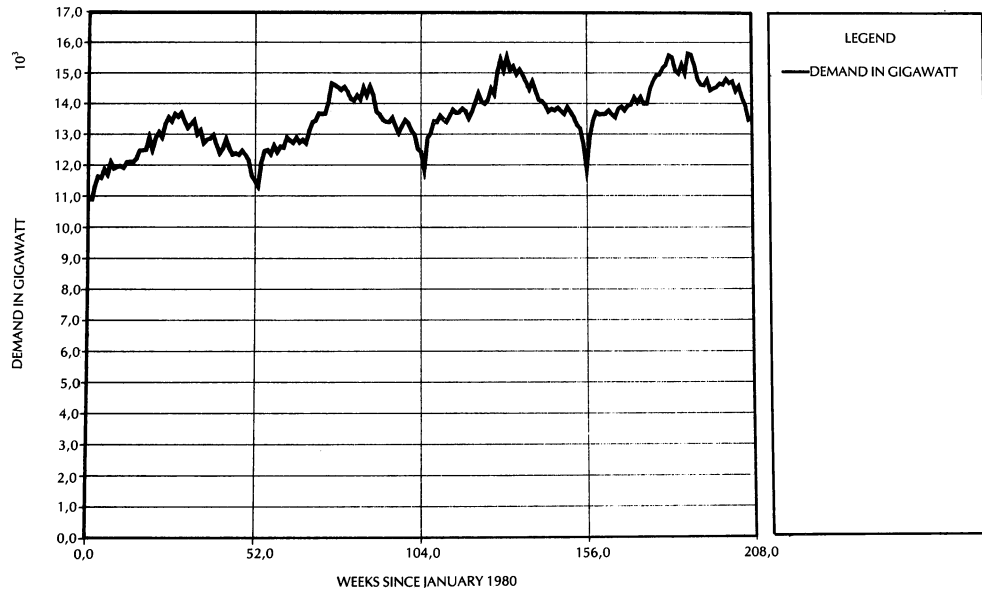
- ☆ similar demand patterns for Mondays, Tuesdays, Wednesdays and Thursdays, with
- ☆ a considerably higher demand, particularly peak demand, on Fridays, and
- ☆ a considerably lower demand on Saturdays and particularly on Sundays.

Graphs 5, 6, 7 and 8 show the demand curves of the integrated Escom system for 1980, 1981, 1982 and 1983 in respect of the following:

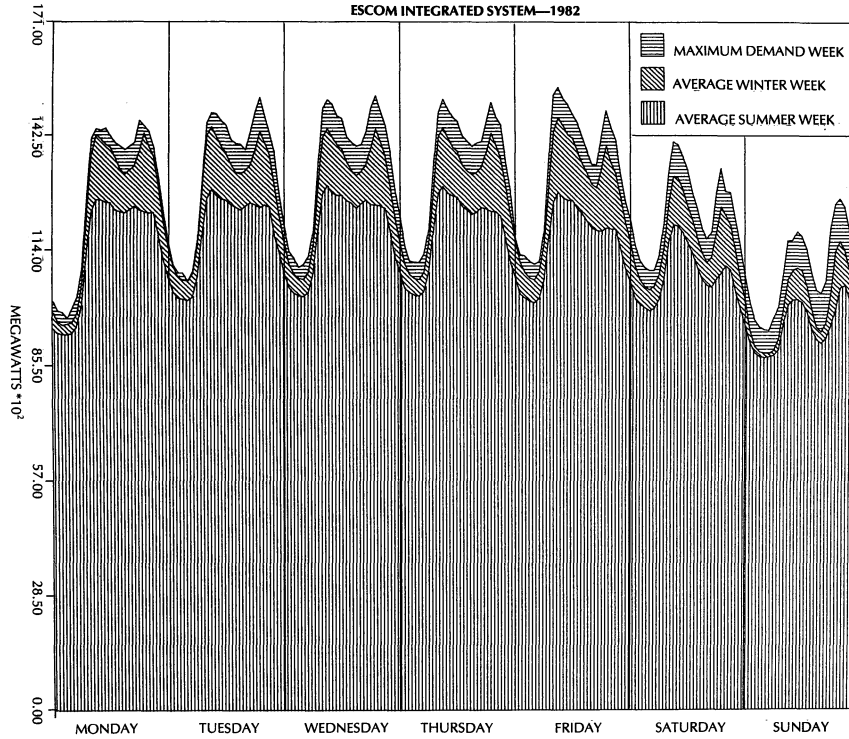
- ☆ Maximum demand day and load factor,
- ☆ a typical winter day, and
- ☆ a typical summer day.

GRAPH 3

WEEKLY MAXIMUM DEMAND 1980 TO 1983



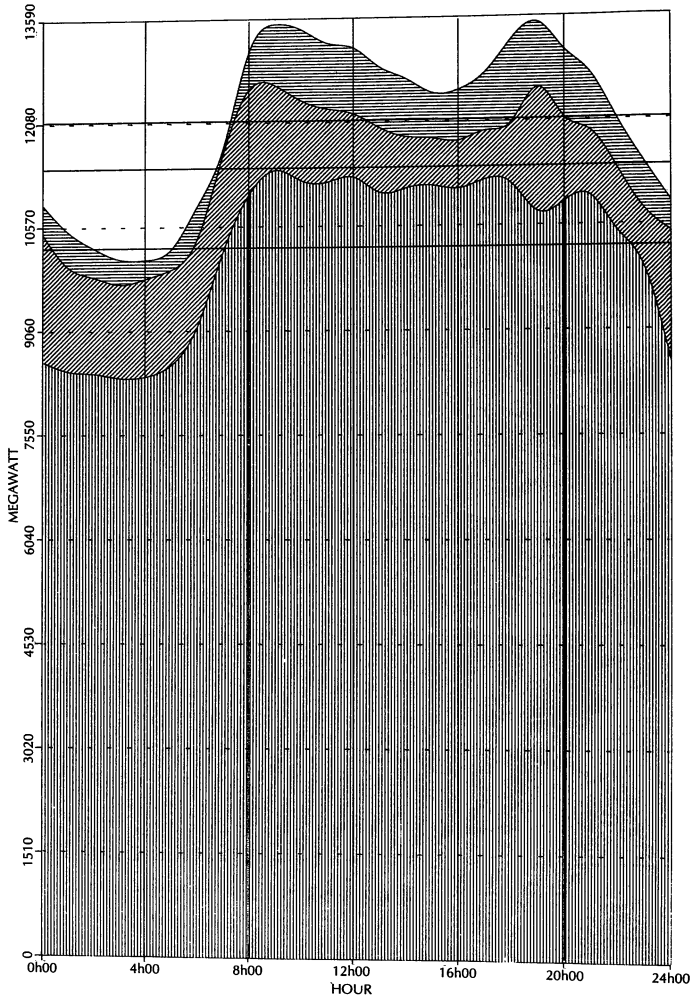
GRAPH 4
ESCOM INTEGRATED SYSTEM—1982



GRAPH 5

ESCOM INTEGRATED SYSTEM—1980

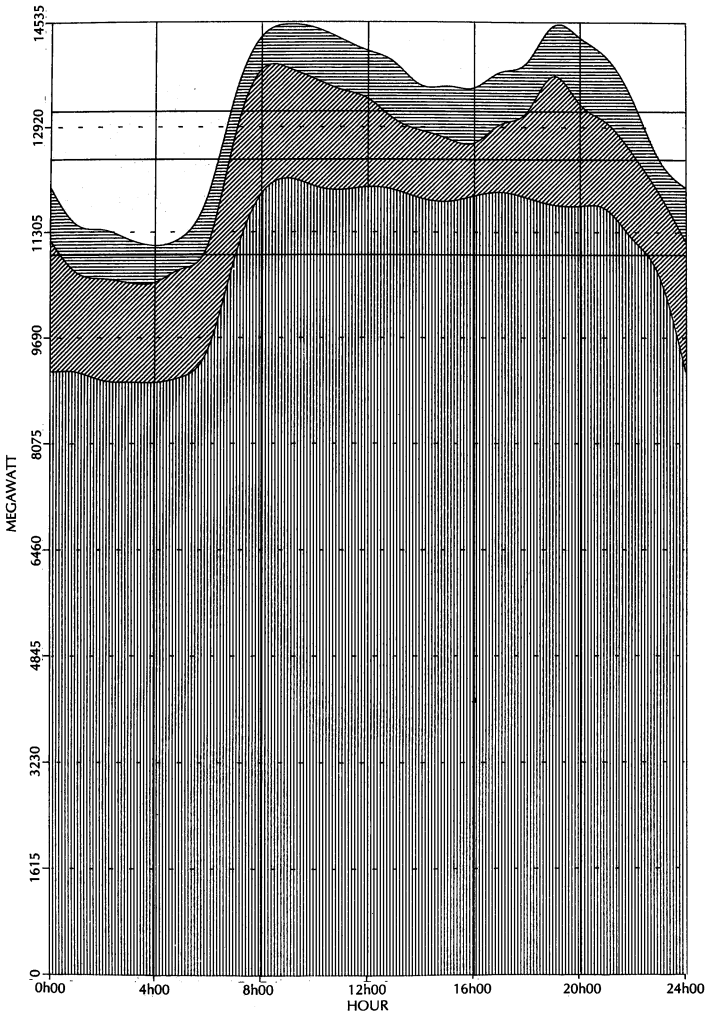
DAY OF MAXIMUM DEMAND	16/7/1980	LOAD FACTOR: 0.8959
TYPICAL WINTER DAY	11/9/1980	LOAD FACTOR: 0.9051
TYPICAL SUMMER DAY	4/2/1980	LOAD FACTOR: 0.9009



GRAPH 6

ESCOM INTEGRATED SYSTEM—1981

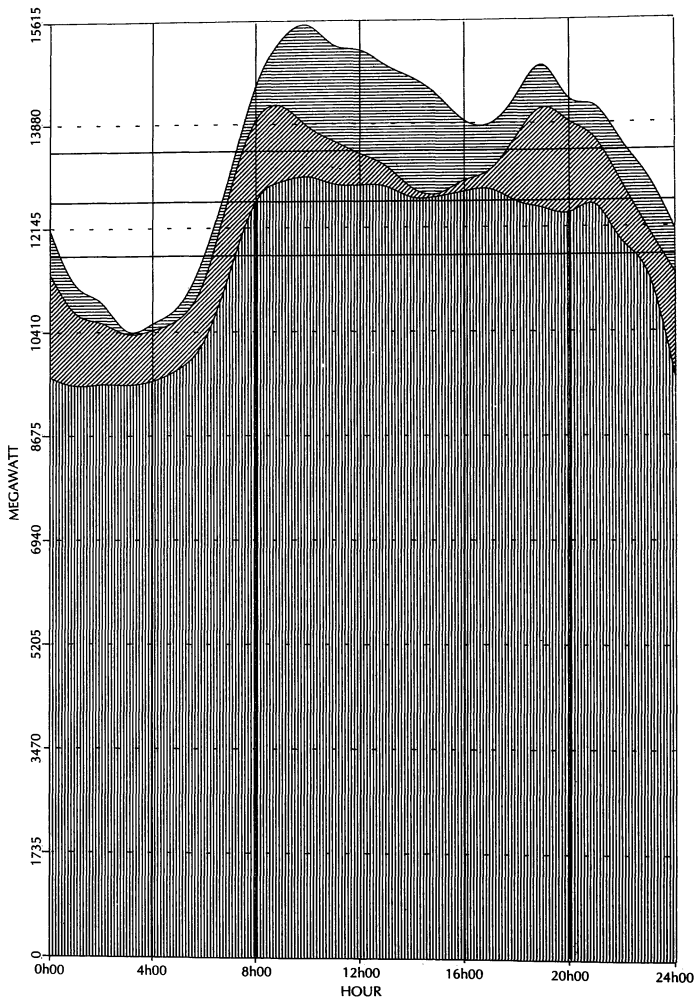
DAY OF MAXIMUM DEMAND	2/9/1981	LOAD FACTOR: 0.9075
TYPICAL WINTER DAY	12/8/1981	LOAD FACTOR: 0.8985
TYPICAL SUMMER DAY	16/2/1981	LOAD FACTOR: 0.9034



GRAPH 7

ESCOM INTEGRATED SYSTEM—1982

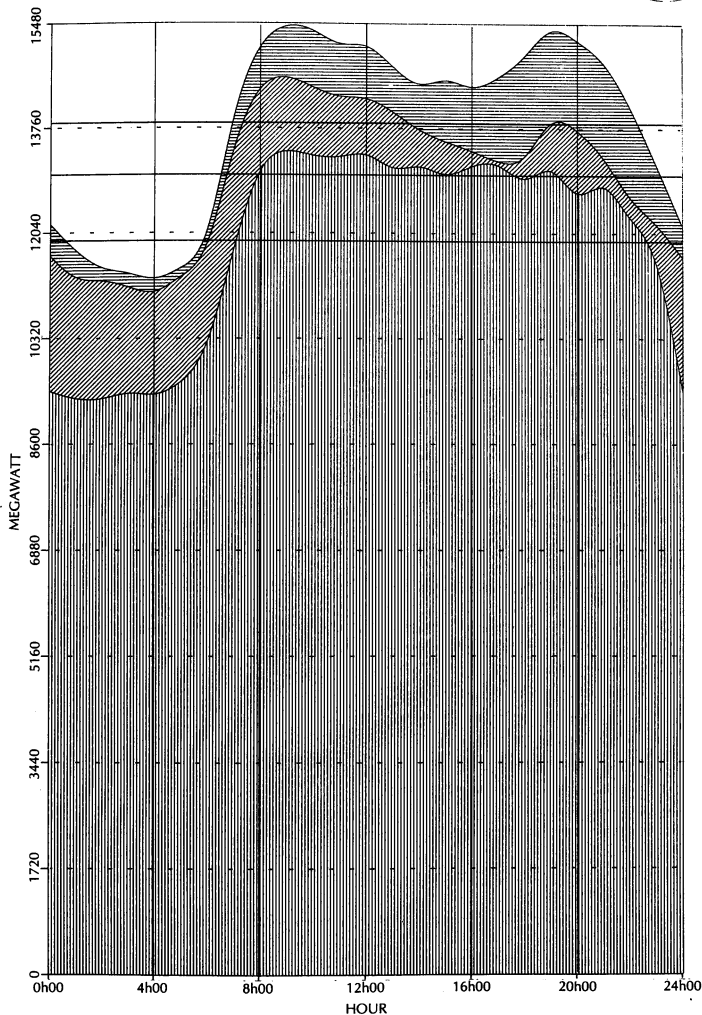
▨ DAY OF MAXIMUM DEMAND	2/7/1982	LOAD FACTOR: 0.8642
▨ TYPICAL WINTER DAY	3/8/1982	LOAD FACTOR: 0.8876
▨ TYPICAL SUMMER DAY	18/1/1982	LOAD FACTOR: 0.8991



GRAPH 8

ESCOM INTEGRATED SYSTEM—1983

■ DAY OF MAXIMUM DEMAND	9/8/1983	LOAD FACTOR: 0.8967
▨ TYPICAL WINTER DAY	16/9/1983	LOAD FACTOR: 0.8906
▤ TYPICAL SUMMER DAY	14/3/1983	LOAD FACTOR: 0.8901



The graphs indicate the following:

- ☆ a high load factor of *almost* 0,90 in all these instances,
- ☆ typical summer day load curves with—
 - a relatively even plateau demand between 08h00 and 21h00,
 - a minimum demand period from 24h00 to 06h00,
 - a sharp increase in demand between 05h00 and 09h00 and a sharp decrease in demand between 21h00 and 24h00,
 - a peak which occurs at approximately 09h00 but does not rise far above the plateau level.
- ☆ Typical winter day load curves very similar to the summer day curve, but which were 1 000 to 1 500 MW higher than the summer day curve during the period 1980–1983 and which show two definite peak demand times, namely at 09h00 and at 19h00.
- ☆ The *maximum demand day curves* for all four of these years indicate that the two daily winter peak demands, that is at 09h00 and at 19h00, can exceed the “average” typical winter day peaks by 800 to 1 350 MW.

At the end of 1982 the following generating capacity was specifically available for handling peak demand:

Station	Name	Assigned sent-out rating in MW
Gas-turbine	Acacia.....	171
	Port Rex.....	171
Hydro-electric	Hendrik Verwoerd.....	320
	VanderKloof	220
Pumped storage	Drakensberg	1 000
		1 882

Apart from this special peak demand generating capacity which is available at short notice, there is the possibility of arranging with certain consumers—

- ☆ to cut down their power consumption during the winter peak periods from say 19h30 or other suitable times, and/or
- ☆ to cut down the demand when *required*, by previously determined arrangements.

In this connection there are two obvious possibilities:

- ☆ Switching off domestic geysers during certain times by means of an automatic system,
- ☆ arrangements with a small number of *large power users* as mentioned before.

Table 27 gives an analysis of data about large power users, excluding municipalities. This analysis indicates the following:

- ☆ Nineteen large power users used 24 012 GW.h in 1983, or 24,4 % of the total Escom sales of 98 251 GW.h.
- ☆ The joint maximum demand of these consumers, whose demand peaks probably did not coincide with the Escom system peak, was 3 669 MW.
- ☆ Of the 19 large power users—
 - nine were gold mines,
 - one was a chromium mine,
 - one was a platinum mine,
 - six were metallurgical plants and
 - one was a major chemical plant.

If special arrangements were made with even a *small* number of users (such as the gold mines with regard to water pumping times) and if a lower tariff were offered, it could affect the peak demand significantly.

In this connection Graph 9 illustrates what is being achieved by Electricité de France by means of special tariff structures.

As illustrated by Graph 9 the following are characteristic of the prices per kW.h of Electricité de France's time-of-day tariff structure:

- ☆ High prices per kW.h during the daily two peak demand periods on a weekday in winter.
- ☆ Lower prices during the winter workday's daylight hours, when the high plateau of consumption occurs.
- ☆ Considerably lower prices during the winter weekday night's low plateau of consumption hours, and for the whole of Sunday.
- ☆ During the summer months the high tariffs for the two daily peak demand periods are not in force.

TABLE 27

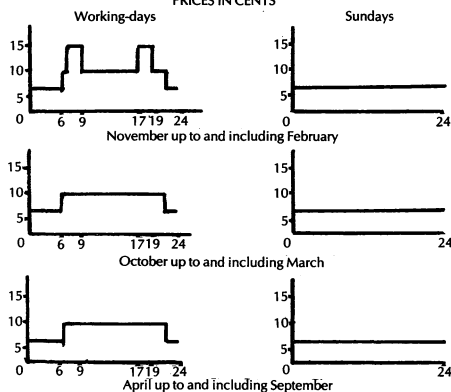
AN ANALYSIS OF DATA ABOUT LARGE POWER USERS, EXCLUDING MUNICIPALITIES

User	1983 maximum demand (MW)	1983 energy (GW.h)	Annual load factor
1. Sasol-Secunda	579	3 125	62%
2. Alusaf	344	2 645	88%
3. Iscor-Vanderbijlpark	338	2 339	79%
4. Vaal Reefs Gold Mine	258	2 002	89%
5. Palmiet Chrome	241	904	43%
6. AECI-Midlands	167	1 159	79%
7. Harmony Gold Mine	163	1 149	80%
8. Ferro Metals	161	1 062	75%
9. Western Deep Levels Gold Mine	160	1 201	86%
10. Buffelsfontein Gold Mine	152	1 113	84%
11. High Veld Steel and Vanadium	138	1 033	85%
12. Richard's Bay Iron and Titanium	138	1 000	83%
13. Free State Geduld Gold Mine	134	912	78%
14. West Area Gold Mine	133	947	81%
15. Impala Plats	124	339	31%
16. West Driefontein Gold Mine	122	836	78%
17. Hartebeesfontein Gold Mine	116	893	88%
18. President Brand Gold Mine	111	818	84%
19. Iscor-Newcastle	90	535	68%
Total	3 669	24 012	

Total sales—98 251 GW.h.

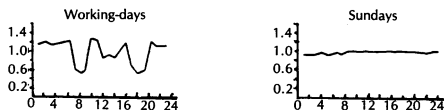
GRAPH 9

PRICES IN CENTS

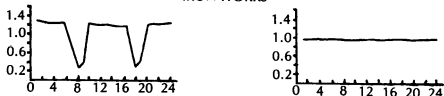


PROGRESS OF DEMAND

CEMENT WORKS

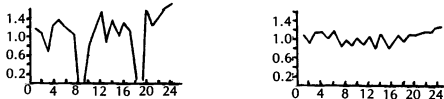


IRON WORKS



DEMAND
Average Daily Demand

ELECTRO-METALLURGICAL WORKS



REFINERIES



The effect of this tariff structure on the day and night as well as peak period demand during *winter* of cement and steel factories, electro-metallurgical works and a refinery, on a weekday as well as a Sunday, is shown in Graph 9.

The possibility of implementing this method of peak demand reduction in South Africa should be seen against the background of—

- ☆ the curve in Graph 10, and
- ☆ the already high load factor of the Eskom system.

Graph 10 shows the hourly demand curve for the Eskom system for 1982. A number of important conclusions may be drawn from the curves of the graph, namely:

- ☆ The maximum demand was 15 532 MW at 11h00 on 2 July 1982 and the minimum 7 024 MW.
- ☆ For $\pm 50\%$ of the hours of the year the demand was less than 11 830 MW.
- ☆ For $\pm 90\%$ of the hours of the year it was less than 13 650 MW and for 95 % it was less than 14 500 MW.

If the gas-turbine, hydro-electric and pumped-storage stations were in operation at the time of the one-hour peak demand of 15 532 MW, the output of the coal-fired power stations would have had to be approximately 13 650 MW.

If the 1 500 MW of the hydro-electric and pumped-storage stations' sent-out capacity had been utilised for approximately 500 hours, the peak demand on the coal-fired power stations could have been limited to $\pm 14\,000$ MW.

CAPITAL INVESTMENT IN THE VARIOUS UNDERTAKINGS

Capital investment in Eskom as a whole

In Table 28 an analysis of certain aspects of Eskom's balance sheet is given.

The figures in line (f) indicate that the value of *the total assets in operation and under construction* increased from R1 015 000 000 in 1967 to R2 338 100 000 in 1974, or that it was, in other words, more than doubled, while it increased from R2 338 100 000 in 1974 to R13 994 100 000 in 1982—a *sixfold* increase.

GRAPH 10
ESCOM SYSTEM LOAD DURATION GRAPH FOR 1982

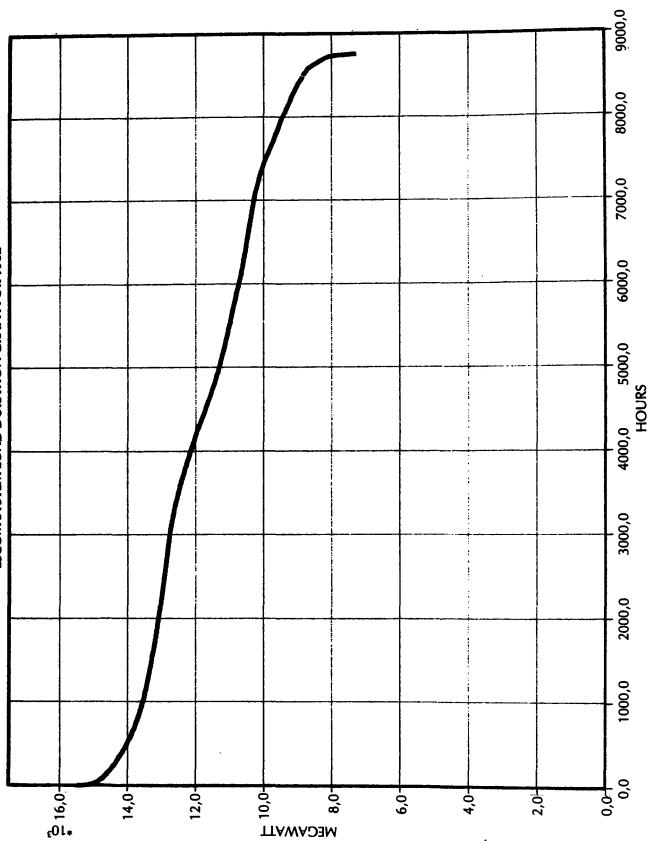


TABLE 28

ANALYSIS OF CERTAIN ASPECTS OF ESCOM'S BALANCE SHEET

FIXED ASSETS	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
(a) Fixed assets in operation at cost price: R million:																
Land and rights, buildings, facilities and production equipment	846,8	911,5	1 059,2	1 165,4	1 390,1	1 526,7	1 669,7	1 847,5	2 008,9	2 311,7	2 851,1	3 564,6	4 255,5	5 604,0	6 323,0	7 689,4
(b) Works under construction R million.....	104,0	202,9	212,6	264,5	214,7	247,7	243,7	323,2	560,8	899,5	1 341,8	1 846,7	2 481,6	2 544,8	3 720,6	5 016,6
(c) Equipment, vehicles and furniture at cost price less accumulated depreciation	5,1	5,5	6,5	7,4	9,5	12,3	15,0	18,2	21,1	31,2	34,2	41,1	56,6	70,4	100,0	152,5
(d) Total fixed assets in operation and under construction R million	955,9	1 119,9	1 278,3	1 437,3	1 614,4	1 786,7	1 958,0	2 188,9	2 590,8	3 242,4	4 227,1	5 452,4	6 793,6	8 219,2	10 143,6	12 858,5
(e) Total fixed assets in operation R million	851,9	917,0	1 065,7	1 172,8	1 399,6	1 539,0	1 714,3	1 865,7	2 030,0	2 342,9	2 885,3	3 605,7	4 312,0	5 674,4	6 423,0	7 841,9
(f) Total assets in operation and under construction R million	1 015,0	1 188,3	1 347,6	1 515,8	1 726,9	1 906,8	2 086,4	2 338,1	2 799,0	3 519,7	4 645,2	6 021,9	7 454,1	8 890,3	10 904,8	13 994,1
(g) Total fixed assets as percentage of total assets	94,2%	94,2%	94,9%	94,8%	93,5%	93,7%	93,8%	93,6%	92,6%	92,1%	91,0%	90,5%	91,1%	92,5%	93,0%	91,9%
(h) Works under construction as percentage of fixed assets in operation	12,2%	22,1%	19,9%	22,6%	15,3%	16,1%	14,2%	17,3%	27,6%	38,4%	46,5%	51,2%	57,6%	44,8%	57,9%	64,0%
$\frac{b}{e} \times \frac{100}{1}$																
(i) Net increase in fixed assets R million.....	110,3	164,0	158,4	159,0	177,0	172,4	171,3	230,9	401,9	651,6	984,7	1 225,3	1 374,6	1 446,9	1 950,6	2 741,2

* Note.—For completion of this table it had to be assumed that only assets earning income are involved.

Deferred expenditure, such as rebates on loans, currency adjustments and losses on stock transactions have been left out of account.

Source: ESCOM.

The figures in line (g) indicate that Escom's *fixed assets*, as a percentage of the *total assets*, varied between 90,5 % and 94,9 % for the entire period 1967–1982.

The value of the *fixed assets* includes *fixed assets in operation*, at cost price, *plus* the value of *works under construction*. Over the years the *balance sheet value of works under construction* as a percentage of *fixed assets in operation* increased from 12,2 % in 1967 to 17,3 % in 1974 and 64,0 % in 1982 when the value of works under construction was R5 016 600 000 and that of fixed assets in operation R7 689 400 000.

The figures in line (i) also indicate how fast the net fixed assets increased, especially since 1974. During the nine years 1974–1982 Escom's *net fixed assets* increased as follows:

	R
1974.....	230 900 000
1975.....	401 900 000
1976.....	651 600 000
1977.....	984 700 000
1978.....	1 225 300 000
1979.....	1 374 600 000
1980.....	1 446 900 000
1981.....	1 950 600 000
1982.....	2 741 200 000

The amount invested in *works under construction* as at 31 December changed as follows during the period 1974–1982:

	R
1974.....	323 200 000
1975.....	560 800 000
1976.....	899 500 000
1977.....	1 341 800 000
1978.....	1 846 700 000
1979.....	2 481 600 000
1980.....	2 544 800 000
1981.....	3 720 600 000
1982.....	5 016 600 000

Interest on the capital expenditure on works under construction is capitalised and the interest on specific capital amounts for certain works under construction becomes a working cost item only when these specific works have been commissioned.

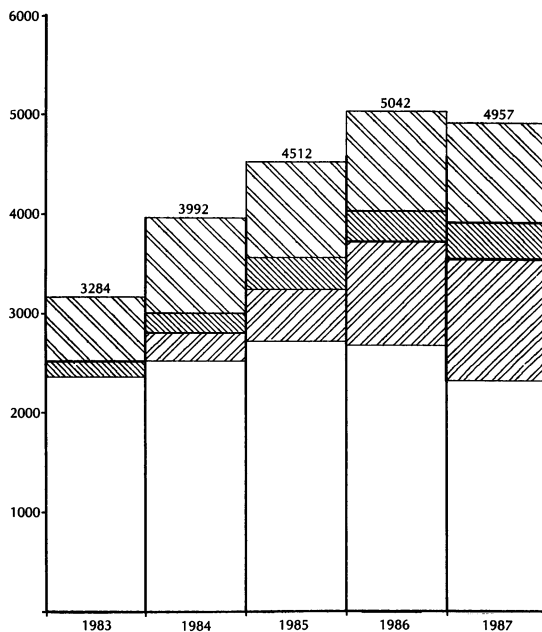
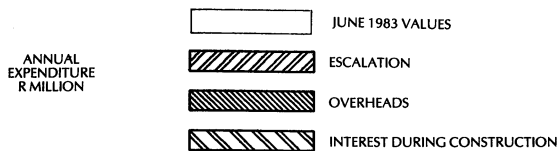
The extent of Escom's estimated capital expenditure for each of the years 1982–1987 is given in Graph 11.

This graph indicates that the estimated capital expenditure will rise from—

- ± R3 284 000 000 in 1983, to
- ± R3 992 000 000 in 1984,
- ± R4 512 000 000 in 1985,
- ± R5 042 000 000 in 1986, and to
- ± R4 957 000 000 in 1987.

The estimated capital expenditure for the period 1983–1987 amounts to R21 787 000 000, so that the total amount of the estimated capital expenditure that will be incurred up to 1987, but not yet in commission on 31 December 1982, will amount to approximately R27 000 000 000.

GRAPH 11
ESCOM'S TOTAL CAPITAL EXPENDITURE
1983-1987



Graph 11 is based on the following figures:

Year	Total capital expenditure R mill. (a)	Total capital expenditure at June 1983 values R mill. (b)	Ratio (b)/(a)	Provision for—		
				Escalation R mill.	Overhead costs	Interest during construction R mill.
1983	3 284	2 320	0,706	—	175	789
1984	3 992	2 565	0,642	291	208	928
1985	4 512	2 742	0,608	663	256	851
1986	5 042	2 713	0,538	1 060	318	951
1987	4 957	2 310	0,466	1 322	395	930
Total	21 787	12 650	—	3 336	1 352	4 449
% of total capital expenditure		58,1%	—	15,3%	6,2%	20,4%

These figures indicate that—

- ☆ total capital expenditure at *basic 1983 values* will constitute *only* 58,1 % of the total capital expenditure at rand values of the day, that
- ☆ escalation will constitute 15,3 %,
- ☆ interest 20,4 %, and that
- ☆ overhead costs will amount to 6,2 % of the total capital expenditure for the period 1983–1987.

Assuming that works under construction but not yet in operation on 31 December 1987 will again amount to R5 016 580 000, the same figure as at 31 December 1982, the above figure indicates an *increase in loan charges* at say 15,235 % a year over the following five years, that is approximately R3 319 200 000 a year.

The loan charges of R3 319 200 000 a year on the additional capital investment is approximately 23,0 % more than the total revenue from all electricity sales by Escom during 1982, which amounted to R2 695 400 000.

The vital question is, how did these circumstances arise?

The changing position of assets in operation in terms of R000 per million kW.h sold

Table 29 provides an analysis of certain aspects of Escom's total assets in operation in terms of R000 per million kW.h sold as well as the marginal position.

The figures in Table 29 indicate that total fixed assets of R29 110 were required in 1965 per million kW.h sold, and that this figure increased over the years to a cumulative figure of R79 980 per million kW.h in 1982. *These figures do not include assets under construction.* When these figures are analysed, it is clear that there was a sharp increase in the value of fixed assets per million kW.h sold, especially since 1976 when it was R36 490 per million kW.h. *In 1982 this figure was more than double that for 1976.*

In a study of the marginal position of assets in operation in terms of R000 per million kW.h sold, on a five-year basis, which normally includes two phases of the trade cycle, the following figures apply:

- ☆ In 1965 the average R000/million kW.h sold, based on Escom's total assets in operation, was R29,11, while the figure based on the increase in sales during the previous five years, as well as increases in assets during that period, was R31,60.
- ☆ Although this figure *fluctuated from one year to another* as a result of relatively large transfers from "works under construction" account to "works in operation" account in some years compared with the steadier increases in electricity sales, for instance in 1971, the general trend was clearly a gradual upward one up to 1976.
- ☆ This upward trend is confirmed by the cumulative figure which was R29 110 per million kW.h in 1965 and 36 490 in 1976.
- ☆ The *marginal* figure was R36 670, R36 040 and R36 410 per million kW.h sold in 1974, 1975 and 1976 respectively but thereafter increased as follows:

TABLE 29

ANALYSIS OF ASSETS: R(000) PER MILLION kW.h SOLD AND MARGINAL R(000) PER MILLION kW.h SOLD*

Calendar year	Million kW.h sold in year	Increase in kW.h sold over figure for previous year	Increase in kW.h sold over figure for previous five years	Assets in operation on 31 December R(000)	Increase in assets in operation over figure for previous year	Increase in assets in operation over figure for previous five years	Cumulative R(000) per million kW.h sold	Marginal R(000) per million kW.h sold: Increase in assets and sales over figures for previous five years
1965.....	23 143,3	1 895,8	7 049,2	673 626	33 987	222 773	29,11	31,60
1966.....	24 554,3	1 411,0	7 523,1	714 213	40 587	245 797	29,09	32,67
1967.....	26 657,1	2 102,8	8 536,1	846 818	132 605	328 096	31,77	38,44
1968.....	28 885,0	2 227,9	9 385,0	911 479	64 661	333 949	31,56	35,58
1969.....	31 505,6	2 620,6	10 258,1	1 074 503	163 024	434 864	34,11	42,39
1970.....	34 890,6	3 385,0	11 747,3	1 180 860	106 357	507 234	33,84	43,18
1971.....	38 040,0	3 149,4	13 485,7	1 390 095	209 235	675 882	36,54	50,12
1972.....	41 648,9	3 608,9	14 991,8	1 526 697	136 602	679 879	36,66	45,35
1973.....	46 578,4	4 929,5	17 693,4	1 699 279	172 582	787 800	36,48	44,53
1974.....	52 585,1	6 006,7	21 079,5	1 847 484	148 205	772 981	35,13	36,67
1975.....	57 869,2	5 284,1	22 978,6	2 008 917	161 433	828 057	34,71	36,04
1976.....	63 355,7	5 486,5	25 315,7	2 311 725	302 808	921 630	36,49	36,41
1977.....	67 125,4	3 769,7	25 476,5	2 851 103	539 378	1 324 406	42,47	51,99
1978.....	72 780,4	5 655,0	26 202,0	3 564 600	713 497	1 865 321	48,98	71,19
1979.....	80 582,8	7 802,4	27 997,7	4 255 502	690 702	2 408 018	52,81	96,01
1980.....	87 539,3	6 956,5	29 670,1	5 604 038	1 348 536	3 595 121	64,02	121,17
1981.....	93 844,0	6 304,7	30 488,3	6 323 048	719 010	4 011 323	67,38	131,57
1982.....	96 135,9	2 291,9	29 010,5	7 689 399	1 366 351	4 838 296	79,98	166,78

* Based on assets in operation only, in other words assets under construction are not included.

Source: ESCOM.

Year	Marginal R(000) per million kW.h sold	Increase over figure for previous year
1976	36,41	—
1977	51,99	42,8%
1978	71,19	36,9%
1979	86,01	20,8%
1980	121,17	40,9%
1981	131,57	8,6%
1982	166,78	26,8%

The sharp rise in capital invested per million kW.h sold since 1976, as indicated by the marginal figure, requires further analysis.

The capital investment in the Central Generating Undertaking and in each of the distribution undertakings

In Table 30 Escom's total fixed assets in operation and under construction in the Central Generating Undertaking and in each of the distribution undertakings, as at 31 December of each year, are set out for the period 1972–1982.

Escom's total fixed assets in operation at cost on 31 December were 4,16 times as much in 1982 as in 1974. Total assets under construction increased from R323 155 000 on 31 December 1974 to R5 016 580 000 on 31 December 1982, or 15,5 times.

The distribution of fixed assets in operation at cost on 31 December among the different undertakings reveals that—

☆ the fixed assets in operation at cost in the *Central Generating Undertaking as a percentage of Escom's total fixed assets* first decreased from 65,9 % in 1972 to 63,3 % in 1977, and then increased to 74,6 % in 1982, while

☆ fixed assets in operation as a percentage of the total changed as follows in the different distribution undertakings:

Rand and OFS	16,8% in 1974 to 10,8% in 1982,
Natal	5,9% in 1974 to 3,0% in 1982,
Eastern Transvaal	5,1% in 1974 to 3,9% in 1982,
Cape Western	4,2% in 1974 to 3,4% in 1982,
Cape Northern	1,9% in 1974 to 2,1% in 1982,
Orange River	0,8% in 1974 to 0,6% in 1982,
Border	0,6% in 1974 to 0,6% in 1982.

During the period 1974–1982 the percentage of Escom's total fixed assets in the distribution undertakings decreased in every case except Cape Northern and Border.

TABLE 30

ESCOM'S TOTAL FIXED ASSETS IN OPERATION AND UNDER CONSTRUCTION, FIXED ASSETS IN OPERATION AND UNDER CONSTRUCTION IN THE CENTRAL GENERATING UNDERTAKING AND IN EACH OF THE DISTRIBUTION UNDERTAKINGS AS AT 31 DECEMBER OF EACH YEAR FOR THE PERIOD 1972-1982

Figures in R000

Year	Total fixed assets in operation at cost 31 December (a)	Fixed assets in operation in Central Generating Undertaking at cost 31 December (b)	(b) as % of (a)	Fixed assets in operation in Rand and OFS Undertaking at cost 31 December (c)	(c) as % of (a)	Fixed assets in operation in Natal Undertaking at cost 31 December (d)	(d) as % of (a)	Fixed assets in operation in Eastern Transvaal Undertaking at cost 31 December (e)	(e) as % of (a)	Fixed assets in operation in Cape Western Undertaking at cost 31 December (f)	(f) as % of (a)	Fixed assets in operation in Cape Northern Undertaking at cost 31 December (g)	(g) as % of (a)	Fixed assets in operation in Orange* River Undertaking at cost 31 December (h)	(h) as % of (a)	Fixed assets in operation in Border Undertaking at cost 31 December (i)	(i) as % of (a)	Head Office	
1972.....	1 526 700	1 006 562	65,9	247 019	16,1	88 294	5,8	75 162	4,9	63 581	4,2	25 007	1,6	9 037	0,6	6 038	0,4		
1973.....	1 699 300	1 115 480	65,6	272 520	16,0	95 858	5,6	88 186	5,2	72 867	4,3	29 814	1,7	11 750	0,7	6 806	0,4		
1974.....	1 847 500	1 188 085	64,3	309 845	16,8	109 810	5,9	95 002	5,1	77 084	4,2	34 536	1,9	15 771	0,8	10 969	0,6		
1975.....	2 008 900	1 285 074	64,0	343 555	17,1	121 475	6,0	99 478	4,9	82 190	4,1	37 736	1,9	18 886	0,9	14 595	0,7		
1976.....	2 311 700	1 462 443	63,3	392 758	17,0	129 492	5,6	117 879	5,1	111 035	4,8	45 976	2,0	25 805	1,1	20 009	0,9		
1977.....	2 851 100	1 772 649	63,3	459 922	16,1	144 390	5,1	154 773	5,4	131 995	4,6	72 654	2,5	30 346	1,1	27 243	0,9		
1978.....	3 564 600	2 293 971	64,3	515 606	14,5	164 547	4,6	184 400	5,2	156 332	4,4	122 642	3,4	33 399	0,9	33 602	0,9		
1979.....	4 255 500	2 844 618	66,8	574 453	13,5	174 461	4,1	220 050	5,2	177 165	4,2	129 106	3,0	34 845	0,8	39 319	0,9		
1980.....	5 604 000	4 024 064	71,8	660 124	11,8	184 784	3,3	239 660	4,3	209 091	3,7	139 708	2,5	39 213	0,7	39 253	0,7		
1981.....	6 323 000	4 603 724	72,8	721 231	11,4	204 636	3,2	251 777	4,0	230 430	3,6	152 717	2,4	45 555	0,7	42 788	0,7		
1982.....	7 689 400	5 739 046	74,6	832 126	10,8	228 932	3,0	297 744	3,9	258 533	3,4	165 217	2,1	49 294	0,6	45 175	0,6		
1982/1974.....	4,16	4,83		2,68		2,08		3,13		3,35		4,78		3,13		4,12			
ADD WORKS UNDER CONSTRUCTION IN GIVEN YEAR																			
1972.....	247 653	178 528	72,1	28 644	11,6	2 977	1,2	14 555	5,9	6 954	2,8	3 520	1,4	3 709	1,5	5 283	2,1	3 483	1,4
1973.....	243 670	157 643	64,7	38 925	16,0	8 267	3,4	11 642	2,6	6 366	2,6	2 308	2,5	6 001	2,5	7 256	3,0	5 262	2,2
1974.....	323 155	232 477	71,9	34 557	10,7	9 132	2,8	14 460	3,7	11 891	3,7	1 873	1,4	4 433	1,4	5 596	1,7	8 736	2,7
1975.....	560 886	438 262	78,1	33 515	6,0	7 053	1,3	20 660	3,7	20 473	3,7	6 123	1,1	4 937	0,9	5 202	0,9	24 661	4,4
1976.....	899 536	713 257	79,3	37 391	4,2	11 510	1,2	32 756	1,6	14 734	1,6	25 788	2,9	3 970	0,4	6 091	0,7	54 393	6,1
1977.....	1 341 815	1 178 987	87,9	39 437	2,9	11 570	0,9	34 802	2,6	21 548	1,6	43 585	3,2	2 105	0,2	3 361	0,3	6 420	0,5
1978.....	1 846 671	1 702 327	92,2	64 012	3,5	12 984	0,7	30 145	1,3	24 017	1,3	1 175	0,6	927	0,1	4 516	0,2	6 658	0,4
1979.....	2 481 627	2 345 997	94,5	74 469	3,0	11 462	0,5	12 329	0,9	21 572	0,9	2 521	0,1	2 124	0,1	916	0,4	10 237	0,4
1980.....	2 544 790	2 433 044	95,6	47 513	1,9	20 039	0,8	11 350	0,5	12 176	0,5	5 340	0,2	2 632	0,1	1 213	0,1	11 483	0,5
1981.....	3 720 640	3 505 861	94,2	70 293	1,9	30 323	0,8	29 731	0,5	18 849	0,5	6 338	0,2	5 325	0,1	2 383	0,1	51 537	1,4
1982.....	5 016 580	4 611 092	91,9	99 597	2,0	64 374	0,3	44 514	0,9	37 143	0,7	33 028	0,7	19 623	0,4	6 876	0,1	100 333	2,0
1982/1974.....	15,5	19,8																	

* Includes Cape Eastern Undertaking.

Source: ESCOM.

Since 1972 the total assets in operation and the fixed assets in operation in the Central Generating Undertaking increased as reflected in the following figures:

Year	Annual increase in Escom's fixed assets in operation at cost as at 31 December	Annual increase in fixed assets in operation in Central Generating Undertaking as at 31 December	Annual increase in fixed assets in operation in the rest of Escom as at 31 December	Annual increase in fixed assets in operation in Central Generating Undertaking as percentage of total
	R	R	R	%
1973.....	172 600 000	108 918 000	63 682 000	63,1
1974.....	148 200 000	72 605 000	65 595 000	49,0
1975.....	151 400 000	96 989 000	54 411 000	64,1
1976.....	222 800 000	177 369 000	44 431 000	79,6
1977.....	539 400 000	310 206 000	229 194 000	57,6
1978.....	713 500 000	521 322 000	192 178 000	73,1
1979.....	690 900 000	550 647 000	139 253 000	79,7
1980.....	1 348 500 000	1 177 446 000	171 054 000	87,0
1981.....	719 000 000	579 660 000	139 340 000	80,6
1982.....	1 366 000 000	1 135 322 000	230 678 000	83,1

The above figures show clearly that the *percentage* of the total annual increase in Escom's fixed assets in operation, contributed *annually* by the increase in fixed assets in operation in the Central Generating Undertaking, has increased sharply since 1975.

As regards the distribution of the capital invested in works under construction on 31 December among the various undertakings—

☆ the capital invested in works under construction in the Central Generating Undertaking, as a percentage of the Escom total, increased from 71,9 % in 1974 to 95,6 % in 1980, dropping to 94,2 % in 1981 and 91,9 % in 1982 and

☆ the capital invested in works under construction in the *distribution undertakings* constituted a small percentage of the Escom total, particularly in the late seventies and early eighties.

Since 31 December 1974, when the capital invested in works under construction in the Central Generating Undertaking was R232 477 000, it increased to R4 611 092 000, or by a factor of 19,8 in this undertaking up to 31 December 1982.

The amount of capital invested in *works under construction* in the Central Generating Undertaking and the rest of Escom, as reflected in the balance sheet on 31 December, changed as follows during the period 1974–1982:

Year	Fixed assets under construction in Central Generating Undertaking at a cost as at 31 December	Fixed assets under construction in the rest of Escom at cost as at 31 December
	R	R
1974.....	232 477 000	90 678 000
1975.....	438 262 000	122 624 000
1976.....	713 257 000	186 279 000
1977.....	1 178 987 000	162 828 000
1978.....	1 702 237 000	144 434 000
1979.....	2 345 997 000	135 630 000
1980.....	2 433 044 000	111 746 000
1981.....	3 505 861 000	214 779 000
1982.....	4 611 092 000	405 488 000

The extent of Escom's estimated capital expenditure for the years 1982–1987, on power stations, facilities, transmission and regions, is set out in Graph 12.

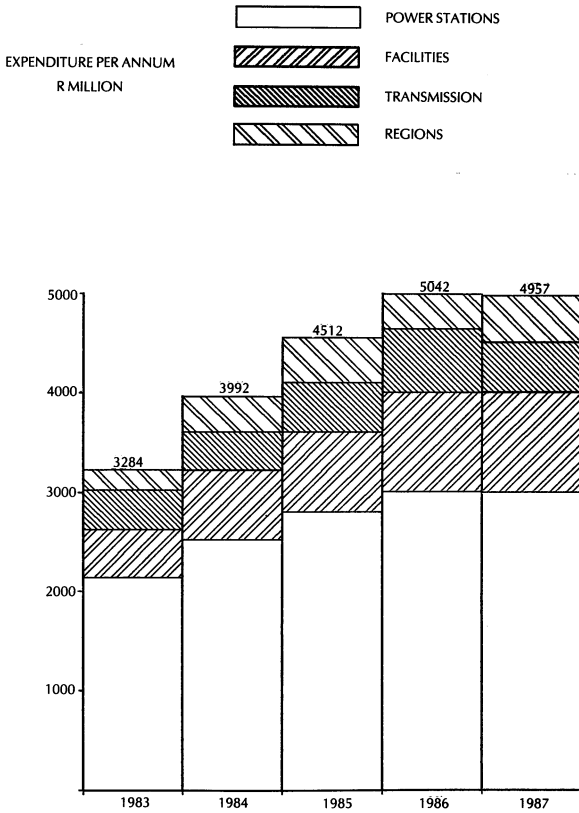
Graph 12 is based on the following figures:

Year	Total R Mill.	Power Stations		Facilities		Transmission		Regions*	
		R Mill.	% of total	R Mill.	% of total	R Mill.	% of total	R Mill.	% of total
1983.....	3 284	2 210	67,3	488	14,8	321	9,8	265	8,1
1984.....	3 992	2 564	64,2	711	17,8	399	10,0	318	8,0
1985.....	4 512	2 824	62,6	857	19,0	469	10,4	362	8,0
1986.....	5 042	3 102	61,5	942	18,7	619	12,3	279	7,5
1987.....	4 957	3 102	62,6	961	19,4	467	9,4	427	8,6
	21 787	13 802	63,3	2 959	18,2	2 275	10,5	1 751	8,0

* Includes distribution, reticulation and certain smaller facilities.

Source: ESCOM.

GRAPH 12
TOTAL ESCOM CAPITAL EXPENDITURE
1983-1987



According to this estimate Escom will allocate between 61,5 % and 67,3 % of its annual capital expenditure to *power stations as such* and between 91,4 % and 92,5 % to *power stations plus facilities and transmission* while expenditure in respect of *regions* will constitute *only* between 7,5 % and 8,6 % of individual annual capital expenditure. Accordingly it appears that a further R20 036 000 000 will be invested in the Central Generating Undertaking during the years 1983–1987.

It is clearly necessary to examine Escom's capital programme for the Central Generating Undertaking.

Capital investment in and programme for Escom's power stations

The capital investment in coal-fired power stations in operation as at 31 December 1982 is reflected in Table 31 while the investment in gas-turbine, pumped-storage and hydro-stations on the same date is reflected in Table 32. Matla and Duvha Power Stations have not yet been completed although a number of sets in these stations have already been commissioned.

Further programmes for new Escom power stations for the periods 1967–1988 and 1982–1994 have also been prepared. In this connection the considerable space of time for planning and construction as well as the rate of cost expenditure during the construction period is important.

In Graph 13 the annual cost rate and cost S-curve of a typical coal-fired power station (6 × 575 MW) are illustrated.

Not only do these graphs indicate that—

- ★ Basic cost constitutes only: 54 %,
- ★ escalation: 24 %,
- ★ overhead cost: 5 %, and
- ★ interest: 17 %

of total cost, but also that—

- ★ the first set is commissioned ± eight years after construction has been decided on, while
- ★ the last set is commissioned almost 14 years after that decision.

On this basis it must be accepted that the *decisions* about power stations to be completed and commissioned during the next seven years, 1983 to 1989, which will add 16 222 MW to Escom's generating capacity, were already taken in the years following 1974. This was directly after the exceptionally high growth rate of electricity consumption during the years 1967–1974. During the seven years 1983 to 1989 the generating capacity of Escom will increase by almost 80 %.

TABLE 31

CAPITAL INVESTMENT IN COAL-FIRED POWER STATIONS IN OPERATION UP TO 31 DECEMBER 1982

Power Station		Station Capacity		Boilers		Main turbogenerators		First set in operation	Number of years in operation	Capital invested on 31/12/82	Capital invested on 31/12/82 per MW of assigned sent-out capacity	Location	
	Boilers kg/s	Generators MW	Assigned sent-out rating MW	Number	Continuous maximum rating each kg/s	Number	Nominal rating each MW	Date in commercial service	on 31/12/83	R Million	R000 per MW	Nearest town and region or city	Province
Coal-fired power stations													
Arnot	1 998,6	2 100	1 980	6	333,1	6	350	7/6/71	13	275	138,9	Middelburg, Eastern Tvl.	Transvaal
Camden	1 814,4	1 600	1 520	8	226,8	8	200	13/4/67	17	161	105,9	Ermelo, Eastern Tvl.	Transvaal
Colenso No. 2	90,8 50,4	50 30	70	4 2	22,7 25,2	2 1	25 30	1/7/43	40	6,2	88,6	Colenso	Natal
	141,2	80		6		3							
Duvha on 1/3/84	3 042	3 600	3 450	6	507,1	6	600	22/8/80	4	1791	519,1	Witbank, Eastern Tvl.	Transvaal
Grootvlei	1 071,0 230,6	1 200	1 130	5 1	214,2 230,6	6	200	30/6/69	15	194	171,2	Balfour, Southern Tvl.	Transvaal
	1 301,6	1 200		6		6							
Hendrina	2 142,0	2 000	1 900	10	214,2	10	200	17/5/70	14	306	161,1	Middelburg, Eastern Tvl.	Transvaal
Hex River	100,8 69,2	60 60	111	4 2	25,2 34,6	3 2	20 30	1/7/61	23	15,3	137,8	Worcester	Cape
	170,0	120		6		5							
Highveld	554,4	480	412	8	69,3	8	60	16/2/59	25	72	174,8	Sasolburg	OFS
Ingagane	567,0	500	465	5	113,4	5	100	29/4/63	21	71	152,7	Newcastle	Natal
Klip	544,8	396 28	325	24	22,7	12	33	10/3/36	48	17,6	54,2	Vereeniging	Transvaal
	544,8	424		24		12							

Power Station		Station Capacity		Boilers		Main turbogenerators		First set in operation	Number of years in operation	Capital invested on 31/12/82	Capital invested on 31/12/82 per MW of assigned sent-out capacity	Location	
	Boilers kg/s	Generators MW	Assigned sent-out rating MW	Number	Continuous maximum rating each kg/s	Number	Nominal rating each MW	Date in commercial service	on 31/12/83	R Million	R000 per MW	Nearest town and region or city	Province
Komati	567,0 566,8	500 500		5 4	113,4 141,7	5 4	100 125						
	1 133,8	1 000	906	9		9		1/2/62	22	135	149,0	Witbank, Eastern Tvl.	Transvaal
Kriel	2 640,0	3 000	2 850	6	440,0	6	500	5/5/76	8	844	296,1	Kriel, Eastern Tvl.	Transvaal
Matla	3 049	3 600	3 450	6	508,2	6	600	29/9/79	4	1 571	455,3	Kriel, Eastern Tvl.	Transvaal
Salt River No. 2	328,0	120 120	228	10	32,8	4 2	30 60						
	328,0	240		10		6		1/5/55	29	34,4	150,9	Cape Town	Cape
Taalbos	584,0	480	440	8	73,1	8	60	9/12/54	29	70	159,1	Sasolburg	OFS
Umgeni	181,6 164,0	120 120		8 5	22,7 32,8	4 2	30 60						
	345,6	240	222	13		6		2/4/54	30	34,5	155,4	Pinetown	Natal
Vaal	430,2	297 21		18	23,9	9	33						
	430,2	318	270	18		9		22/1/45	39	28,5	105,6	Sasolburg	OFS
Vierfontein	503,5	360	336	19	26,5	12	30	4/5/53	31	55	163,7	Vierfontein	OFS
West Bank	85,6 53,0	45 40		4 2	21,4 26,5	3 2	15 20						
	138,6	85	80	6		5		1/4/56	28	10,9	136,3	East London	Cape
Wilge	62,8 201,6 73,1	60 180		4 4 1	15,7 50,4 73,1	2 3 3	30 60						
	337,5	240	221	9		5		16/7/54	29	32	144,8	Ogies, Eastern Tvl.	Transvaal

The figures for capital invested per MW of assigned sent-out rating, as at 31 December 1982, reflect a considerable increase between the old power stations which were built years ago and the newer ones. These figures are however subject to two shortcomings:

- ★ firstly Matla and Duvha Power Stations were not entirely completed by 31 December 1982, and
- ★ secondly, capital investment is shown as at 31 December.

Source: ESCOM.

TABLE 32

CAPITAL INVESTMENT IN GAS-TURBINE, PUMPED-STORAGE AND HYDRO-STATIONS IN OPERATION ON 31 DECEMBER 1982

	Station capacity		Main turbo-generators		First set in operation date in commercial service	Number of years in operation on 31/12/83	Capital invested on 31/12/82 R million	Capital invested per MW of assigned rating R000	Location	
	Installed rating		Number	Nominal rating each MW					Nearest town and region or city	Province
	Generators	Assigned sent-out rating								
Gas-Turbine Stations in operation										
Acacia	171	171	3	57	13/5/76	8	24	140,4	Cape Town	Cape
Port Rex	171	171	3	57	20/9/76	7	23	134,5	East London	Cape
Pumped-storage Station in operation										
Drakensberg	1 000	1 000	4	250	17/6/81	2,5	421	421,0	Bergville Northern Natal	Natal
Hydro-Stations in operation										
Hendrik Verwoerd	320	320	4	80	8/9/71	13	29	90,5	Colesberg Orange River	Cape
Vanderkloof	220	220	2	110	1/1/77	7	33	59,1	Petrusville Orange River	Cape

Source: ESCOM.

The annual cost rate curve also reflects the following figures which are very important from a financing point of view:

- ★ The percentage of the total capital spent in each of these years and the cumulative percentage at the end of each of the years indicated are as follows:

Year	Total during year %	Cumulative total %
0-5.....	1	1
6.....	6	7
7.....	13	20
8.....	23	43
9.....	19	62
10.....	18	80
11.....	14	94
12.....	4	98
13.....	1,5	99,5
14.....	0,5	100

- ★ During the 7th to 11th years the expenditure rate is very high, namely between 13 % and 23 % of the total capital cost for each year and during these five years $\pm$ 87 % of the total capital cost is spent.

- ★ Graphs 14 and 15 show the present and previous planning for new Escom power stations—

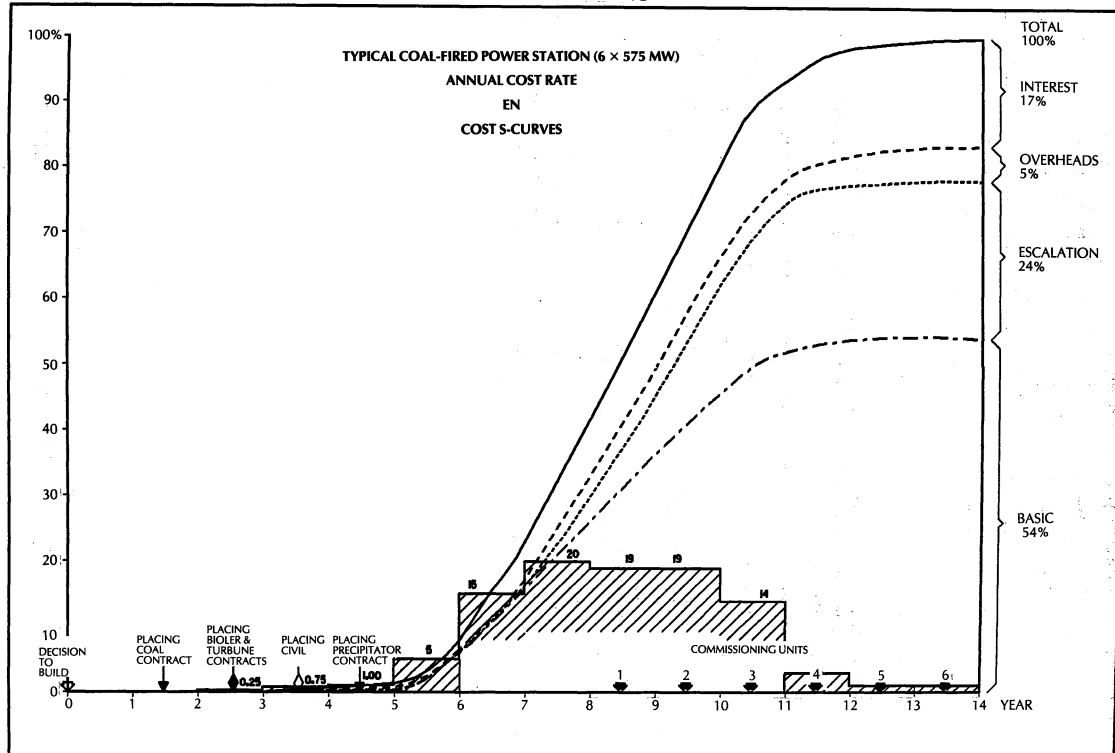
- Power station expansion programme: Main activities from 1976 to 1988, and
- Power station expansion programme: Main activities from 1982 to 1994.

The information contained in these graphs has been summarised in Table 33 which indicates that the installation of 27 220 MW of additional capacity has been planned for the period 1976–1989.

Table 34 provides information on the estimated capital investment in power stations under construction at the time of commercial commissioning. Of these power stations Tutuka, Lethabo, Matimba, Kendal and Majuba are coal-fired power stations, while Palmiet and Mvumase are pumped-storage stations and Koeberg is a nuclear power station.

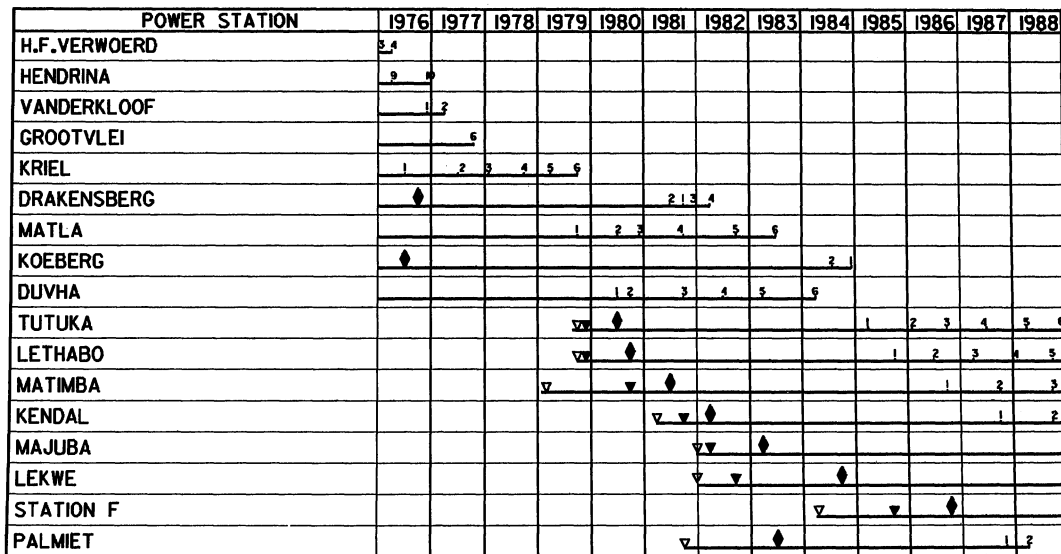
The figures in Table 34 include an amount of between R352 million and R610 million for residential areas for each of the coal-fired power stations. This high expenditure on residential areas may partially explain why, according to Graph 12, R6 220 000 000 or 26,8 % of the total estimated capital expenditure for the period 1983–1987 is allocated to facilities.

GRAPH 13



GRAPH 14

POWER STATION EXPANSION PROGRAMME : MAIN ACTIVITIES FROM 1976 TO 1988



▽ - INITIATION OF PROJECT AND ISSUE OF COAL TENDER ENQUIRIES

◆ - AWARDING OF BOILER AND TURBO-GENERATOR CONTRACTS

▼ - AWARDING OF COAL CONTRACT

1, 2 --- 6 - COMMISSIONING OF UNITS

GRAPH 15

POWER STATION EXPANSION PROGRAMME : MAIN ACTIVITIES FROM 1982 TO 1994

POWER STATION	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
DRAKENSBERG	1												
MATLA	5	5											
KOEBERG			2	1									
DUVHA	4	5	6										
TUTUKA				1	2	3	4	5	6				
LETHABO				1	2	3	4	5	6				
MATIMBA					1	2	3	4	---			5	6
KENDAL	◆					1	2	3	4	5	5		
MAJUBA	▽▽	◆						1	2	3	4	5	5
LEKWE	▽	▽		◆					1	2	3	4	5
STATION F			▽	▽	◆						1	2	3
PALMIET		◆				1	2						

▽ - INITIATION OF PROJECT AND ISSUE OF COAL TENDER ENQUIRIES

▼ - AWARDING OF COAL CONTRACT

◆ - AWARDING OF BOILER AND TURBO-GENERATOR CONTRACTS

1,2 --- 6 - COMMISSIONING OF UNITS

TABLE 33
POWER STATION CAPACITY INSTALLED IN VARIOUS YEARS

Year	Power Station and number of sets	Size of sets in MW	Capacity in MW installed	
			Year	Cumulative from 1976
1976	HF Verwoerd 2, Hendrina 2, Vanderkloof 1, Kriel 1 = 6	$2 \times 80 + 2 \times 200 + 1 \times 110 + 1 \times 500$	1 170	1 170
1977	Vanderkloof 1, Grootvlei 1, Kriel 1 = 3	$1 \times 100 + 1 \times 200 + 1 \times 500$	810	1 980
1978	Kriel 2 = 2	2×500	1 000	2 980
1979	Kriel 2, Matla 1 = 3	$2 \times 500 + 1 \times 600$	1 600	4 580
1980	Matla 2, Duvha 2 = 4	$2 \times 600 + 2 \times 600$	2 400	6 980
1981	Drakensberg 3, Matla 1, Duvha 1 = 5	$3 \times 250 + 1 \times 600 + 1 \times 600$	1 950	8 930
1982	Drakensberg 1, Matla 1, Duvha 1 = 3	$1 \times 250 + 1 \times 600 + 1 \times 600$	1 450	10 380
1983	Matla 1, Duvha 1 = 2	$1 \times 600 + 1 \times 600$	1 200	11 580
1984	Koeberg 2, Duvha 1 = 3	$2 \times 965 + 1 \times 600$	2 530	14 110
1985	Tutuka 1, Lethabo 1 = 2	$1 \times 609 + 1 \times 618$	1 227	15 337
1986	Tutuka 2, Lethabo 1, Matimba 1 = 4	$2 \times 609 + 1 \times 618 + 1 \times 665$	2 501	17 838
1987	Tutuka 1, Lethabo 1, Matimba 1, Kendal 1, Palmiet 1 = 5	$1 \times 609 + 1 \times 618 + 1 \times 665 + 1 \times 672 + 1 \times 200$	2 764	20 602
1988	Tutuka 2, Lethabo 2, Matimba 1, Kendal 1, Palmiet 1 = 7	$2 \times 609 + 2 \times 618 + 1 \times 665 + 1 \times 672 + 1 \times 200$	3 991	24 593
1989	Lethabo 1, Matimba 1, Kendal 1, Majuba 1 = 4	$1 \times 618 + 1 \times 665 + 1 \times 672 + 1 \times 672$	2 627	27 220

Source: ESCOM.

TABLE 34

ESTIMATED CAPITAL INVESTMENT IN POWER STATIONS UNDER CONSTRUCTION AT THE TIME OF COMMERCIAL COMMISSIONING

Power Station under construction	Station capacity			Boilers		Main turbo-generators		First set in commission	Number of years in operation	Capital invested as at 31/12/82	Estimated capital invested at commercial commissioning R Mill.	Estimated date of commissioning	Capital invested per MW of assigned rating R000	Situation	
	Installed capacity			Number	Maximum continuous rating each kg/s									Nearest town, and region or city	Province
	Boilers kg/s	Generators MW	Assigned sent-out rating MW			Number	Nominal capacity each MW	Date in commercial service	on 31/12/83	R Mill.					
Tutuka (coal)	3 042	3 654	3 492	6	507	6	609	1985	—	354,6	3 889†	1988	1 061	Standerton Southern Tvl.	Transvaal
Lethabo (coal)	3 054	3 708	3 558	6	508,2	6	618	1985	—	283,4	4 194†	—	1 178,8	Sasolburg	OFS
Matimba (coal)	2 308	2 660	2 460	4	577	4	665	1986	—	125,6	3 256†	—	1 323,6	Ellisras, Northern Tvl.	Transvaal
Kendal (coal)	3 462	4 032	3 780	6	577	6	672	1987	—	103,4	5 692†	—	1 505,9	Ogies, Eastern Tvl.	Transvaal
Majuba (coal)	3 462	4 032	3 780	6	577	6	672	1989	—	—	6 767†	—	1 790,2	Volksrust, Southern Tvl.	Transvaal
Palmiet (pumped-storage)	—	400	—	—	—	2	200	1987	—	13,5	614†	1988	1 535	Gordons Bay.	Cape
Koeberg (nuclear)	3 022	1 930	1 840	2	1 511	2	965	1983	—	2 805,0	2 835*	—	1 468,9	Cape Town.	Cape
Mvumase (pumped-storage)	—	1 500	—	—	—	5	300	1992	—	5,0	2 663	—	1 775,3	KwaZulu	Natal

* Does not include fuel.

† This figure includes an amount of between R352 million and R610 million for residential areas for coal-fired power stations.

Source: ESCOM.

The figures in Table 34 indicate a total capital expenditure of R29 910 000 000 for the power stations under construction.

However, expenditure, which rose from R400 million in 1982 to R1 780 million in 1987 on facilities, should be investigated separately and in depth. Indications are that a large percentage of this is for housing.

Thus far, in this part of the inquiry only power stations currently in operation and planned future power stations have been taken into account. To bring long-term trends of capital cost per MW and the life of coal-fired power stations into perspective, information is given in Table 35, on power stations decommissioned since 1970.

Salt River No. 1, Colenso No. 1 and Congella No. 1 were in operation for 51, 50 and 44 years respectively, while Colenso No. 1, Set 6, was in operation for 37 years and Congella No. 2, for 33 years. These figures, which indicate a power station life of 40 years, are the generally accepted figures.

The capital costs in R000/MW, as indicated in this table are based on the book value at the end of the power station's life.

For the investigation of the changing capital investment per MW of assigned power station rating, the figures for *certain* coal-fired power stations, as given in Table 36, may be high-lighted. The figures in this table indicate that the amount of capital invested per MW of assigned rating increased more than fivefold from September 1969, when Camden was brought into commercial operation, up to the commissioning of Duvha, in February 1984.

Basic information from previous tables on the historical and estimated future capital costs per MW of capacity in coal-fired power stations, and also in Koeberg, has been summarised in Table 37, and also in Graph 16. For the purpose of this table and graph the date of commissioning of the middle set has been taken as the date for capital cost change.

Between 1928 and 1971/72, over a period of nearly 45 years, i.e. approximately the economic life of a power station, the capital cost per MW of coal-fired power stations has increased to approximately three times that in 1928.

Between 1972 and 1982, over a period of only 10 years, the capital cost per MW of coal-fired power stations increased to three times the 1972 figure.

Since the middle of the seventies improved technology, high cost of inflation, high cost of financing, long lead times, the fluctuating exchange rate of the rand as against other currencies, the control of air pollution, security measures, the premium for the support of South African industries and the premium for the use of Conference lines contributed to the escalating capital cost per MW.

The rapid increase in the marginal cost in R000 per million kW.h sold during recent years can to a large extent be attributed to the trends of increasing capital cost per MW of power station capacity.

TABLE 35

INFORMATION ON POWER STATIONS DECOMMISSIONED SINCE 1970

Power Station	Installed capacity	Assigned sent-out rating	Main turbo-generators		First set commissioned	Station finally decommissioned	Number of years in operation	Capital cost of station	Capital cost	Reasons
			Number	Maximum						
	MW	MW		MW	month/year			R000	R000/MW	
Colenso No. 1 Sets 1-5	60	45	5	12	10/24*	1/1/73	50	4 298	96	Cracked steam receiver and decommissioning of boilers
Colenso No. 1 Set 6	25	21	1	25	7/43	7/5/80	37	1 245	59	Generator out of operation due to earth fault
West Bank No. 1	32	32	1 2 4	1,5 4 7,5	Taken over from East London Municipality in January 1947	1/6/78	31	2 847	89	The small capacity, low efficiency, high coal costs made the station uneconomical
Congella No. 1	86	82	3 1 1	12 20 30	7/28	1/1/73	44	4 071	50	Decommissioning of 7 boilers due to age
Congella No. 2	120	111	3	40	2/46	14/12/78	33	7 123	64	Turbine deterioration caused sent-out rating of only 97 MW. Small effect on reserve margin
Salt River No. 1	90	57	3	10	2/28	31/7/79	51	2 452	43	Decommissioning of boilers due to age

* Colenso Power Station was taken over from the South African Railways in January 1927.

Source: ESCOM.

TABLE 36

CAPITAL INVESTMENT IN CERTAIN COAL-FIRED POWER STATIONS WHEN THEY WERE BROUGHT INTO COMMERCIAL OPERATION—R000

Power station			Date brought into commercial operation	Capital cost including residential area as at date below		Month and year of commissioning of middle set	Capital invested per MW of assigned rating R000
1. Camden (8 sets)	4 x 200 MW 2 x 200 MW 2 x 200 MW	1967 1968 1969	Set No. 8 in September 1969	Date	R000		
Data readily available on.....				1/1/72	146 039	3/1966	96,1
2. Ingagane (5 sets)	1 x 100 MW 1 x 100 MW 1 x 100 MW 1 x 100 MW 1 x 100 MW	— — — — —	April 1963 March 1964 March 1967 February 1968 January 1969				
Data readily available on.....				1/1/72	51 642	5/1966	111,1
3. Grootvlei (6 sets)	2 x 200 MW 1 x 200 MW 1 x 200 MW 1 x 200 MW 1 x 200 MW	1969 1970 1971 1973 1977	Set No. 6 in November 1977				
				31/12/77 31/12/78	174 216 178 012	1/1972	157,5
4. Arnot (6 sets)	2 x 350 MW 1 x 350 MW 1 x 350 MW 1 x 350 MW 1 x 350 MW	1971 1972 1973 1974 1975	Set No. 6 in August 1975				
				31/12/75 31/12/76	232 344 236 490	3/1973	119,4
5. Hendrina (10 sets)	2 x 200 MW 2 x 200 MW 1 x 200 MW 1 x 200 MW 1 x 200 MW 1 x 200 MW 1 x 200 MW 2 x 200 MW	1970 1971 1972 1973 1974 1975 1975 1976	Set No. 10 in December 1976				
				31/12/77 31/12/78	279 497 282 644	4/1973	148,8

Power station			Date brought into commercial operation	Capital cost including residential area as at date below		Month and year of commissioning of middle set	Capital invested per MW of assigned rating R000
				Date	R000		
6. Kriel (6 sets)	1 × 500 MW 1 × 500 MW 2 × 500 MW 2 × 500 MW	1976 1977 1978 1979	Set No. 6 in November 1979	31/12/79 31/12/80	725 240 759 053	3/1978	266,3
7. Matla (6 sets)	1 × 600 MW 2 × 600 MW 1 × 600 MW 1 × 600 MW	1979 1980 1981 1982	Sets No. 6 still under construction for July 1983				
Estimated				31/12/83	1 600 000	5/1981	463,8
8. Duvha (6 sets)	2 × 600 MW 1 × 600 MW 1 × 600 MW	1980 1981 1982	Set No. 6 still under construction for February 1984				
Estimated				31/12/84	1 800 000	1/1982	521,7
9. Tutuka (6 sets)	6 × 609 MW	—	Under construction	1988	3 889 000	5/1987	1 061,0
10. Lethabo (6 sets)	6 × 618 MW	—	Under construction	—	4 194 000	11/1987	1 178,8
11. Matimba (4 sets)	4 × 665 MW	—	Under construction	—	3 256 000	3/1989	1 323,6
12. Kendal (6 sets)	6 × 672 MW	—	Under construction	—	5 692 000	3/1990	1 505,9
13. Majuba (6 sets)	6 × 672 MW	—	Under construction	—	6 767 000	3/1992	1 790,2
14. Koeberg*	2 × 965 MW	—	Under construction	—	2 835 000	10/1984	1 468,9

* Nuclear Power Station.

Source: ECSOM.

TABLE 37

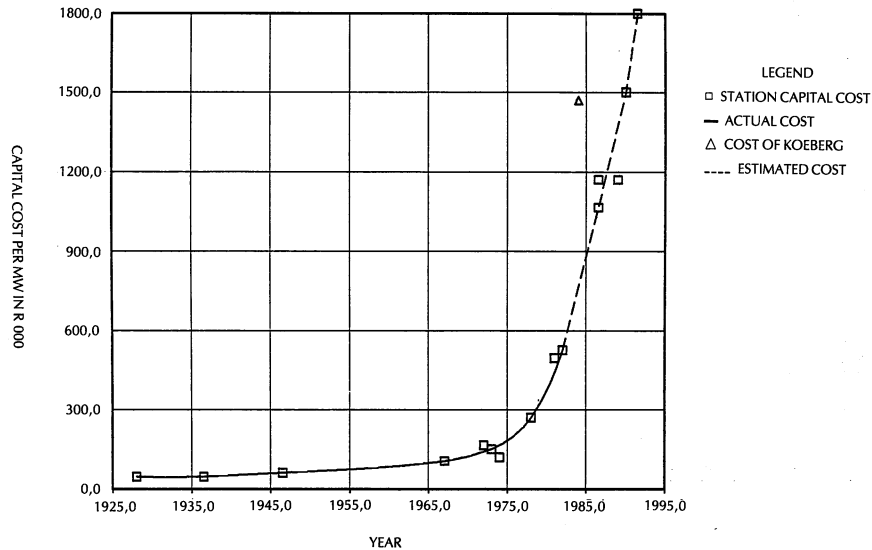
HISTORICAL AND ESTIMATED FUTURE CAPITAL COST PER MW OF CAPACITY INSTALLED IN COAL-FIRED POWER STATIONS, INCLUDING KOEBERG (NUCLEAR)

Month and year in which middle set was/will be commissioned	Name of power station	Capital: Final book value	Cost at commissioning	Rounded figure
		R	R	R
1928	Congella No. 1	50 000	50 000	50 000
1936	Klip (still in operation)	54 000	54 000	54 000
1946	Congella No. 2	64 000	64 000	64 000
3/1966	Camden 1 520 MW	105 900	96 100	96 100
5/1966	Ingagane 465 MW	152 700	111 100	111 100
1/1972	Grootvlei 1 130 MW	171 200	157 500	157 500
3/1973	Arnot 1 980 MW	138 900	119 400	119 400
4/1973	Hendrina 1 900 MW	161 100	148 800	148 800
4/1978	Kriel 2 850 MW	296 100	266 300	266 300
5/1981	Matla 3 450 MW	Estimated	463 800	463 800
1/1982	Duvha 3 450 MW	Estimated	521 700	521 700
5/1987	Tutuka 3 492 MW	Estimated	—	1 061 000
11/1987	Lethabo	Estimated	—	1 178 800
3/1989	Matimba	Estimated	—	1 323 600
3/1990	Kendal	Estimated	—	1 505 900
3/1992	Majuba	Estimated	—	1 790 200
10/1984	Koeberg*	Estimated	—	1 468 900

* Nuclear power station.

Source: ESCOM.

GRAPH 16
CAPITAL COST PER MW
(STEAM POWER STATIONS) 1928 TO 1992



ANALYSIS OF THE CONSOLIDATED REVENUE AND EXPENDITURE ACCOUNTS FOR EACH OF THE YEARS FROM 1967 TO 1982

In Table 38 Escom's consolidated revenue and expenditure account is given for each year from 1967 to 1982. In addition the annual sales in GW.h, average annual cost, tariff per GW.h and the annual tariff increase are given at the end of the table, while the compounded mean annual growth rates of certain costs for various periods are also indicated.

The figures in Table 38 clearly show the following:

- ☆ The tariff per GW.h increased at a relatively low average rate of 3,1 % per annum during the period 1967–1974. However, since 1974 this tariff increased at an average annual rate of 19,3 % per annum.
- ☆ Escom's total GW.h sales increased by an average of 10,19 % per annum during the period 1967–1974 and by an average of 7,83 % per annum during the period 1974–1982.
- ☆ During the period 1967–1974 revenue from electricity sales increased annually by 13,6 %, operating costs by 14,5 %, loan charges by 12,6 % and contributions to funds by 16,1 %.
- ☆ During the period 1974–1982—
 - revenue from electricity sales increased by 28,6 % per annum,
 - operating costs by 28,0 % per annum,
 - loan charges by 25,6 % per annum, and
 - *contributions to funds by the exceptionally high percentage of 42,4 % per annum.*
- ☆ It is clear that the exceptionally *high growth rate of 42,4 % per annum in contributions to funds* during the 1974–1982 period disturbed the previous tariff increase pattern completely.

Contributions to funds increased from R16 600 000 in 1972, when the first contribution to the Capital Development Fund was made, to R28 200 000 in 1974 and R476 000 000 in 1982.

In spite of the above adjustments Escom's accumulated surplus of R3 200 000 in 1967 changed into an accumulated deficit of R95 800 000 on the revenue and expenditure account in 1982.

TABLE 3B

STATEMENT OF ESCOM'S REVENUE FROM ELECTRICITY SUPPLIES IN MILLION FROM a TO j)

	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1967-1974	1974-1982	1967-1982
Electricity sold.....	146.8	161.5	176.2	193.5	219.6	254.4	302.0	358.7	460.1	656.4	1 000.5	1 301.8	1 529.5	1 772.0	2 140.7	2 695.4	%	%	%
Working costs.....	75.2	82.5	90.1	97.6	109.9	124.2	151.0	194.4	277.2	385.7	454.3	548.6	648.3	836.3	1 061.1	1 400.6	14.5	28.0	21.5
Loan charges.....	61.8	67.2	71.7	83.1	101.2	117.2	136.0	141.4	167.8	215.3	287.8	385.0	462.5	606.4	720.6	876.7	12.6	25.6	19.3
Contributions to funds.....	9.9	12.3	13.6	15.2	8.6	16.6	19.1	28.2	42.1	55.3	224.9	300.9	280.9	427.3	436.4	476.0	16.1	42.4	29.5
b + c + d =	146.9	162.0	175.4	195.9	219.7	258.0	306.1	374.0	487.1	656.3	997.0	1 234.5	1 311.7	1 870.0	2 218.1	2 753.3	13.8	28.8	21.6
Surplus (Deficit) g = e - f.....	(0.1)	(0.5)	(0.8)	(2.4)	(0.1)	(3.6)	(4.1)	(5.3)	(27.0)	0.1	33.5	67.5	17.8	(98.0)	(77.4)	(57.9)			
Accumulated surplus (deficit) at beginning of year.....	3.2	3.1	2.6	3.4	1.0	0.9	(2.7)	(6.8)	(12.1)	(39.1)	(39.0)	(5.5)	61.8	79.6	(18.4)	(95.8)			
f + g	3.1	2.6	3.4	1.0	0.9	(2.7)	(6.8)	(12.1)	(39.1)	(39.0)	(5.5)	61.8	79.6	(18.4)	(95.8)	(153.7)			
Sales in GW.h.....	26 657	28 885	31 506	34 891	38 040	41 649	46 578	52 585	57 869	63 356	67 125	72 780	80 583	87 539	93 844	96 136	10.2	7.8	8.9
Tariff per GW.h.....	0.5580	0.5580	0.5580	0.5545	0.5772	0.6106	0.6405	0.6822	0.7980	1.0360	1.3353	1.7887	1.8980	2.0242	2.2811	2.4618	13.1	19.3	11.5
Tariff increase per annum.....	0.5506	1.5%	0.5590	-0.8%	4.1%	5.8%	6.2%	5.2%	16.5%	30.3%	48.2%	16.5%	6.1%	6.6%	12.7%	22.9%	3.1	3.1	11.5

Source: ESCOM.

Table 39 gives a summary of Escom's consolidated revenue and expenditure accounts for the period 1967-1982. The period 1967-1982 to which the figures apply, may once again, as in the previous table, be divided into two distinct periods, namely 1967-1974 and 1974-1982.

The different trends in the two periods are summarised in Table 40.

Although the compound average annual growth rate of electricity sales in GW.h was lower, at 7,8 % a year during the period 1974-1982 than the rate of 10,2 % for 1967-1974, *Escom's total cost* increased at an average annual rate of 28,78 % in the second period as compared with 13,84 % in the first period.

With the exception of "Distribution operation and maintenance costs", which increased at a lower compound annual rate during the second period than during the first period, each element of cost rose at a *considerably accelerated rate* during the second period in comparison with the first period, as shown in Table 40.

The compound average annual increase rate of 42,4 % per annum for "Contribution to Reserve Fund plus Capital Development Fund", and of 35,99 % per annum for "General Expenditure" are especially characteristic of the period 1974-1982 when compared with the respective average annual rates of increase for these two cost elements during the first period, namely 16,1 % and 17,4 %.

THE INCREASE IN CERTAIN COST FACTORS AND PRODUCTIVITY PERFORMANCE DURING THE PERIOD 1967-1982

A comparison between the number of power station employees per MW of capacity and the total number of Escom employees per kW.h of sales during the period 1967-1982 is given in Table 41. These figures indicate productivity progress during this period.

For the total period 1967-1982 electricity sales increased at a compound growth rate of 8,9 % a year, installed power station capacity by 9,2 % a year and the number of employees by 7,5 % a year.

During the entire period 1967-1982 the installed power station capacity increased at a higher average annual growth rate than that of electricity sales while the average annual rate of increase in the total number of employees was lower than the growth rate of electricity sales.

The total number of employees per GW.h sold decreased from 0,74 to 0,61 during the period 1967-1982; this means that Escom's labour productivity, in total terms, improved by approximately 21 % during this period.

However, the labour productivity of power station employees decreased from 0,93 employees per MW in 1972 to 1,14 per MW in 1982. GW.h sales per power station employee decreased from 5,142 in 1974 to only 3,865 in 1982, a decrease of $\pm 24,8$ % in productivity.

TABLE 39

SUMMARY OF ESCOM'S CONSOLIDATED REVENUE AND EXPENDITURE ACCOUNT FOR THE PERIOD 1967-1982

Year	Escom total million kW.h sold	Interest in R000	Redemption and provision for repayment of loans R000	Reserve Fund in R000	Subtotal Capital-related Costs before Capital Development Fund		Capital Development Fund	Subtotal Capital-related Costs after Capital Development Fund		Purchase of electricity R000	Fuel		Other Power Station operating and Maintenance Costs		Distribution Operation and Maintenance Costs		General Expenditure		Total Cost in R000	Total Revenue in R000		
					R000	% of total		R000	% of total		R000	% of total	R000	% of total	R000	% of total	R000	% of total			R000	% of total
1967	26 657.1	37 312	24 536	9 912	71 760	48.84	—	—	71 760	48.84	313	42 488	28.92	14 618	9.95	7 146	4.86	10 603	7.22	146 928	146 783	
1968	28 885.0	43 282	23 884	12 300	79 466	49.06	—	—	79 466	49.06	121	45 117	27.85	17 016	10.50	8 097	5.00	12 126	7.52	161 993	161 475	
1969	31 505.6	50 943	20 809	13 605	85 357	48.67	—	—	85 357	48.67	102	48 035	27.39	19 038	10.86	9 264	5.28	13 578	7.74	173 374	176 106	
1970	34 890.6	59 484	23 654	15 202	98 340	50.21	—	—	98 340	50.21	89	49 440	25.24	21 955	11.21	10 594	5.41	15 448	7.89	195 866	193 475	
1971	38 040.0	70 266	30 923	8 568	109 762	49.97	—	—	109 762	49.97	82	53 587	24.40	26 276	11.96	11 492	5.23	18 440	8.50	219 639	219 584	
1972	41 648.9	86 631	30 575	3 056	120 262	46.61	13 596	5.27	133 858	51.88	95	57 259	22.19	31 586	12.24	13 486	5.23	21 737	8.42	258 021	254 394	
1973	46 578.4	101 858	34 200	3 760	139 818	45.67	15 366	5.02	155 184	50.69	117	68 634	22.42	38 685	12.64	17 082	5.58	26 460	8.64	306 162	302 034	
1974	52 585.1	114 308	27 151	66	141 525	38.87	28 114	7.72	169 639	46.60	86	92 530	25.42	48 572	13.34	20 617	5.66	32 611	8.96	364 055	358 768	
1975	57 869.2	136 963	30 814	1 400	169 177	34.73	40 730	8.36	209 907	43.09	114	141 913	29.13	44 980	9.23	18 477	3.79	71 758	14.73	487 149	460 073	
1976	63 355.7	173 829	41 470	1 700	216 999	33.06	53 584	8.16	270 583	41.23	2 399	208 316	31.74	62 477	9.52	19 712	3.00	92 835	14.14	656 322	656 381	
1977	67 125.4	224 418	63 403	900	288 721	28.96	224 000	22.47	512 721	51.42	15 501	239 228	23.90	76 294	7.65	19 859	1.99	133 494	13.39	997 097	1 030 552	
1978	72 780.4	308 970	76 036	900	385 906	31.26	300 000	24.30	685 906	55.56	26 364	271 222	21.97	89 193	7.22	23 677	1.92	138 106	11.19	1 234 468	1 301 829	
1979	80 582.8	373 718	88 800	900	463 418	30.30	380 000	25.14	843 418	55.79	36 061	319 428	21.13	95 887	6.34	28 689	1.90	188 203	12.45	1 511 686	1 529 474	
1980	87 539.3	504 732	101 629	900	607 261	34.27	426 400	22.80	1 033 661	55.28	35 806	405 630	21.69	117 968	6.31	36 824	1.97	240 078	12.84	1 869 967	1 772 000	
1981	93 844.0	603 546	117 088	900	721 534	33.71	435 478	19.63	1 157 012	52.16	4 106	569 949	25.70	170 206	7.67	43 034	1.94	273 756	12.34	2 218 063	2 140 689	
1982	96 135.9	721 948	154 758	26 000	902 706	33.49	450 000	16.34	1 352 706	49.13	3 615	693 979	25.21	261 842	9.51	59 852	2.17	381 348	13.85	2 753 342	2 695 422	

Source: ESCOM.

TABLE 40

TRENDS OF COST ESCALATION DURING THE PERIODS 1967-1974, 1974-1982 AND 1967-1982

Cost element	Average annual rate of increase		
	1967-1974	1974-1982	1967-1982
	%	%	%
Sales in GW.h	10,2	7,8	8,9
Interest on payments	17,34	25,91	21,84
Interest plus amortization and provision for redemption of loans	12,6	25,6	19,3
Contribution to Reserve Fund plus Capital Development Fund	16,1	42,4	29,5
Increase in capital-related costs (after Capital Development Fund)	13,08	29,63	21,62
Cost of fuel	11,76	28,64	20,47
Other power station operation and maintenance costs	18,71	23,44	21,21
Distribution, operation and maintenance costs	16,34	14,25	15,22
General expenses	17,4	35,99	26,98
Total cost	13,84	28,78	21,58

Source: ESCOM

TABLE 41

NUMBER OF EMPLOYEES PER MW OF CAPACITY AND PER kW.h OF SALES

Year	Total number of employees	Power station employees	Installed capacity (MW)	Sales (GW.h)	Power station employees per MW	Total number of employees per GW.h sold
1967	19 817	} Not readily available	5 845	26 657	} Not readily available	0,74
1968	20 893		6 345	28 885		0,72
1969	21 644		6 985	31 606		0,69
1970	22 700		7 583	34 891		0,65
1971	25 050		9 018	38 040		0,66
1972	26 937	8 883	9 551	41 649	0,93	0,65
1973	28 559	9 013	10 142	46 578	0,89	0,61
1974	29 891	10 226	10 692	52 585	0,96	0,57
1975	33 999	11 120	11 242	57 869	0,99	0,59
1976	36 915	11 771	12 444	63 356	0,95	0,58
1977	39 112	12 107	13 556	67 125	0,89	0,58
1978	41 040	16 749	14 434	72 780	1,16	0,56
1979	43 690	18 835	15 974	80 583	1,18	0,54
1980	47 490	20 553	18 349	87 539	1,12	0,54
1981	52 080	21 962	20 049	93 844	1,10	0,55
1982	58 850	24 874	21 749	96 136	1,14	0,61
Compound growth rate:						
1967-1974	6,0		9,0	10,2		
1974-1982	8,8		9,3	7,8		
1967-1982	7,5		9,2	8,9		

Source: ESCOM.

Average salaries and wages for the period 1972-1982 are given in Table 42.

During the period 1972-1977 when the consumer price index rose at a compound rate of 11,4 % per annum, the wages of black employees rose at a compound rate of 20,5 %, that of coloureds at 12,2 % and that of whites at 11,4 % per annum. The average compound wage increase rate for all employees was 13,9 % per annum.

During the second period, 1977-1982, when the consumer price index rose at a compound rate of 13,5 % per annum, the wages of black employees rose at a compound rate of 11,2 %, that of coloureds at 13,5 % and that of whites at 10,4 % per annum. The average compound wage increase rate for all employees was 10,2 % per annum for the second period.

ESCOM BALANCE SHEETS FOR THE YEARS 1967-1982

In Table 43 a recompiled balance sheet is given of Escom's assets for the years 1967-1982.

Escom does not write off fixed assets, but amortizes loans and consequently the following two accounts have been created:

☆ redemption fund, and

☆ provision for the repayment of foreign loans.

As a result of Escom's funding calculation system a Capital Reserve Account has been created. The average annual growth rate of certain balance sheet items for certain periods are given at the end of the balance sheet. The following figures, especially, are significant:

	Average annual growth rate		
	1967-1974	1974-1982	1967-1982
	%	%	%
Production plant	11,8	21,9	15,8
Redemption Fund	5,2	11,7	8,6
Provision for repayment of foreign loans	13,1	36,6	25,1
Capital Reserve Fund	16,7	12,0	14,2
Book value of assets in operation	13,0	21,8	17,6
Works under construction	17,6	40,9	29,5

TABLE 42

AVERAGE SALARIES AND WAGES—PERIOD 1972-1982

Year	Blacks		Coloureds		Whites		Total	
	Amount R	% increase over amount for previous year	Amount R	% increase over amount for previous year	Amount R	% increase over amount for previous year	Amount R	% increase over amount for previous year
1972	760	—	1 153	—	4 591	—	2 143	—
1973	1 061	39,6	1 204	4,4	5 230	13,9	2 549	18,9
1974	1 216	14,6	1 939	61,0	6 132	17,2	3 017	18,4
1975	1 548	27,3	2 025	4,4	6 972	13,7	3 548	17,6
1976	1 839	18,8	2 242	10,7	7 750	11,2	4 011	13,0
1977	1 930	4,9	2 052	-8,5	7 886	1,8	4 117	2,6
1978	2 065	7,0	2 056	0,2	8 323	5,5	4 236	2,9
1979	2 070	0,2	2 537	23,4	9 554	14,8	4 652	9,8
1980	2 613	26,2	2 820	11,2	10 247	7,3	5 220	12,2
1981	2 947	12,8	3 173	12,5	10 928	6,6	5 694	9,1
1982	3 278	11,2	3 870	22,0	12 923	18,3	6 681	17,3
Compound increase (%) as average per employee:								
1972-1977	20,5		12,2		11,4		13,9	
1977-1982	11,2		13,5		10,4		10,2	
1972-1982	15,7		12,9		10,9		12,0	

Note:

1. Number of employees is the average for the year.
2. Compound increase in consumer price index:
1972 to 1977 = 11,4%
1977 to 1982 = 13,5%
1972 to 1982 = 12,5%

Source:

1972 to 1977—Report No. 1889 of Board of Trade and Industries.

1978 to 1982—Escom's Annual Staff Report.

TABLE 43

RECOMPILED BALANCE SHEET OF ESCOM AS AT 31 DECEMBER—ASSETS (R MILLION)

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	Average annual growth rate			
																			1967-1974	1974-1982	1967-1982
Fixed assets																					
Land and rights	a	9,8	10,5	14,7	13,4	15,4	17,1	20,1	26,1	30,1	33,4	50,1	65,5	87,2	78,3	84,6	107,6	15,0	19,4	17,3	
Buildings and facilities	b	184,3	188,4	207,0	247,8	321,1	351,1	377,2	396,8	118,8	136,5	226,9	320,1	380,8	475,6	509,5	625,1	11,6	5,8	8,5	
Production equipment	c	652,7	712,6	837,5	904,2	1 053,6	1 158,5	1 302,6	1 424,6	1 860,0	2 141,8	2 574,1	3 179,0	3 787,5	5 050,1	5 728,9	6 956,7	11,8	21,9	17,1	
a+b+c=	d	846,8	911,5	1 059,2	1 165,4	1 390,1	1 526,7	1 699,3	1 847,5	2 008,9	2 311,7	2 851,1	3 564,6	4 255,5	5 604,0	6 323,0	7 689,4	11,8	19,5	15,8	
Less:																					
Redemption Fund	e	208,4	203,5	213,6	216,4	253,9	302,2	312,3	296,6	318,9	325,7	359,3	413,8	483,5	551,4	592,5	717,5	5,2	11,7	8,6	
Provision for repayment of foreign loans	f	5,2	5,2	4,6	4,9	5,5	7,1	10,8	12,3	14,9	22,1	42,9	58,6	83,0	89,0	118,7	148,7	13,1	36,6	25,1	
Capital reserve	g	87,4	108,8	138,9	170,7	173,1	172,0	206,0	258,0	298,0	349,9	362,2	373,9	396,8	457,1	504,6	637,2	16,7	12,0	14,2	
Book value of assets in operation	h	545,8	594,0	702,1	773,4	957,6	1 045,4	1 170,2	1 280,6	1 377,1	1 614,0	2 086,7	2 718,3	3 292,2	4 506,5	5 107,2	6 186,0	13,0	21,8	17,6	
Works under construction	i	104,0	202,9	212,6	264,5	214,7	247,7	243,7	323,2	560,9	899,5	1 341,8	1 846,7	2 481,6	2 544,8	3 720,6	5 016,6	17,6	40,9	29,5	
	j	649,8	769,9	914,7	1 037,9	1 172,3	1 293,1	1 413,9	1 603,8	1 938,0	2 513,5	3 428,5	4 565,0	5 773,8	7 051,3	8 827,8	11 202,6	13,8	27,5	20,9	
Movable assets																					
At cost	k								33,1	40,0	54,8	65,8	81,3	105,8	132,0	179,9	263,0		29,6		
Depreciation	l								14,9	18,9	23,6	31,6	40,2	49,3	61,6	79,9	110,5		28,5		
Book value	m	5,1	5,5	6,5	7,4	9,6	12,3	14,9	18,2	21,1	31,2	34,2	41,1	56,5	70,4	100,0	152,5	19,9	30,4	25,4	
Stores	n	38,4	37,7	41,5	46,5	51,4	60,8	66,9	83,9	107,3	153,6	192,0	195,3	223,7	245,1	306,1	447,6	11,8	23,3	17,8	
External investments	o	9,4	11,9	23,1	23,3	26,0	27,0	29,9	33,8	38,4	40,3	60,2	49,8	57,1	73,3	113,7	20,1	16,4	18,1		
Deferred expenditure	p								57,8	65,0	85,0	140,4	238,0	255,4	289,1	968,5					
	q	702,7	852,0	985,8	1 115,1	1 259,3	1 393,2	1 525,6	1 739,7	2 158,0	2 801,7	3 780,0	5 002,0	6 341,8	7 679,3	9 596,3	12 884,9	13,8	28,4	21,4	
Book value of fixed assets in operation/cost price of buildings and production equipment:																					
$\frac{h}{b+c} \times \frac{100}{1} =$	r	65,2%	65,9%	67,2%	67,1%	69,7%	69,3%	69,7%	70,3%	69,6%	70,8%	74,5%	77,7%	79,0%	81,6%	81,9%	81,6%				
Book value of fixed assets in operation (including works under construction):																					
$\frac{j}{q} \times \frac{100}{1} =$	s	92,5%	90,4%	92,8%	93,1%	93,1%	92,8%	92,7%	92,2%	89,8%	89,7%	90,7%	91,3%	91,0%	91,8%	92,0%	86,9%				
Installed capacity MW	t	5 845	6 345	6 985	7 583	9 013	9 551	10 142	10 692	11 242	12 444	12 856*	14 434	15 974	18 349	20 049	21 749	9,0	9,3	9,2	
Electricity sales in GW.h	u	26 657	28 885	31 506	34 891	38 040	41 649	46 578	52 585	57 869	63 356	67 125	72 780	80 583	87 539	93 844	96 136	16,2	7,8	8,9	

* Excluding 700 MW from Cahora Bassa.

Source: ESCOM.

It is clear that average annual growth rates during the period 1974–1982 showed a sharp increase in almost all cases compared with the corresponding figure for the preceding period, 1967–1974. These trends apply particularly to investments in production plant, provision for repayment of foreign loans, book value of assets in operation and investments in works under construction. During the period 1967–1982 the book value of fixed assets in operation, as a percentage of cost price of buildings and production plant, increased from 65,2 % in 1967 to 81,6 % in 1982.

Works under construction increased at an average growth rate of 40,9 % a year during the period 1974–1982, that is from R323 200 000 in 1974 to R5 016 000 000 in 1982.

During—

★ 1967–1974 electricity sales increased by an average of 10,2 % a year and during

★ 1974–1982 by an average of 7,8 % a year.

During—

★ 1967–1974 installed capacity increased by an average of 9,0 % a year and during

★ 1974–1982 by an average of 9,3 % a year.

During the period 1967–1982 installed capacity increased by an average of 9,2 % a year while electricity sales increased by an average of 8,9 % a year during the same period.

In Table 44 a recompiled balance sheet of Escom's capital structure for the years 1967 to 1982 is set out.

The average annual growth rates of certain balance sheet items in Table 44 for certain periods are again given at the end of the balance sheet. The following figures, in particular, are significant:

	Average annual growth rate		
	1967–1974	1974–1982	1967–1982
	%	%	%
Outstanding loans	11,2	25,3	18,5
Escom stock held by Escom itself	8,9	28,4	18,9
Escom stock held outside Escom	12,3	23,8	18,3
Import financing facilities		64,5	
Short-term loans		14,2	
Net borrowed capital	13,6	25,4	19,8
Capital Development Fund		64,1	
Equity	15,2	41,6	28,6

TABLE 44
RECOMPILED BALANCE SHEET OF ESCOM AS AT 31 DECEMBER—CAPITAL STRUCTURE (R MILLION)

		1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	Average annual growth rate		
																		1967– 1974	1974– 1982	1967– 1982
External loans																				
Loans outstanding	a	834,3 (283,0)	1 005,3 (288,8)	1 086,6 (306,9)	1 130,5 (323,5)	1 300,8 (366,5)	1 477,8 (444,8)	1 611,1 (445,3)	1 753,8 (513,1)	1 895,1 (619,6)	1 998,7 (709,1)	2 278,8 (961,1)	4 405,6 (1 408,8)	5 537,6 (2 080,9)	6 424,9 (2 655,9)	8 155,5 (3 212,8)	10 625,2 (3 794,6)	11,2 8,9	25,3 28,4	18,5 18,9
Less: Escom stock held by Escom itself	b																			
Escom stock held outside Escom	c	551,3	716,5	779,7	807,0	934,3	1 033,0	1 165,8	1 240,7	1 275,5	1 289,6	1 817,7	2 996,8	3 456,7	3 769,0	4 942,7	6 830,6	12,3	23,8	18,3
Import financing facilities	d				16,5	23,2	33,8	27,7	28,8	61,0	128,5	251,0	497,5	888,7	1 200,3	1 427,5	1 547,2		64,5	
Short-term loans	e			27,4	115,6	147,4	138,2	112,8	195,2	435,0	891,4	938,8	304,4	213,1	360,5	345,3	566,4		14,2	
Total	f	551,3 68,4	716,5 42,9	807,1 70,9	939,1 51,5	1 104,9 15,9	1 205,0 26,7	1 306,3 31,7	1 464,7 51,9	1 771,5 103,1	2 309,5 125,8	3 007,5 111,7	3 798,7 99,8	4 558,5 168,2	5 329,8 241,5	6 715,5 281,7	8 944,2 330,2	15,0 4,0	25,4 26,0	20,4 11,1
Net current liabilities	g																			
Net borrowed capital	h	619,7	759,4	878,0	990,6	1 120,8	1 231,7	1 338,0	1 516,6	1 874,6	2 435,3	3 119,2	3 898,5	4 726,7	5 571,3	6 997,2	9 274,4	13,6	25,4	19,8
Own capital																				
Capital Development Fund	i						14,1	31,4	63,7	112,9	181,6	435,2	801,9	1 291,4	1 872,1	2 365,6	3 357,0	—	64,1	—
Reserve Fund	j	79,9	90,0	104,4	123,5	137,6	150,1	163,0	171,5	183,8	195,9	199,4	202,6	210,4	212,1	191,0	218,4	11,5	3,1	6,9
Unrealized surplus on Escom stock held by Escom itself	k										25,8	27,9	31,7	37,2	33,7	42,2	138,2			
Surplus (Deficit)	l	3,1	2,6	3,4	1,0	0,9	(2,7)	(6,8)	(12,1)	(39,1)	(39,0)	(5,5)	61,8	79,6	(18,4)	(95,7)	(153,7)			
Own capital	m	83,0	92,6	107,8	124,5	138,5	161,5	187,6	223,1	283,4	366,4	660,8	1 103,5	1 615,1	2 108,0	2 599,1	3 610,5	15,2	41,6	28,6
	n	702,7	852,0	985,8	1 115,1	1 259,3	1 393,2	1 525,6	1 739,7	2 158,0	2 801,7	3 780,0	5 002,0	6 341,8	7 679,3	9 596,3	12 884,9	13,8	28,4	21,4
Own capital/Total assets $\frac{m}{n} \times \frac{100}{1} =$	o	11,8	10,9	10,9	11,2	11,0	11,6	12,3	12,8	13,1	13,1	17,5	22,1	25,5	7,5	27,1	28,0			

Source: ESCOM

It is clear that the average annual growth rates during the period 1974–1982 showed a sharp increase in all cases compared with the corresponding figure for the preceding period, 1967–1974.

During the period 1974–1982 net borrowed capital increased by an average of 25,4 % a year, outstanding loans by 25,3 % a year, Escom stock held by Escom itself by 28,4 % a year and Escom stock held outside Escom by 23,8 % a year. Import financing facilities, which constitute a form of loan capital, did not yet exist in 1967 but increased during 1974–1982 at an average growth rate of 64,1 % a year. The Capital Development Fund, which was established only in 1972, increased at an average growth rate of 64,1 % a year during the period 1974–1982.

During the period 1974–1982 Escom's equity increased by 41,6 % a year, so that the ratio of equity/total assets increased from 11,8 % in 1967 to 28,0 % in 1982.

Escom loans

A large percentage of Escom's total loans is obtained from sources abroad. In Table 45 information is given on loans negotiated in each of the years 1970–1982. There is clearly a considerable fluctuation in overseas loans as a percentage of total loans negotiated in certain years. For instance, in 1977 after the Soweto riots, the figure reached a low of 13,3 %.

During the years 1972–1982 the loan financing pattern changed significantly as evidenced by the figures in Table 46.

While 100 % of *local* loans negotiated in 1972 matured after more than 15 years, the percentage of loans that matured in that period decreased to 75 % of the loans negotiated in 1976 and to 41,5 % of those negotiated in 1982. On the other hand Escom negotiated no *local* loans that matured in less than one year during the period 1972–1976. In 1977 35,8 % of the total loans negotiated during that year were in this category and of those negotiated in 1982, this category already constituted 45,1 % of the year's total.

Between 1972 and 1976 Escom did not negotiate any foreign loans with a life of 15 years or more to maturity, but since then the percentage has increased and in 1982 17,2 % of the loans negotiated were in this category.

As regards both local and foreign loans, 61 % of the total loans negotiated in 1972 had a life of more than 15 years to maturity, but this percentage decreased to 37,6 % of those negotiated in 1982. Of the total loans negotiated during that year, those that matured in one year constituted 37,9 % of the total.

TABLE 45

FOREIGN LOANS AS A PERCENTAGE OF TOTAL LOANS RAISED EACH YEAR

Year	Foreign loans as percentage of total gross loans raised each year	Net foreign loans as a percentage of net total loans raised each year (i.e. after deduction of loan repayments)
1970.....	57,8	62,0
1971.....	62,8	47,5
1972.....	38,5	11,2
1973.....	31,6	(6,9)
1974.....	41,8	40,7
1975.....	69,7	70,9
1976.....	59,4	55,2
1977.....	13,3	(77,2)
1978.....	47,0	33,6
1979.....	66,0	53,7
1980.....	64,1	49,0
1981.....	35,9	32,1
1982.....	25,6	22,1

Source: ESCOM.

TABLE 46

LOAN PERIODS (EXPRESSED AS PERCENTAGE)—PERIOD TO EXPIRY OF TERM

Description	Year in which negotiated	Less than 1 year	1 to 3 years	3 to 6 years	6 to 10 years	10 to 15 years	More than 15 years	Total
Local.....	1972	—	—	—	—	—	100,0	100
	1973	—	20,7	20,7	—	—	58,6	100
	1974	—	6,1	—	—	—	93,9	100
	1975	—	—	7,7	3,8	—	88,5	100
	1976	—	—	16,3	8,7	—	75,0	100
	1977	35,8	—	6,1	1,5	3,8	52,8	100
	1978	28,0	—	—	8,7	—	63,3	100
	1979	21,8	—	3,7	8,9	—	65,6	100
	1980	53,8	—	—	4,0	23,1	19,1	100
	1981	42,6	—	—	—	4,0	53,4	100
	1982	45,1	—	7,3	—	6,1	41,5	100
Foreign.....	1972	—	5,5	65,7	15,9	12,9	—	100
	1973	—	—	51,1	34,9	14,0	—	100
	1974	—	6,3	55,3	38,4	—	—	100
	1975	25,0	—	51,1	10,8	13,1	—	100
	1976	15,4	35,5	49,1	—	—	—	100
	1977	14,5	24,4	13,5	8,8	16,0	22,8	100
	1978	2,6	11,1	47,2	12,9	6,9	19,3	100
	1979	3,7	3,7	42,0	21,8	5,2	23,6	100
	1980	1,4	8,4	42,2	11,4	2,7	33,9	100
	1981	—	0,1	16,2	62,2	2,3	19,2	100
	1982	—	—	16,3	63,0	3,5	17,2	100
Foreign and local	1972	—	2,1	25,6	6,2	5,1	61,0	100
	1973	—	11,4	34,3	15,7	6,3	32,3	100
	1974	—	6,1	12,5	8,7	—	72,7	100
	1975	15,4	—	34,4	8,1	8,1	34,0	100
	1976	11,0	25,4	39,8	2,5	—	21,3	100
	1977	32,5	3,8	7,3	2,6	5,7	48,1	100
	1978	21,1	3,0	12,7	9,8	1,9	51,5	100
	1979	16,5	1,1	14,9	12,7	1,5	53,3	100
	1980	39,1	2,3	11,8	6,1	17,4	23,3	100
	1981	32,5	—	3,8	14,7	3,6	45,5	100
	1982	37,9	—	8,8	10,0	5,7	37,6	100

Source: ESCOM.

Assuming that loans are concentrated on the middle of the period (e.g. that the average life of loans in the six to ten year category is eight years and that the maximum period for loans with a life of more than 15 years is 23 years) the average life of loans negotiated in specific years can be determined as set out in Table 47.

TABLE 47

AVERAGE LIFE OF ALL LOANS

Year	Average life of loans in years
1972.....	13,9
1973.....	10,0
1974.....	15,2
1975.....	9,8
1976.....	6,6
1977.....	10,6
1978.....	11,5
1979.....	12,1
1980.....	7,9
1981.....	10,6
1982.....	9,2

Source: ESCOM.

The average life to maturity of loans negotiated in specific years decreased from 13,9 years in 1972 to 6,6 years in 1976 but subsequently fluctuated between 12,1 years in 1979 and 9,2 years in 1982.

Although the above-mentioned figures apply to specific years, they suggest that loans should be redeemed in approximately ten years. This period is approximately one quarter of the life of Escom's major assets, namely power stations and power lines.

Another matter which deserves attention is the Capital Development Fund. The original purpose of this fund was to provide capital to finance the growth of assets and at the same time to increase the ratio of equity to borrowed funds. In 1972 the Franzsen Commission recommended 'that the share of internal funds, as a source of financing the capital expenditures of government enterprises, should be increased, not only that dependence on borrowed funds and the accompanying pressure on interest rates can be reduced but also that the interest and redemption burden on current revenue can gradually diminish or at least, not rise so rapidly. To this end tariffs, i.e. prices of services and goods rendered by government enterprises, will gradually have to be adjusted so that provision for depreciation can be made on the basis of replacement instead of original cost of assets, and 40 per cent, or such a percentage as may be determined by the Cabinet Committee for Finance, of the net or new investment i.e. the difference between the gross capital expenditure and the provision for depreciation, can be provided from current revenue'.

The fund was launched in 1972 with a contribution of R13,6 million and, as shown in Table 48, amounted to R63,7 million in 1974 and R3 040,9 million in 1982.

The ratio of equity to total assets

The Franzsen Commission raised the question what the ratio of equity to total assets should be in Escom's case.

In Table 49 the ratio is given between equity and net book value of total assets as well as the marginal values and ratios.

The average ratio of equity to total assets increased from 6,5 % in 1960 to 12,8 % in 1974. Since 1974, there was a sharp increase to 28,0 % in 1982. The marginal ratio increased from 16,6 % in 1974 to 30,1 % in 1977 and since then its course was as follows:

1978—36,2 %.

1979—38,2 %.

1980—36,9 %.

1981—25,6 %.

1982—30,8 %.

Since 1977 the rapid increase in the marginal ratio of equity to total assets coincided with the growth of the Capital Development Fund, which increased from a total of R435 200 000 to R3 040 900 000 during the period 1977–1982.

Effect of Capital Development Fund on tariffs

The effect of the Capital Development Fund on electricity tariffs is indicated in Table 50.

The contribution to the Capital Development Fund added 10,1 % to electricity tariffs in 1975, increasing to 25,8 % in 1977 and since that year, expressed as a percentage of tariffs, was 30,0 %, 32,5 %, 31,3 %, 25,3 % and 29,1 % for the years 1978, 1979, 1980, 1981 and 1982 respectively. Funds held back from tariffs contributed to the capital expenditure during each of the years 1975–1982, as indicated below:

TABLE 48
CAPITAL DEVELOPMENT FUND (R MILLION)

	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
Balance at beginning of year.....		14,1	31,4	63,7	112,9	181,6	438,8	809,0	1 300,4	1 886,3	2 556,9
Contributions.....	13,6	15,4	28,1	40,7	53,6	224,0	300,0	380,0	426,4	435,5	450,0
Interest earned.....	0,5	1,9	4,2	8,5	15,1	33,2	70,2	111,4	159,5	235,1	350,1
	14,1	31,4	63,7	112,9	181,6	438,8	809,0	1 300,4	1 886,3	2 556,9	3 357,0
Less:											
Difference between value and proceeds from stock sold.....						3,6	7,1	9,1	14,2	191,3	316,1
						435,2	801,9	1 291,3	1 872,1	2 365,6	3 040,9

Source: ESCOM.

TABLE 49

RATIO BETWEEN EQUITY AND NET BOOK VALUE OF TOTAL ASSETS

Year	Equity R million	Total assets R million	Marginal equity R million	Marginal total assets R million	Average ratio %	Marginal ratio %
	a	b	$c = a_n - a_{n-1}$	$d = b_n - b_{n-1}$	$e = a/b$	$f = c/d$
1960.....	12,7	194,6	—	—	6,5	—
1961.....	32,8	410,9	20,1	216,3	8,0	9,3
1962.....	39,3	447,5	6,5	36,6	8,8	17,8
1963.....	47,5	481,6	8,2	34,1	9,9	24,1
1964.....	55,6	502,1	8,1	20,5	11,1	39,5
1965.....	63,4	542,0	7,8	39,9	11,7	19,6
1966.....	71,6	617,9	8,2	75,9	11,6	10,8
1967.....	83,0	702,7	11,4	84,7	11,8	13,4
1968.....	92,6	852,0	9,6	149,4	10,9	6,4
1969.....	107,8	985,8	15,2	133,8	10,9	11,4
1970.....	124,5	1 115,1	16,7	129,3	11,2	12,9
1971.....	138,5	1 259,3	14,0	144,2	11,0	9,7
1972.....	161,5	1 393,2	23,0	133,9	11,6	17,2
1973.....	187,6	1 525,6	26,1	132,4	12,3	19,7
1974.....	223,1	1 739,7	35,5	214,1	12,8	16,6
1975.....	283,4	2 158,0	60,3	418,3	13,1	14,4
1976.....	366,4	2 801,7	83,0	643,7	13,1	12,9
1977.....	550,8	3 780,0	294,4	978,3	17,5	30,1
1978.....	1 103,5	5 002,0	442,7	1 222,0	22,1	36,2
1979.....	1 615,1	6 341,8	511,6	1 339,8	25,5	38,2
1980.....	2 108,0	7 679,3	492,9	1 337,5	27,5	36,9
1981.....	2 599,1	9 596,3	491,1	1 917,0	27,1	25,6
1982.....	3 610,5	12 884,9	1 011,4	3 288,6	28,0	30,8

Source: ESCOM.

TABLE 50

EFFECT OF CAPITAL DEVELOPMENT FUND ON ELECTRICITY TARIFFS

Year	Contribution to Capital Development Fund R million	Interest contributed to Fund	Total R million	GW.h sold	Capital development cost per kW.h in cents	Total cost per kW.h in cents	Percentage
	a	b	$c = a + b$	d	$e = c/d$	f	$g = e/f \times \frac{100}{1}$
1972.....	13,6	0,5	14,1	41 649	0,0339	0,6195	5,5
1973.....	15,4	1,9	17,3	46 578	0,0371	0,6573	5,6
1974.....	28,1	4,2	32,3	52 585	0,0614	0,6923	8,9
1975.....	40,7	8,5	49,2	57 869	0,0850	0,8418	10,1
1976.....	53,6	15,1	68,7	63 356	0,1084	1,0360	10,5
1977.....	224,0	33,2	257,2	67 125	0,3832	1,4854	25,8
1978.....	300,0	70,2	370,2	72 780	0,5087	1,6961	30,0
1979.....	380,0	111,4	491,4	80 583	0,6098	1,8759	32,5
1980.....	426,4	159,5	585,9	87 539	0,6693	2,1361	31,3
1981.....	325,5	235,1	560,6	93 844	0,5974	2,3636	25,3
1982.....	450,5	350,1	800,1	96 136	0,8323	2,8640	29,1

Source: ESCOM.

Year	Percentage contribution from tariffs to capital expenditure during year
1975.....	22,0
1976.....	24,1
1977.....	41,4
1978.....	46,3
1979.....	48,6
1980.....	46,0
1981.....	41,1
1982.....	38,1

Source: ESCOM.

The contribution by tariff revenue, collected during the year, to the capital expenditure of that year, increased sharply from 22,0 % in 1975 to 48,6 % in 1979 but dropped to 38,1 % in 1982.

The effect of the Capital Development Fund on the source and application of funds is illustrated in Tables 51, 52 and 53.

From the information in Table 51 it is clear that—

- ☆ the tariff revenue which was retained had increased from R93 600 000 or 20,3 % of the total in 1975 to R1 012 400 000 or 37,5 % of the total in 1982, and that
- ☆ a peak was reached in 1978 when 43,8 % of tariff revenue was retained.

Table 52 indicates that—

- ☆ annual loans on the local market increased from R47 200 000 or 9,1 % of the total inflow of funds in 1975 to R682 700 000 or 16,3 % of the inflow in 1982, while;
- ☆ annual loans on the foreign market increased in quantum terms from R322 800 000 in 1975 to R749 500 000 in 1982 which, as a percentage of the inflow of all funds, represents a decrease from 61,9 % of the total in 1975 to 17,9 % in 1982;
- ☆ the inflow of funds in the form of foreign loans dropped from 61,9 % and 55,1 % of the total inflow in 1975 and 1976 respectively to 20,1 % in 1977, increased to 35,0 % in 1979 and dropped again to 17,9 % of the total inflow for the year 1982;
- ☆ although Escom sold only R4,4 million of its own stock in 1975 and R7,7 million in 1976, the sales increased to R367 400 000 million in 1977, constituting 25,6 % of the total inflow of funds during that year. Subsequently the sale of Escom stock contributed between 20,0 % of the inflow in 1980 and 38,8 % in 1982. The sale of Escom stock made only minor contributions to annual inflow of funds during the years 1975 and 1976;

TABLE 51
REVENUE RETAINED

	1975		1976		1977		1978		1979		1980		1981		1982	
	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%
Revenue																
Electricity revenue	460,1	100,0	656,4	100,0	1 030,5	100,0	1 301,8	100,0	1 529,5	100,0	1 772,0	100,0	2 140,7	100,0	2 695,4	100,0
Surplus on grid which was taken over ...	0,1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	460,2	100,0	656,4	100,0	1 030,5	100,0	1 301,8	100,0	1 529,5	100,0	1 772,0	100,0	2 140,7	100,0	2 695,4	100,0
Expenditure																
Cost of coal burnt, other operating costs and maintenance	205,4	44,7	290,5	44,3	335,4	32,6	384,1	29,5	444,0	29,0	560,4	31,6	783,2	36,6	1 015,7	37,7
Electricity purchased	0,1	—	2,4	0,4	15,5	1,5	26,4	2,0	36,1	2,4	35,8	2,0	4,1	0,2	3,6	0,1
Administration and general expenses....	66,9	14,5	87,1	13,3	124,8	12,1	138,1	10,6	188,2	12,3	240,1	13,6	273,8	12,8	381,3	14,1
External interest	92,2	20,0	117,2	17,8	144,1	14,0	172,1	13,3	189,2	12,4	264,1	14,9	267,7	12,5	245,9	9,2
	364,6	79,2	497,2	75,8	619,8	60,2	720,7	55,4	857,5	56,1	1 100,4	62,1	1 328,8	62,1	1 646,5	61,1
Tariff revenue retained according to Board of Trade and Industries	95,6	20,8	159,2	24,2	410,7	39,8	581,1	44,6	672,0	43,9	671,6	37,9	811,9	37,9	1 048,9	38,9
Reserve Fund expenditure	2,0	—	4,3	—	4,2	—	11,5	0,8	16,4	1,0	19,4	1,1	31,2	1,4	36,5	1,4
Adjusted tariff revenue retained.....	93,6	20,3	154,9	23,6	406,5	39,4	569,6	43,8	655,6	42,9	652,2	36,8	780,7	36,5	1 012,4	37,5

Source: ESCOM.

TABLE 52

SOURCE AND APPLICATION OF FUNDS

	1975		1976		1977		1978		1979		1980		1981		1982	
	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%	R mill.	%
Source:																
1. Tariff revenue retained	95,6	18,3	159,2	17,5	410,7	28,6	581,0	29,4	672,0	29,1	671,6	26,5	811,9	26,7	1 048,9	25,0
2. Local loans	47,2	9,1	218,1	23,9	326,3	22,7	221,3	11,2	215,0	9,3	406,3	16,0	517,4	17,0	682,7	16,3
3. Foreign loans	322,8	61,9	501,8	55,1	288,6	20,1	586,2	29,6	807,9	35,0	869,9	34,4	733,0	24,1	749,5	17,9
4. Sale of Escom stock	4,4	0,8	7,7	0,8	367,4	25,6	504,4	25,5	533,3	23,1	506,4	20,0	932,8	30,6	1 630,5	38,8
5. Increase in net current liabilities	50,9	9,8	22,7	2,5	39,9	2,8	82,2	4,2	68,6	3,0	73,1	2,9	40,3	1,3	73,1	1,7
6. Proceeds from assets sold	0,1	—	1,2	0,1	1,0	0,1	0,9	—	4,1	0,2	0,7	—	2,8	0,1	6,2	0,1
7. Interest on external investments	0,7	0,1	0,7	0,1	0,7	0,1	0,6	—	0,6	—	0,5	—	0,3	—	—	—
8. External investments	—	—	—	—	—	—	0,1	—	1,9	0,1	1,5	0,1	3,3	0,1	0,6	—
9. Other	—	—	—	—	0,4	—	1,6	0,1	4,8	0,2	1,5	0,1	3,3	0,1	6,9	0,2
	521,7	100,0	911,4	100,0	1 435,0	100,0	1 978,3	100,0	2 308,2	100,0	2 531,5	100,0	3 045,1	100,0	4 198,4	100,0
Application:																
1. Capital expenditure	425,5	81,6	642,7	70,5	982,8	68,5	1 229,9	62,2	1 349,2	58,5	1 418,8	56,1	1 898,9	62,4	2 653,8	63,2
2. Movable equipment	8,3	1,6	15,9	1,7	12,5	0,9	16,8	0,8	25,4	1,1	28,2	1,1	51,7	1,7	87,4	2,0
3. Stores and material	23,4	4,4	46,3	5,1	38,4	2,7	3,3	0,2	28,5	1,2	21,4	0,9	60,9	2,0	141,5	3,4
4. External investments	5,3	1,0	4,6	0,5	1,9	0,1	—	—	—	—	—	—	—	—	—	—
5. Repayment of local loans	18,4	3,5	38,9	4,3	142,7	9,9	159,9	8,0	68,0	2,9	102,2	4,0	335,5	11,0	396,6	9,4
6. Repayment of foreign loans	23,1	4,4	150,6	16,5	186,4	13,0	333,4	16,9	408,2	17,7	515,1	20,3	269,4	8,8	239,2	5,7
7. Purchase of foreign Escom stock	—	—	—	—	6,7	0,5	98,5	5,0	340,2	14,7	376,8	14,9	379,4	12,5	457,5	10,9
8. Future fuel supply	6,5	1,3	8,3	0,9	5,5	0,4	53,6	2,7	63,5	2,8	41,5	1,6	40,4	1,3	91,1	2,2
9. Contribution to Reserve Fund	2,0	0,4	4,3	0,5	4,2	0,3	11,5	0,6	16,4	0,7	19,4	0,8	31,2	1,0	36,5	0,9
10. Other	9,2	1,8	(0,2)	—	—	—	6,3	0,3	8,8	0,4	8,1	0,3	(22,3)	(0,7)	70,0	1,7
11. Financing required	521,7	100,0	911,4	100,0	1 381,1	96,3	1 913,2	96,7	2 308,2	100,0	2 531,5	100,0	3 045,1	100,0	4 173,6	99,4
12. Moneys at call	—	—	—	—	53,9	3,7	65,1	3,3	—	—	—	—	—	—	24,7	0,6
Total	521,7	100,0	911,4	100,0	1 435,0	100,0	1 978,3	100,0	2 308,2	100,0	2 531,5	100,0	3 045,1	100,0	4 198,3	100,0

Source: ESCOM

TABLE 53
APPLICATION OF TARIFF REVENUE RETAINED (R000)

	1976				1977				1978				1979				1980				1981				1982			
	Total	Interest	Contri- bution	Depre- ciation	Total	Interest	Contri- bution	Depre- ciation	Total	Interest	Contri- bution	Depre- ciation	Total	Interest	Contri- bution	Depre- ciation	Total	Interest	Contri- bution	Depre- ciation	Total	Interest	Contri- bution	Depre- ciation	Total	Interest	Contri- bution	Depre- ciation
Redemption Fund.....	47 884	27 717	20 167	—	56 262	31 420	24 842	—	67 690	36 496	31 221	—	89 922	45 844	44 078	—	107 069	50 906	56 163	—	135 268	64 775	70 493	—	183 030	76 315	106 715	—
Provision for foreign loans	21 300	—	21 300	—	38 561	—	38 561	—	44 815	—	44 815	—	44 722	—	44 722	—	45 466	—	45 466	—	46 595	—	46 595	—	48 044	—	48 044	—
Reserve Fund	15 470	13 770	1 700	—	16 625	15 725	900	—	21 221	20 321	900	—	18 295	17 395	900	—	17 360	16 460	900	—	16 324	15 424	900	—	41 216	15 216	26 000	—
Capital Development Fund	68 702	15 118	53 584	—	257 171	33 171	224 000	—	370 091	70 091	300 000	—	491 264	111 264	380 000	—	583 571	159 171	424 400	—	649 198	233 720	435 478	—	800 163	350 163	450 000	—
Accumulated depreciation.....	5 736	—	—	5 736	8 653	—	—	8 653	9 872	—	—	9 872	9 975	—	—	9 975	14 121	—	—	14 121	21 931	—	21 931	—	34 371	—	—	34 371
Surplus/Deficit.....	159 092	56 605	96 751	5 736	377 272	80 316	288 303	8 653	513 689	126 881	376 936	9 872	654 178	174 503	469 700	9 975	769 587	226 537	528 929	14 121	869 316	313 919	553 466	21 931	1 106 824	441 694	630 759	34 371
Revenue retained	75	—	—	—	33 455	—	—	—	67 361	—	—	—	17 788	—	—	—	(97 967)	—	—	—	(27 374)	—	—	—	(57 920)	—	—	—
Reserve Fund expenditure	2,0	—	—	—	4,200	—	—	—	581 050	—	—	—	671 966	—	—	—	671 620	—	—	—	811 942	—	—	—	1 048 904	—	—	—
Revised revenue retained	157 167	—	—	—	406 527	—	—	—	569 573	—	—	—	653 582	—	—	—	632 227	—	—	—	780 728	—	—	—	1 012 367	—	—	—

Source: ESCOM.

☆ the total inflow of funds from all sources indicated increased from R521 700 000 in 1975 to R4 198 400 000 in 1982 and of this R425 500 000, or 81,6 %, was used for Escom capital expenditure in 1975 and R2 653 800 000 or 63,2 % in 1982;

☆ the annual capital expenditure increased sixfold during the period 1975–1982.

The annual quantum and percentage of the tariff revenue which was retained, as well as the application of this part of tariff revenue, is set out in Tables 51 and 53.

The most important information contained in these tables is summarised in Table 54.

The following commentary refers to the figures in Table 54.

☆ tariff revenue *retained* increased from 20,3 % of total tariff revenue in 1975 to 43,8 % in 1978 and to 37,5 % in 1982,

☆ the percentage of the tariff revenue *retained and transferred* to the Capital Development Fund increased from 49,2 % in 1975 to 89,8 % in 1980 and to 79,0 % in 1982,

☆ while the percentage allocated to—

— the Redemption Fund decreased from 30,9 % in 1976 to 22,8 % in 1982; that allocated to

— provision for foreign loans decreased from 13,7 % to 4,8 %; that to

— the Reserve Fund decreased from 10 % to 4,1 %, and that to

— the accumulated depreciation decreased slightly from 3,6 % to 3,4 %.

☆ The tariff revenue retained as a percentage of capital expenditure in the same year increased from 22,0 % in 1975 to 48,6 % in 1979 and to 38,1 % in 1982.

☆ The Capital Development Fund as a percentage of capital expenditure increased from 21,6 % in 1975 to 41,3 % in 1980 and to 30,2 % in 1982.

Escom's capital/output ratios

As Escom is not motivated by gain, it is necessary to examine its capital/output ratios and those of its distribution undertakings for the periods 1967–1982 and 1972–1982 with a view to determining the relative efficacy of the application of capital.

TABLE 54

INFORMATION ON TARIFF REVENUE RETAINED

	1975		1976		1977		1978		1979		1980		1981		1982	
	R mill.	% †	R mill.	% †	R mill.	%	R mill.	% †	R mill.	% †	R mill.	% †	R mill.	% †	R mill.	% †
Tariff revenue retained.....	93,6	20,3*	154,9	23,6*	406,5	39,4*	569,6	43,8*	655,6	42,9*	652,2	36,8*	780,7	36,5*	1 012,4	37,5*
Capital Development Fund.....	49,2	52,6	68,7	44,3	257,2	63,3	370,1	64,9	491,3	74,9	585,6	89,8	669,2	85,7	800,2	79,0
Redemption Fund.....			47,9	30,9	56,3	13,8	67,9	11,9	89,9	13,7	107,1	16,4	135,3	17,3	183,0	22,8
Provision for foreign loans.....			21,3	13,7	38,6	9,4	44,8	7,9	44,7	6,8	45,5	7,0	46,6	6,0	48,0	4,8
Reserve fund.....			15,5	10,0	16,6	4,1	21,2	3,7	18,3	2,8	17,4	2,7	16,3	2,1	41,2	4,1
Accumulated depreciation.....			5,7	3,6	8,6	2,1	9,9	1,7	10,0	1,5	14,1	2,2	21,9	2,8	34,9	3,4
Capital expenditure (a).....	425,4		642,7		982,8		1 229,9		1 349,2		1 418,8		1 898,9		2 653,8	
Tariff retained (b).....	93,6		154,9		406,5		569,6		655,6		652,2		780,7		1 012,4	
Tariff retained (b).....		22,0		24,1		41,4		46,3		48,6		46,0		41,7		38,1
Capital expenditure (a).....																
Capital Development Fund.....		21,6		10,7		26,2		30,1		36,4		41,3		35,2		30,2
Capital expenditure.....																

* Percentage of total tariff revenue.

† Other percentages calculated on tariff revenue retained.

Source: ESCOM.

To determine capital/output ratio, the capital investment as at 31 December of a given year is divided by the total revenue for that year.

The information on capital/output ratios for Escom as a whole and for the different distribution undertakings for the period 1967–1982 is summarised in Table 55.

During the period 1967–1974, when the annual increase in tariffs was 3,21 %, the capital/output ratio remained relatively high:

- ☆ 6,33 and 5,15 in terms of fixed assets in operation,
- ☆ between 7,39 and 6,05 for works under construction, and
- ☆ between 4,36 and 3,57 for total assets less Redemption Fund, etc.

During the period 1974–1982 all the above-mentioned ratios improved considerably due to electricity tariffs having been increased by 19,32 % a year.

The present dispensation between the Central Generating Undertaking and the distribution undertakings took effect only in 1972. The rapid increase in electricity tariffs in all the distribution undertakings during the period 1974–1982 was moreover responsible for the improvement in the capital/output ratio for all undertakings during this period. The relative efficacy of application of capital in order of merit in the different undertakings was as follows:

- ☆ Natal Undertaking—1974: 1,63 and 1982: 0,53,
- ☆ Rand and OFS Undertaking—1974: 1,74 and 1982: 0,58,
- ☆ Eastern Transvaal Undertaking—1974: 2,23 and 1982: 0,77,
- ☆ Border Undertaking—1974: 1,36 and 1982: 1,01,
- ☆ Cape Western Undertaking—1974: 1,73 and 1982: 1,02,
- ☆ Orange River Undertaking—1974: 2,69 and 1982: 1,03,
- ☆ Cape Northern Undertaking—1974: 2,89 and 1982: 1,60.

The improvement in capital/output ratio in the Orange River and Cape Northern Undertakings since 1974 was remarkable.

TABLE 55

CAPITAL/OUTPUT RATIO (AMOUNTS IN R000)

Capital/Output ratio	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
1. Total revenue.....	146 134	160 757	175 338	193 475	219 584	254 394	302 034	358 768	460 073	656 381	1 030 552	1 301 829	1 529 474	1 772 000	2 140 689	2 695 422
2. Fixed assets in operation at cost on 31 December.....	846 800	911 500	1 059 200	1 165 400	1 390 100	1 526 700	1 699 300	1 847 500	2 008 900	2 311 700	2 851 100	3 564 600	4 255 500	5 604 000	6 323 000	7 689 400
3. Capital/output ratio basis, fixed assets in operation.....	5,79	5,67	6,04	6,02	6,33	6,00	5,63	5,15	4,37	3,52	2,77	2,74	2,78	3,16	2,95	2,85
4. Fixed assets in operation plus works under construction 31 December.....	950 800	1 114 400	1 271 800	1 429 900	1 604 800	1 774 400	1 943 000	2 170 700	2 569 800	3 211 200	4 192 900	5 411 300	6 737 100	8 148 800	10 043 600	12 706 000
5. Capital/output ratio basis, fixed assets in operation and under construction.....	6,51	6,93	7,25	7,39	7,31	6,98	6,43	6,05	5,59	4,89	4,07	4,16	4,40	4,60	4,69	4,71
6. Total assets less redemption fund etc. in operation 31 December.....	545 800	594 000	702 100	773 400	957 600	1 045 400	1 170 200	1 280 600	1 377 100	1 614 000	2 086 700	2 718 300	3 292 200	4 506 500	5 107 200	6 186 000
7. Capital/output ratio basis, total assets less redemption fund etc. in operation.....	3,73	3,70	4,00	4,00	4,36	4,11	3,87	3,57	2,99	2,46	2,02	2,09	2,15	2,54	2,39	2,30
8. Fixed assets in operation at cost in Natal Undertaking.....						88 294	95 858	109 810	121 475	129 492	144 390	164 547	174 461	184 784	204 636	228 932
9. Revenue of Natal Undertaking.....						48 664	57 284	67 497	83 707	121 499	200 143	220 529	241 490	272 671	325 615	435 154
10. Capital/output ratio for Natal Undertaking.....						1,81	1,67	1,63	1,45	1,07	0,72	0,75	0,72	0,68	0,63	0,53
11. Fixed assets in operation at cost in Rand and OFS Undertaking.....						247 019	272 520	309 845	343 155	392 758	459 922	515 606	574 453	660 124	721 231	832 126
12. Revenue of Rand and OFS Undertaking.....						131 630	153 550	178 337	232 206	337 186	520 166	685 587	806 511	944 737	1 134 500	1 422 764
13. Capital/output ratio for Rand and OFS Undertaking.....						1,88	1,77	1,74	1,48	1,16	0,88	0,75	0,71	0,70	0,64	0,58
14. Fixed Assets in operation at cost in Eastern Transvaal Undertaking.....						75 162	88 186	95 002	99 478	117 879	154 773	184 400	220 050	239 660	251 777	297 744
15. Revenue of Eastern Transvaal Undertaking.....						28 094	34 222	42 613	55 382	78 337	126 881	173 191	219 440	252 678	316 915	386 255
16. Capital/output ratio for Eastern Transvaal Undertaking.....						2,68	2,58	2,23	1,80	1,50	1,22	1,06	1,00	0,95	0,79	0,77
17. Fixed assets in operation at cost in Border Undertaking.....						6 038	6 806	10 969	14 595	20 009	27 243	33 602	39 319	39 253	42 788	45 175
18. Revenue of Border Undertaking.....						5 702	7 085	8 075	9 956	14 035	21 199	22 819	25 745	29 206	35 277	44 728
19. Capital/output ratio for Border Undertaking.....						1,06	0,96	1,36	1,47	1,43	1,29	1,47	1,53	1,34	1,21	1,01
20. Fixed assets in operation at cost in Cape Western Undertaking.....						63 581	72 867	77 084	82 190	111 035	131 995	156 332	177 165	209 091	230 430	256 533
21. Revenue of Cape Western Undertaking.....						30 339	37 150	44 432	55 860	73 195	111 984	124 362	138 950	159 977	197 005	253 513
22. Capital/output ratio for Cape Western Undertaking.....						2,10	1,96	1,73	1,47	1,52	1,18	1,26	1,28	1,31	1,17	1,02
23. Fixed assets in operation at cost in Orange River Undertaking.....						9 037	11 750	15 771	18 886	25 805	30 346	33 399	34 845	39 213	45 555	49 294
24. Revenue of Orange River Undertaking.....						1 850	2 630	5 867	7 483	10 373	15 257	20 145	25 355	31 697	38 740	48 038
25. Capital/output ratio for Orange River Undertaking.....						4,88	4,47	2,69	2,52	2,49	1,99	1,66	1,37	1,24	1,18	1,03
26. Fixed assets in operation at cost in Cape Northern Undertaking.....						25 007	29 814	34 536	37 736	45 976	72 654	122 642	129 106	139 708	152 717	165 217
27. Revenue of Cape Northern Undertaking.....						8 115	10 113	11 947	15 469	21 756	34 922	55 196	71 983	81 034	92 637	102 970
28. Capital/output ratio for Cape Northern Undertaking.....						3,08	2,95	2,89	2,44	2,11	2,08	2,22	1,79	1,72	1,65	1,60

Source: ESCOM.

PHASE 2

STEP 2: EVALUATION OF PAST PERFORMANCE

With all the information made available by Step 1, it is now necessary to evaluate the present and past performance of the undertaking. This evaluation must be done by—

- ☆ evaluating the past performance of the undertaking against
- ☆ the declared objectives of management and by a comparison between the performance of the undertaking, and that of
- ☆ major electricity suppliers in other countries, and by matching the performance
- ☆ against the requirements of the total market within which the undertaking functions.

If the past performance of Escom is to be evaluated against the declared objective and policy of management and the performance of major electricity suppliers in other countries, two periods must be distinguished:

- ☆ The period 1950–1974, and
- ☆ the period 1974–1982.

THE PERIOD 1950–1974

During this period Escom's average growth rates in electricity sales and selling price were respectively 8,81 % and 3,87 % per annum.

At the same time Escom's assigned sent-out capacity increased at an average annual rate of 8,9 % from 1 290 MW in 1950 to 10 002 MW in 1974.

Escom's policy was therefore applied with particular success during this period and a cheap, dependable and abundant supply of electricity was made available where and when the demand for it arose.

The principal factors responsible for the slowly-rising selling price trend were the following:

- ☆ The price of coal rose from R0,84 per ton in 1950 to R2,03 per ton in 1960 and to R2,92 per ton 15 years later in 1974 while inflation and interest rates and the extent of annual wage increases were considerably lower than those for the period after 1974.
- ☆ The continuous growth in the demand for electricity enabled Escom to apply improved technology, especially in the commissioning of bigger generating sets with higher pressure and temperature and higher voltage distribution networks.
- ☆ As a result of the commissioning of sets with ever-increasing MW capacity, higher inlet steam pressures and temperatures during the years the overall *thermal efficiency* of Escom's coal-fired power stations increased from 18,2 % in 1950 to 28,7 % in 1974, an increase of 57,7 %, while the average availability of all Escom sets reached 82,3 % in 1974.
- ☆ In 1960 *Escom's assets in commission were R28 010 per million kW.h sold*, and these increased to R35 130 in 1974.
- ☆ The capital cost per MW capacity installed in coal-fired power stations increased from R64 000 for Congella No. 2 in 1946 to R119 400 for Arnot which was commissioned in 1975.
- ☆ During 1974 the increase in the Capital Development Fund was R32,3 million which as a percentage of the gross income from electricity sales amounted to 9,0 %.
- ☆ In 1974 capital related costs constituted 46,6 %, fuel 25,42 % and other expenses 27,98 % of the total operating costs.

The Escom share in the total national sales of electricity first increased from 77,1 % in 1967 to 77,7 % in 1970 and then rapidly to 85,9 % in 1974.

THE PERIOD 1974–1982

During this period the average annual growth rates of Escom's electricity sales and selling price were respectively 7,82 % and 19,32 %.

At the same time Escom's assigned sent-out capacity increased at an average annual growth rate of 9,4 %, from 10 002 MW in 1974 to 20 523 MW in 1982.

The principal factors responsible for the trend of rapidly increasing selling price during the period 1974–1982 were the following:

- ☆ The price of coal rose sharply from R2,92 per ton in 1974 to R11,75 per ton in 1982, or 19,1 % annually. The inflation rate during this period averaged 14,4 % per annum, interest rates rose sharply and the average compounded wage increase for all employees averaged 10,2 % per annum for the period 1977–1982.
- ☆ The continuous growth in the demand for electricity enabled Escom still to apply improved technology aimed at curbing selling price increases; nevertheless the unit price of electricity rose by 19,23 % per annum during this period.
- ☆ Thermal efficiency increased from only 28,7 % in 1974 to 30,5 % in 1982, an increase of 6,2 %, while the average availability of all Escom sets decreased from 82,3 % in 1974 to 73,1 % in 1982.
- ☆ In 1974 Escom's *assets in commission* were R35 130 per million kW.h sold, but these increased sharply to R79 980 in 1982.
- ☆ Escom's *assets in commission per million kW.h sold*, calculated as an average for the previous five years, increased from R36 040 to R166 780 during the seven years ended on 31 January 1982, an annual escalation of 24,5 %.
- ☆ The capital cost per MW capacity installed in coal-fired power stations increased *sharply* from R119 400 for Arnot in 1975 to an estimated R521 700 for Duvha which was commissioned in 1984.
- ☆ During 1982 the increase in the Capital Development Fund was R800,1 million, which as a percentage of the gross income from electricity sales amounted to 29,7 %.
- ☆ In 1982 capital related costs constituted 49,13 %, fuel 25,21 % and other expenses 25,66 % of the total operating costs.

The Escom share of total sales increased from 77,7 % in 1970 to 85,9 % in 1974 and to 93,6 % in 1982. It is clear that Escom, with so large a market share, had become the absolutely dominant supply utility and also the planner for supplying electricity needs in the Republic.

The performance and basis of success in the first period and the restrictive factors in the second period indicate the following aspects which must be reconsidered in this evaluation:

- ☆ **Firstly**, whether the long-term view of the country's electricity needs is justified or not.
- ☆ **Secondly**, whether the long-term estimate of required increases in generating capacity was and is reliable, and whether the increases were achieved effectively in the application of technology and capital costs.
- ☆ **Thirdly**, whether the other operating costs of Escom and their contribution to electricity tariffs were adequately controlled.
- ☆ **Fourthly**, whether the method of financing applied is the most suitable for Escom.
- ☆ **Fifthly**, whether the present electricity tariffs, especially as an incentive to limit maximum load and encourage consumption at appropriate times, are suitable or not.

THE COUNTRY'S LONG-TERM ELECTRICITY NEEDS

Because of the high cost of capital and the relatively high contribution of capital related costs to the price of electricity, an accurate forecast of the growth rate of sales is very important.

Estimates as a prerequisite for planning are important in any undertaking. This is even more so in capital intensive industries like Escom where the *period needed for design, acquisition, construction and commissioning, can cover eight to 12 years*, or several business cycles. The *forecast of electricity consumption* should therefore be valid for long-term periods, normally ten to 20 years. In the past, in most industrial countries, historical trends of the *growth rate of the economy and the growing share of electricity* in the pattern of energy consumption were in the main taken into consideration in the forecast.

However, in these countries the electricity supply utilities discovered after the oil crisis of 1973 that the previously proven methods of extrapolating historical trends had become unreliable and that they had, especially in the short term, totally over-estimated the growth rate of energy consumption.

Although the previously proven methods of estimating the growth rate of electricity consumption have become outmoded, the most reliable method of forecasting future trends *still remains* the understanding and evaluation of past and present trends and factors that influence these trends.

In this connection the world's economic growth rate trends in the post-war period and their effect and influence on the growth rate in energy and electricity consumption are of primary importance as a starting point for future estimates.

The post-war state of the world

At present the world is experiencing the most drastic and rapid change in history; this rate of change is still accelerating, especially since the end of the Second World War.

In the *fifties and sixties* the political map of the world was altered drastically by the great number of colonies that gained their independence; the Western countries experienced an era of very high economic growth; industrial development also started in the developing countries; food production evidently kept pace with growing populations; and the life expectancy of people across the globe increased. Industrial production, steel production and energy consumption were constantly growing. All these factors, seen as a whole, created a spirit of optimism, belief in the future and the expectation of higher living standards for mankind.

The end of the sixties ushered in a new era. Mankind's attention was forcibly drawn to the alarming growth of the world population, to the probability of food shortages, to the *excessive growth in industrial capacity*, to the accelerated consumption of diminishing raw materials and to pollution of the environment.

The era of exceptional post-war prosperity that had reached its peak in the sixties was dramatically terminated during the last quarter of 1973 when the oil-producing countries quadrupled the price of oil. It was however preceded by a period of rapidly increasing inflation that indicated an imbalance in the world economy.

Although the abnormally high increases in the price of oil drove the economies of the Western world to a critical point, there were already signs of approaching problems in the mid-sixties.

In 1968 the wealthy and powerful USA declared that paper was equal in value to gold and created paper money as Special Drawing Rights.

Between 1970 and 1974 the world saw an exceptional increase in the money supply.

The oil-producing countries realised that the "intrinsic value" of their oil underground was far more than that of the fast depreciating dollar for which they were selling it above ground.

In 1973 and 1978 political events in the Middle East disturbed the balance between consumption and supply in the oil market. During 1973–1981 the nominal price of crude oil delivered in the countries belonging to the Organisation for Economic Co-operation and Development (OECD Countries) increased almost tenfold while non-oil fuel and electricity prices quadrupled.

With hindsight the oil crisis of 1973 really divided the post-war growth pattern into two phases. Since the oil crisis circumstances and a number of factors that determine and measure the prosperity of the Western industrial countries have changed rather radically.

Some of these important circumstances and factors can briefly be summarised as follows:

- ☆ The economic growth rate of most countries immediately fell sharply. In some it was even negative in 1974 and especially so in 1975, but it recovered later to a lower average than that in the sixties and seventies.
 - While the economic growth rate of the OECD countries, for example, was an average of 5 % per annum for the period 1960–1973, it decreased to 2,3 % for the period 1973–1981.⁽¹⁾
 - In South Africa the growth rate of the gross domestic product decreased from an average of 5,6 % per annum during 1964–1971 to 4,6 % for the period 1967–1974 and to 3,2 % per annum for the period 1974–1982.⁽²⁾
- ☆ The growth rate of industrial production decreased sharply in most Western countries. Before the oil crisis it was 5,6 % for the period 1946–1973 for the OECD countries, while it decreased to 2,0 % per annum for the period 1973–1982.⁽¹⁾
 - This decrease limited the growth rate of the Third World and other countries which export raw materials for industrial use.
 - In South Africa, for example, the real growth rate of commodity exports during 1946–1973 was 5,6 % per annum, but the growth rate decreased after the oil crisis to 1,9 % per annum for the period 1973–1982.⁽²⁾

☆ The sharp increase in the oil price forced industrial countries—

⁽¹⁾ Main Economic Indicators: OECD.

⁽²⁾ Quarterly Magazine of the South African Reserve Bank.

- to lessen their dependence on oil—especially imported oil;
 - to limit the consumption of oil and exploit alternative sources of energy; these steps in turn resulted in the price of other energy materials like gas and coal, and that of electricity increasing rapidly, and consumer patterns of energy sources changed.
- ★ During the period 1960–1973 the share of *oil* in the total energy market of the OECD countries and that of South Africa increased while that of coal decreased. *After 1973* both trends changed in all these countries: the share of coal increased while that of oil decreased and nuclear power made a greater contribution.
- ★ In the twenty-four OECD countries, for example, oil supplied 39,6 % of the total energy needs in 1960 and 53,8 % in 1973, but this percentage fell to 47 % in 1982.⁽³⁾
- ★ In South Africa oil supplied 12,5 % of the total energy needs in 1960 and 22,8 % in 1973 but after the oil crisis this percentage fell to 13,5 % in 1982.⁽⁴⁾
- ★ The steep price increases of oil and other energy sources created strong incentives to increase the efficient exploitation of energy and its conservation.
- ★ Energy consumption was severely curtailed in most countries of the Western World. The curtailment was due not only to—
- the decrease in the economic growth rate and the industrial growth after 1973, but also to
 - structural changes in the economies, and
 - reactions to increased oil and energy source prices,
 - as well as to the conservation policies that were applied.
- ★ Two examples of structural changes are Japan which moved away from smelting-based, high energy intensive industries, and South Africa which built the Sasol 2 and 3 petrol-from-coal plants.
- ★ As to conservation policy, the European Economic Community decided at the time of the Venice Economic Summit that the efficient exploitation of energy should be intensified and that oil should be substituted by other energy sources.⁽³⁾
- ★ Total energy consumption per unit of real gross domestic product declined by 16 % in the OECD countries between 1973 and 1982, while oil consumption in these countries fell by an estimated 25 % over the same period.⁽³⁾
- ★ In the United States of America energy consumption per real dollar of the gross domestic product dropped by nearly 23 % between 1972 and 1982.⁽⁵⁾
- ★ The energy consumption of the world had, during the 50 years before 1973, increased at about the same growth rate as the gross world product.⁽³⁾
- ★ In OECD countries a 1 % increase in the gross domestic product accompanied by a 1 % increase in energy consumption characterised the period 1960–1973.⁽³⁾
- ★ The gross domestic product of the OECD countries grew by an average of 2,3 % per annum during 1973–1981, while energy consumption grew by only 2 % per annum, an indication that the ratio of growth rates in energy consumption to the economy had declined from 1:1 for the period 1960–1973 to 0,1:1 for 1973–1981.⁽³⁾
- ★ The conservation of energy and structural changes in the seven largest OECD countries resulted in—
- the decline of the ratio of energy consumption per unit of industrial turnover from 1,11/1 in 1973 to 0,82/1 in 1982, a decline of 26 %⁽³⁾, and that
 - a drop in the average annual increase rate of energy consumption in the domestic/commercial sector in these countries from 4,9 % during the period 1960–1973 to 0,6 % for the period 1973–1980, while the consumption of petrol and diesel, which constituted 85 % of the consumption of energy in the transport sector, declined from an average increase of 5 % for the period 1960–1973 to an average increase of 2,1 % per annum after 1973 as a result of the smaller growth in motor vehicle sales and of economy measures.⁽³⁾

⁽³⁾ World Energy Outlook, International Energy Agency OECD, Paris 1982.

⁽⁴⁾ Energy Bulletin; Department of Mineral and Energy Affairs; Plus Private Information.

⁽⁵⁾ Fortune.

- ☆ Although the special drawing rights, the dollar revolving credit facilities of the International Monetary Fund and other measures averted a crash in the world economy just after the oil crisis, the economic growth rates of Western countries declined sharply, investments decreased rapidly, huge balance of payment problems as well as monetary problems arose, the rate of international trade declined, more countries started applying protective measures and the United States of America started exerting pressure on other countries to save itself. However it was the steps that were taken with regard to the energy policy that allowed most of the countries to survive the years of crisis.
- ☆ The oil crisis clearly precipitated a totally new world economic climate. As a result of the sharp increases in energy prices in 1973 and again in 1978, energy policy of necessity became an integral part of economic policy.
- ☆ The oil crisis also disturbed—
 - the growth in the demand for electricity,
 - the ratio between the average annual growth rates of the economy and the electricity demand, as well as
 - the econometric basis on which long-term electricity load estimates in most countries were computed.

This last fact is of cardinal importance.

The influence of the oil crisis on the econometric estimate of electricity consumption

Sawhill and Silverman⁽⁶⁾ pointed out that in the past electricity supply organisations in many countries estimated the total future power consumption in the main by extrapolating historical trends and then provided adequate generating capacity to cope with these estimated needs.

Before 1970, according to them, this approach worked well, but conditions have changed during the last decade. They put it like this:

“In the last decade this ‘forecast-and-build’ approach has not served the industry well. Forecasts have been less accurate and high construction costs have imposed a heavy penalty for building excess capacity. In fact in each of the past ten years the industry’s load forecasts have been revised downward.”

They then produce the following graph (Graph 17) to support this statement.

Their commentary is the following:

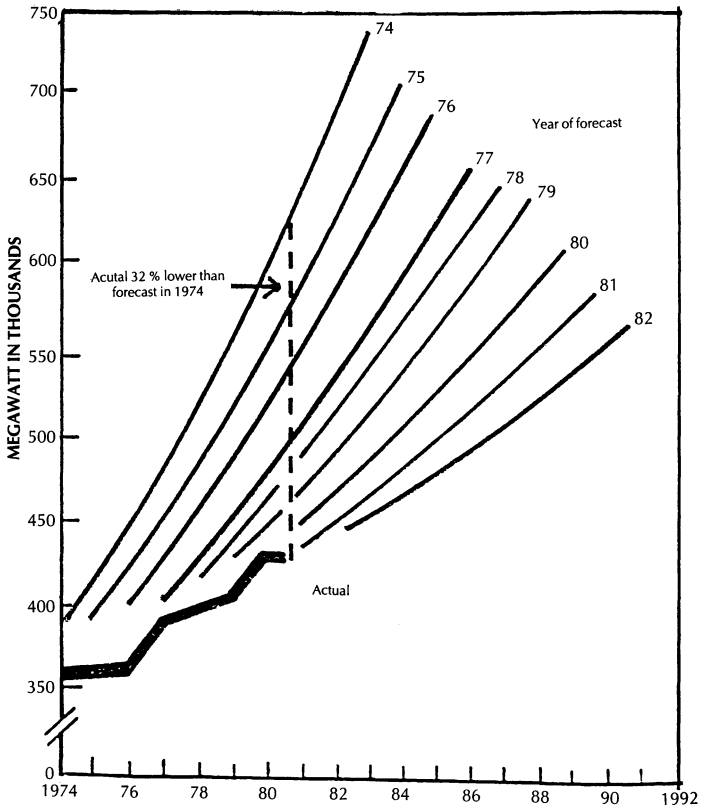
- ☆ “Actual 1981 demand was about 32 per cent lower than estimated in 1974—the equivalent of 200, 1 000 megawatt plants each costing \$3 billion.”—and then later
- ☆ “Why the large difference? Because the econometric forecast assumed this historical relationship between electricity use and both income and price would continue.”

Most econometric long-term electricity load forecasts are based on the historical facts that—

⁽⁶⁾ Do Utilities Have Strategic Options?
Ask the Customer
By John C. Sawhill and Lester P. Silverman
Public Utilities Fortnightly, March 31, 1983.

GRAPH 17

PROJECTIONS OF PEAK DEMAND IN SUMMER—COMPARISON OF ANNUAL TEN YEAR FORECASTS (USA AND ADJACENT)



Source: NERC, 12th Annual Review, August 1982

- ☆ the average annual percentage growth of the total energy consumption is equal to the average annual growth of the gross domestic product, and that
- ☆ the share of electricity in the total energy market has grown at a reasonably constant rate depending on the prevailing circumstances in that particular country, so that
- ☆ the average annual growth in the demand for electricity in most countries was therefore greater than the average annual economic growth of the gross domestic product.

These historical ratios have however been disturbed by the oil crisis

Colombo and Bernardini⁽⁷⁾ pointed out that their investigation into the historical ratio between energy and gross domestic product in industrial countries found a common pattern;

- ☆ In the initial stage of economic and industrial development, when basic industries and infrastructure are established in a country and the community sets high standards for material goods, the ratio of energy consumption to gross domestic product rises dramatically. This trend lasts till industrial maturity has been reached.
- ☆ When the stage is reached at which the above-mentioned requirements are satisfied the demand shifts to more sophisticated goods and services.
- ☆ The energy intensity of the gross domestic product does not therefore increase continuously but stabilises at a certain stage in the development of a particular country, *and then decreases*.
- ☆ In addition the technological efficiency of energy generation and application improves continuously. It contributes further to the reduction of the energy intensity of the gross domestic product. These trends are indicated on Graph 18.

With regard to the future energy consumption of the world, great differences exist in the forecasts of experts:

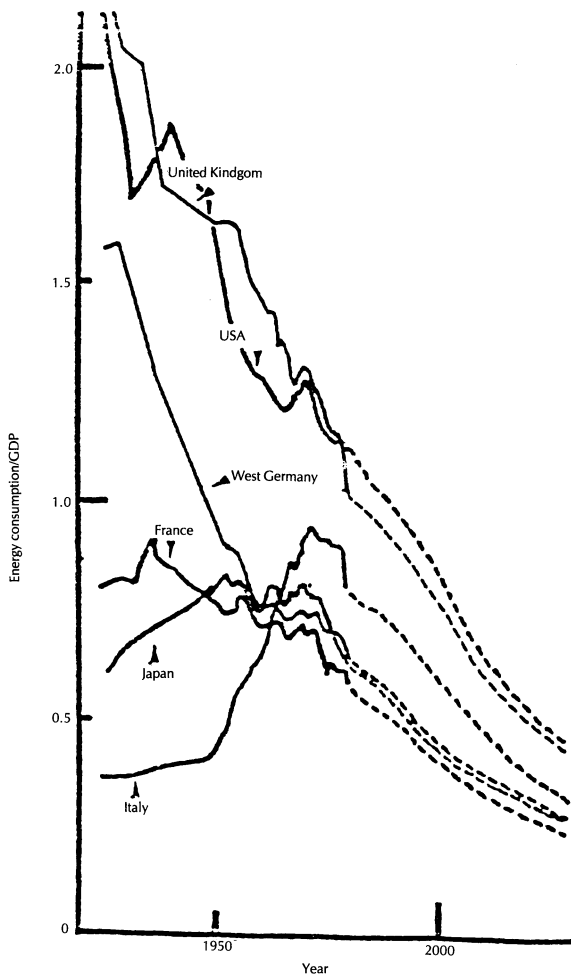
- ☆ Haefele⁽⁸⁾ and his contributors at the International Institute for Applied Systems Analysis (IASA) estimate a high energy consumption that will bring about a *tripling or quadrupling* in the present world primary energy consumption over the next 50 years.

⁽⁷⁾ A low energy growth 2030 scenario and the perspectives for Western Europe by U. Colombo and O. Bernardini; Commission of the European Communities, Panel on Low Energy Growth, Brussels 1979.

⁽⁸⁾ W. Haefele, J. Anderer, A. McDonald, N. Nakicenovich; Energy in a finite world. A global energy system analysis, Ballinger Cambridge Mass. 1981.

GRAPH 18 ENERGY CONSUMPTION/GDP RATIOS IN VARIOUS INDUSTRIAL COUNTRIES

Ratios are calculated on the basis of equivalent oil in kilogram per USA dollar (1973 value)



☆ Colombo and Bernardini⁽⁷⁾ with a more pragmatic approach estimate a *doubling* of both the population and the present energy consumption of the world in the next 50 years, but add that a significant redistribution of energy consumption per capita will take place in the industrial and developing countries.

☆ Lovins⁽⁹⁾ and his contributors indicate that the world can exist comfortably and even increase living standards over the next 50 years while only *half* of the present energy is used even if the world population doubles in the same period.

Lovins⁽⁹⁾ accepts that at present there is a huge waste of energy and that, in the foreseeable future, technological breakthroughs will occur and techniques will become available to attain final energy consumption at a much higher efficiency.

In this connection the following technological breakthroughs and developments among others must be pointed out:

☆ Present production processes of chlorine have already been improved over the past few years to reduce electricity consumption from 3 400 kW.h per ton to 3 100 and further to 2 300–2 700 kW.h per ton, and now, on an experimental basis, to 2 000 kW.h per ton against a theoretical minimum of 1 600 kW.h.⁽⁶⁾

☆ Refrigerators sold in 1981 consume 31 % less, freezers 52 % less and dishwashers 31 % less energy than those of 1971.⁽⁶⁾

☆ Investigations in Australia indicate a possible saving in energy of 20–30 % in existing houses, 40–60 % in new houses, 30–40 % in commercial and public buildings and 15–30 % in industries.⁽¹³⁾

Concerning the future a number of forecasts made by the International Energy Agency⁽³⁾ of the OECD countries are of importance:

☆ The indications are that the energy markets and especially the oil market will remain deceptively stable during the middle eighties, but will become firmer when the oil market moves slowly to a basic imbalance while increasing demand for oil has to be reconciled with stagnant production. Demand will once more tend to surpass available supply. Since 1973 and as a result of a further price increase in 1978 there have been strong incentives to achieve improvements in conservation and efficiency. The higher levels of conservation and efficiency in the utilisation of energy can be maintained, but conservation will become more difficult.

The same source⁽³⁾ also gives the following forecasts for the OECD countries:

AVERAGE ANNUAL GROWTH RATES FOR DIFFERENT PERIODS⁽³⁾

	1980–1985	1985–1990	1990–2000
Economic growth rate.....	2,4%–2,6%	2,7%–3,2%	2,7%–3,2%
Total energy consumption	0,1%–0,3%	1,4%–2,1%	1,3%–2,2%
Electricity sales	2,0%–2,2%	2,8%–3,6%	3,2%–4,1%

The higher growth rates in each of these periods are based on a real reduction in the price of oil of 3,9 % per annum until 1985, followed by a constant real oil price with a long-term increase in the efficiency of energy consumption.

The low growth rate on the other hand is based on a somewhat lower economic growth rate than in the previous case with an *oil price that falls by 3,3 % per annum*. Energy conservation is also allowed for in the estimate.

World Energy Outlook comments as follows:

“In the short and medium term, growth rates in developing countries are expected to be closely related to economic growth rates in the industrialised countries. Middle income countries are expected to grow 1 %–2 % faster and lower income countries at about the same pace as the developed countries.”

An important aspect of these forecasts is the conservation of energy consumption that is foreseen for the future.

Apart from these long-term trends due to economic growth in industrial countries, energy consumption, as already indicated, was drastically curtailed for economic reasons in most Western countries since 1973.

⁽³⁾ World Energy Outlook, International Energy Agency OECD, Paris 1982.

⁽⁶⁾ Do Utilities Have Strategic Options?

⁽⁷⁾ A low energy growth 2030 scenario and the perspectives for Western Europe by U. Colombo and O. Bernardini; Commission of the European Communities, Panel on Low Energy Growth, Brussels 1979.

⁽⁹⁾ A. B. Lovins and L. H. Lovins in World Energy Production and Productivity, Ballinger, Cambridge Mass. 1982.

⁽¹³⁾ Electricity Supply in Australia; Present and Future Prospects and Policies by A. R. Burdon; Sixth Meeting of Asia-Pacific Energy Studies Consultative Group, Resources Systems Institute; East West Centre, Honolulu USA, 23–26 May 1983.

The ratio of electricity consumption to the economic growth did not decrease as drastically after the oil crisis as was the case with the other energy sources.

During the years before 1973—

- ☆ oil consumption as a percentage of total *primary* energy consumption *increased* because of its low price and declining real price while
- ☆ electricity consumption as a percentage of *final* energy consumption also *increased*

The reasons for the penetration of electricity in the *total final energy market* are obvious.

Electricity as a source of energy can be distributed, applied and utilised more easily and more efficiently than other forms of energy. Add to this that electricity is the *ideal* energy source for the advanced new technologies and it becomes clear why electricity has captured a growing share of the *final energy* market in most Western countries during the past decades.

Trends in the demand for electricity in the post-war period in certain OECD countries

In the past the demand for electricity in the OECD countries increased consistently at a higher growth rate than that of total energy needs. In the period of 1960–1973 the average growth in the demand for electricity was 7 % per annum while the total demand for energy grew *by only 5 % per annum*⁽³⁾.

In the years *before* the oil crisis the average annual growth rate in electricity consumption exceeded the average annual growth rate in energy consumption, which had for almost 50 years remained the same as the economic growth rate in the OECD countries, by a substantial margin.

Since the oil crisis this margin has *narrowed* in most countries and has even *disappeared* in some.

The following reasons are given for this trend:

- ☆ The sharply rising electricity prices which, especially in the first two years after the oil crisis of 1973, came as a shock,
- ☆ energy conservation campaigns that curtailed waste,
- ☆ a decline in and even stagnant population growth, and
- ☆ the strong competitive position of other energy sources as a result of the rising price of electricity.

Apart from the above-mentioned factors that led to the more efficient use of electricity—

- ☆ the recession that lowered the growth of the domestic product, and
- ☆ the decline in international trade

also played their part in the lower growth rate in electricity consumption in these countries after 1973.

The result is that West Germany forecasts an annual growth rate in electricity sales as well as an economic growth rate of between 1,5 % and 2,5 % over the next 10 years.

In America the Bonneville Power Administration that forms part of the Department of Energy in the USA also found, according to its 1982 annual report, that the previously proven methods of forecasting long-term growth rates in electricity consumption were no longer suitable. In 1982 Bonneville therefore applied a number of new procedures in their forecasting methods.

Its final estimate indicates—

- ☆ a downswing in the demand for electricity, and
- ☆ a total average annual growth rate of 1,5 % until the year 2000 within highest and lowest levels of 2,4 % and 0,8%.

In its edition of 29 February 1982, *Forbes Magazine* reported as follows about AEP (American Electric Power) a private company in the United States:

"Few industries have faced a more abrupt and dramatic reversal in their circumstances than the US electric power industry. It wasn't all that long ago that US electric power consumption was growing at nearly twice the rate of the real gross national product. But now the growth in demand has slackened, and in 1982 US power consumption actually declined."

"Instead of the 6,8 % annual gain in consumption AEP had gotten used to between 1960 and 1973, demand now seemed likely to grow only 2,3 % annually through the next 10 years."

Trends in the demand for electricity in the post-war period in South Africa and Australia

After the oil crisis *the energy consumption in South Africa and Australia was not curtailed as drastically as was the case with other countries*

⁽³⁾ World Energy Outlook, International Energy Agency OECD, Paris 1982.

Both these countries have large reserves of coal and uranium. In addition Australia possesses considerable hydro-electric power potential and at present supplies over 60 % of its own oil requirements. During the sixties and seventies South Africa and Australia, countries with relatively large energy sources, had considerably extended their high energy-intensive industries based on domestic raw materials, like ferro-alloys, aluminium and other metal smelting plants (and, in the Republic, also its petrol-from-coal-projects). In Australia a 1 % increase in the annual economic growth rate for the period 1960–1969 coincided with a 0,94 % increase in the consumption of primary energy, for the period 1970–1973 the increase was 1,3 % and for the period 1974–1981 1,15 %⁽¹³⁾. The figures for South Africa were respectively 0,79 % for 1964–1971, 1,10 % for 1967–1974 and 1,25 % for 1974–1982⁽¹⁴⁾.

Apart from the above there are also a number of other common factors that make the development patterns in South Africa and Australia comparable and instructive.

These common factors are discussed firstly to determine their true extent. The South African case will be investigated first and then compared with the Australian case to find a better background for future forecasts.

The electricity supply industries in South Africa and Australia have the following in common:

- ☆ Escom, a public utility, supplied 93,6 % of the Republic's electricity in 1982 while public sector undertakings in Australia supplied $\pm$ 90 % of Australia's electricity in the same year.⁽¹⁵⁾
- ☆ Nearly 100 % of South Africa's electricity is generated from coal, although the Republic has recently commissioned a nuclear power station at Koeberg while Australia had decided against the application of nuclear power. In the sixties almost 80 % of Australia's electricity consumption was generated from coal while hydro-electric generation contributed about 20 %.⁽¹⁵⁾
- ☆ In both countries the electricity supply industry performed impressively as suppliers of cheaply available electricity and the growth rates of electricity sales in both countries were higher than the growth rates of energy consumption and the growth rates of the gross domestic product.
- ☆ The growth rate in the demand for electricity and primary energy, the growth rate of the gross domestic product and the difference between the growth rate of electricity demand and of the economy during different periods for the two countries are given below:

TABLE 56

MARGIN BETWEEN AVERAGE ANNUAL GROWTH RATES OF ELECTRICITY CONSUMPTION AND THE ECONOMY
SOUTH AFRICA

Period	Average annual growth rates			Margin between the average annual growth rate of electricity consumption and the economy
	Of the gross domestic product	Of total primary energy consumption	Of electricity consumption in the Republic	
	%	%	%	%
1964–1971	5,6	4,4	8,13	2,53
1967–1974	4,6	5,1	8,54	3,96
1974–1982	3,2	4,0	6,64	3,44

AUSTRALIA

Period	Average annual growth rates			Margin between the average annual growth rate of electricity consumption and the economy
	Of the gross domestic product	Of total primary energy consumption	Of electricity consumption in Australia	
	%	%	%	%
1960–1969	5,4	5,1	9,0	3,6
1970–1973	4,4	5,7	6,0	1,6
1974–1981	2,5	2,9	5,7	2,2

- ☆ Before the oil crisis in 1973 the average annual growth rate of the gross domestic product in South Africa was about 0,2 % higher than that in Australia, but the difference for the period 1974–1981 increased to 0,7 %.

⁽¹³⁾ Electricity Supply in Australia; Present and Future Prospects and Policies by A. R. Burdon; Sixth Meeting of Asia-Pacific Energy Studies Consultative Group, Resources Systems Institute; East West Centre, Honolulu USA, 23–26 May 1983.

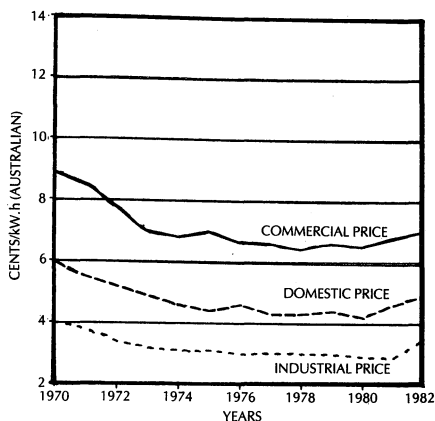
⁽¹⁴⁾ Mineral and Energy Affairs—Private Information.

⁽¹⁵⁾ Electricity—A National Perspective by D. J. Ives.

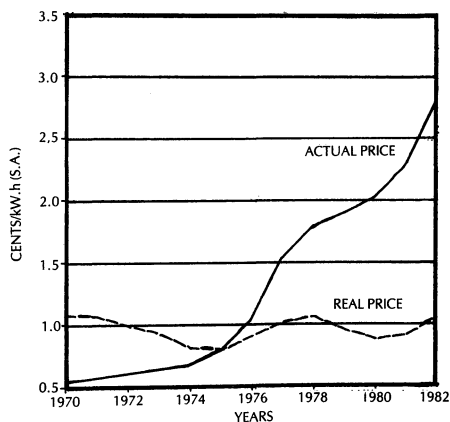
- ☆ The growth rate in electricity consumption was higher in Australia before the oil crisis than that in South Africa. After the oil crisis the growth rate of electricity sales in South Africa was 6,64 % per annum compared with 5,7 % in Australia.
- ☆ The margin between the average annual growth rate in electricity consumption and the economy in South Africa in the sixties was about 2,5 %, but increased considerably in the seventies. In Australia the trends were in the opposite direction, the margin being 3,6 % in the sixties falling to 1,6 % and 2,2 % in the seventies and eighties.
- ☆ In Graph 19 the average electricity prices are given for industrial, commercial and domestic consumers in Australia at 1981 money values for the period 1970–1982, as well as the Escom selling prices in real terms, the 1975 money values and present selling prices. In both South Africa and Australia selling prices per unit of electricity in real terms dropped after 1970, in Australia until 1980 and Escom's until 1975. The prices in real terms in both countries increased, Escom's until 1978 declining until 1980 and then increasing again.
- ☆ Three further aspects of the curves on Graph 19 must be emphasised:
 - In Australia the price per kW.h supplied to the industrial sector, during the period to which the curves apply, was about 45 % of the price to the commercial sector, while the price to the domestic sector fell between these two prices, but nearer to the industrial price.

GRAPH 19 AVERAGE ELECTRICITY PRICES

FOR INDUSTRIAL, COMMERCIAL AND DOMESTIC CONSUMER CATEGORIES IN AUSTRALIA FOR 1970-1982 (AT 1981 MONEY VALUES).



ESCOM'S ACTUAL AND REAL AVERAGE ELECTRICITY PRICE—AT 1975 REAL VALUES



- The South African actual and real prices are average prices and the South African cents/kW.h price *cannot be compared directly* with the Australian prices in cents/kW.h.
- The difference in price per kW.h for the South African industries, mines, bulk and small consumers will be discussed later.
- ☆ During the sixties when electricity sales by public undertakings in Australia grew from 19 000 GW.h in 1960 at a 9 % average annual growth rate to 45 000 GW.h in 1970, the growth rate of the manufacturing and industrial sectors was exceptionally high. The country's first aluminium smelting works was commissioned in 1961. The capacity of aluminium smelting works in Australia reached 308 000 tons in 1979, 607 000 tons in 1982 and 966 000 tons in 1983. In 1982 Australia's electricity requirements for this purpose alone were 95 000 GW.h at maximum capacity or 11 % of the total. The development of the energy-intensive industries to utilise the country's natural resources was also the predominant factor in the strong growth of electricity consumption in the industrial sector in the late seventies and eighties.
- ☆ Sixty per cent of the total electricity sales in Australia is used by industrial and commercial consumers and forty per cent by domestic consumers. Higher living standards, more electrical appliances and a fast-growing population also contributed to a higher growth rate of domestic electricity consumption.
- ☆ At the end of 1982 the investment in the Australian electricity industry was A\$14 000 million at historical values, or an estimated A\$44 000 million at present values, and it is estimated that a further A\$22 000 million will be needed to supply generating, transmission and distribution equipment until 1990.
- ☆ In Australia further possibilities are seen for more aluminium smelting works and mineral processing like copper and zinc refining and the processing of titanium.

The published forecast of electricity sales until 1991/92 of the Australian Department of Resources and Energy must be seen against this background. An increase of 4 % per annum for Australia as a whole is forecast with annual growth rates of 5,5 % and 4,4 % in the mining and manufacturing sectors respectively. These estimates are based on electricity capturing an ever-growing share of the final energy market.

This estimate points to an expected low economic growth rate and a narrowing of the gap between the growth rates of electricity consumption and the economy, probably because of the application of conservation measures.

The South African case can be investigated against this broad background.

The South African case

The South African trends of the economic growth rate and the rate of increase of electricity sales followed the same pattern as those in the OECD countries and Australia before the oil crisis, but have since taken an opposite course to the trends in those countries.

After reasonable similarity in the growth rates of electricity consumption before the oil crisis, the annual growth rate of electricity sales in the Republic was 6,64 % per annum for the period 1974–1982, which was in *sharp contrast* to the average of 3,0 % for the same period in the six OECD countries and also more than the average of 5,7 % in Australia which, like South Africa, was orientated towards upgrading of its own resources.

While the difference in the annual growth rates of electricity consumption and of the economies of most countries including Australia decreased *after the oil crisis* and in some almost disappeared, it increased in South Africa, from 2,53 % for the period 1964–1971 to 3,44 % for the period 1974–1982.

To determine the causes of the deviations from the pattern of the past as well as the trends in the OECD countries and Australia, it is necessary to investigate the economic trends of—

- ☆ the retail price of electricity in South Africa,
- ☆ the economic growth rate and growth pattern in the Republic.
- ☆ the growth rate of electricity sales since the sixties and how this was affected by the oil crisis, and
- ☆ possible changes in the future growth pattern and the expected success of conservation measures

to forecast the demand for electricity against this background.

The selling price of electricity

Electricity in South Africa is generated mainly from very cheap coal in large power stations on the coal-fields with the result that the price of electricity has been of the lowest in the world over the years. During the period 1950–1974 Escom's policy was applied with considerable success and a cheap, dependable and abundant supply of electricity was made available. The sixties were characterised by an average increase in the price of electricity of only 0,88 % per annum. The average price increase during the period 1967–1974 was only 3,21 % per annum, but this figure increased to 19,32 % per annum for the period 1974–1982.

The oil price did *not* have an immediate and dramatic effect on the price of electricity in South Africa like the shock increases in 1973 and 1974 in the OECD countries. Seen against the background of the low price of electricity before the oil crisis, this was also one of South Africa's strategic advantages, particularly in the mineral and metal refining industry, in the early seventies.

Graph 20 reflects the average selling price of electricity sold by Escom for the period 1960–1983 for the following:

- ☆ Actual selling price,
- ☆ actual selling price without the contribution to the Capital Development Fund,
- ☆ real selling price, and
- ☆ real selling price without the contribution to the Capital Development Fund.

During the period 1960–1974—

- ☆ the actual selling price of electricity increased at a relatively low rate, while
- ☆ the real selling price decreased at a gradual rate.

This was also the trend in most industrial countries due to technological advances that made a higher thermal efficiency and the advantages of scale possible in addition to a decline in the real price of fuel up to and during the oil crisis. After the oil crisis the real price of electricity reacted differently in the various countries, depending inter alia on the type of fuel used, whether oil or coal, and on its price increases.

In Australia where coal is used mainly for the generation of electricity, the real price of electricity decreased throughout the seventies until 1980.

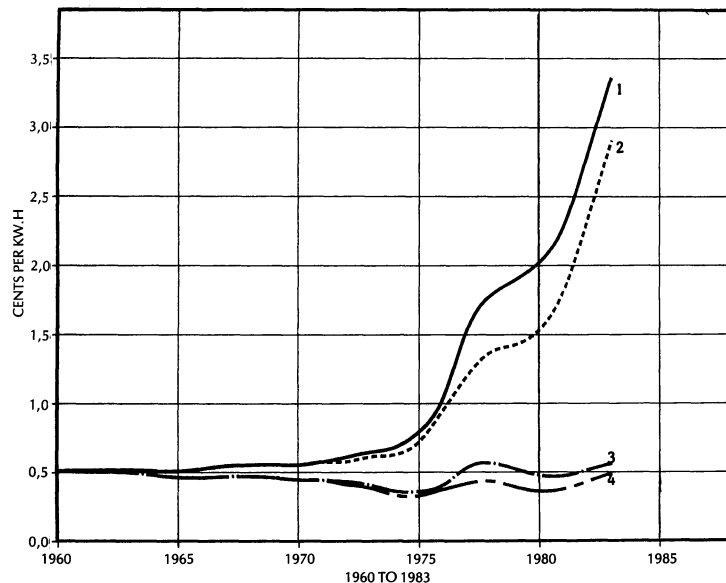
In South Africa the real price of electricity increased sharply since 1974 as can clearly be seen from the curves on Graph 20. The contributions to the Capital Development Fund, according to these curves, increased the average price of electricity by about 0,5 cent/kW.h.

The price per kW.h in real terms increased sharply between 1975 and 1978, but decreased later and has again increased since 1981.

During the period 1974–1982 the actual price increased by an average of 19,32 % per annum while the inflation rate averaged 14,4 % per annum.

GRAPH 20

AVERAGE SELLING PRICE OF
ESCOM ELECTRICITY FOR THE PERIOD 1960 TO 1983



LEGEND

- 1 ACTUAL SELLING PRICE
- - - 2 ACTUAL SELLING PRICE
NO CAP DEV FUND CONTRIBUTION
- . - 3 REAL SELLING PRICE
- - - 4 REAL SELLING PRICE
NO CAP DEV FUND CONTRIBUTION

While South Africa concentrated, in great measure, and in the late seventies at an ever-increasing rate, on the export of energy intensive raw materials, certain aspects of the real price of electricity must be faced:

- ☆ Firstly, a country's real price of electricity is calculated in terms of that country's inflation rate. When the inflation rate of a country is two or three times higher than that of its trading partners or competitors it is a poor consolation to the exporter that the real price of electricity has not increased excessively as he may lose his markets because of the actual price that determines his export price.
- ☆ Secondly, in connection with the export of energy intensive materials, it must be taken into consideration that manufacture has moved to countries with "cheap" electricity and that other countries can subsidise these exports indirectly.

After 1973 electricity changed almost immediately in most Western industrial countries from a *very cheap* to a *much more expensive* source of energy. In South Africa the price of electricity started increasing sharply only in 1976. The effect of the oil crisis on the selling price of electricity, and also to a great extent on the growth rate of the economy, as well as on the margin between the growth rate of electricity prices and that of the South African economy, was delayed.

Trends in the South African economy and their influence on electricity consumption

Long-term growth trends in the economy

The growth rate of the economy over the past decades is reflected in the following statistics:

Period	Annual average economic growth rate ⁽¹⁶⁾	
	EDP objective	Actually achieved
1964-1971.....	5,5%	5,6%
1968-1975.....	5,5%	4,3%
1972-1982.....	5,2%	3,3%

Since 1968 the growth rate objectives set by the EDP were not achieved. The dependence basically of the South African economy on the economic world environment has been demonstrated, especially during the post-war years.

It was mentioned previously that tremendous balance of payment and monetary problems arose in the Western industrial countries after the oil crisis, that the rate of world trade declined and that more and more countries started to apply protective measures.

The long-term impact of the oil crisis on these aspects of the world economy and their influence on the South African economy are best portrayed by the average annual growth rates, before and after the oil crisis, of a number of important parameters of the OECD countries and certain average growth trends in South Africa's imports and exports and gross domestic product. These are given below:

Description of Factor	Average annual growth rate in real terms ⁽¹⁷⁾⁽¹⁸⁾	
	Phase 1 Period 1946-1973	Phase 2 Period 1973-1982
	%	%
Economic growth of OECD countries	5,0	2,3
Industrial production of OECD countries	5,6	2,0
South African exports	5,6	1,9
South African imports	4,5	0,4
South African gross domestic product	5,0	3,2

These trends clearly indicate that the South African economic trends in the long term, when cyclical movements are eliminated, coincide with world trends:

The period 1946-1973 in the South African economy

High economic and industrial growth rates in the Western World created markets that were well exploited by South Africa to reach a high real average annual economic growth rate of 4,6 % during 1946-1960 and 5,6 % during 1960-1973.

The sixties were, as with the Western World, a boom period for the South African economy.

⁽¹⁶⁾ S.A. Reserve Bank.

⁽¹⁷⁾ Main Economic Indicators: OECD.

⁽¹⁸⁾ Quarterly Magazine of the South African Reserve Bank.

During this period gold production played an important role in exports and increased from 367,6 ton in 1952 to a peak of 1000,4 ton in 1970 and then started falling. Although the gold price remained almost constant during this period until 1970, the ever-growing production increased the value of South Africa's gold output from R304 million in 1952 to R837 million in 1970.

This increase in the value of gold production made a considerable contribution to the balance of payments.

The deficit on the current account of the balance of payments on average amounted to 3,24 % of the gross domestic product during the years 1946–1973. The deficit was supplemented by the influx of foreign capital, mainly as equity investment in the private sector.

The influx of foreign capital constituted more than 10 % of the total investment during this period and total investments formed 25 % of the gross domestic product for the period 1946–1973. The high economic growth rate period of the sixties was characterised by—

- ☆ strong growth in private consumer spending,
- ☆ the high growth rate of exports as indicated above,
- ☆ high imports, particularly during the period after 1963, which was also an indication of high investment, and
- ☆ investments in the public sector that still increased.

This period of high growth rate of the sixties coincided with the high growth phase in the world economy.

In the late sixties South Africa *had an advantageous competitive position in the mineral and metal markets of the world* because of its low mining costs per ton of ore mined, low electricity tariffs, relatively low transport costs, a low inflation rate and a low rate of increase in electricity tariffs.

During the late sixties and early seventies the South African ferro-alloy and smelting industry was expanded extensively and the Richards Bay and Saldanha Bay harbours for the mass export of coal and iron ore were built.

The period 1973–1982

Although the oil crisis in the third quarter of 1973 had created a totally new economic climate and the rate of world trade had slowed down—

- ☆ the increase in the price of gold, directly and through its secondary influence,
- ☆ the rising exports of materials with a high energy content like ferro-alloys, aluminium, steel and coal, and
- ☆ that there was no real growth in imports, the result of the import substitution policy and the growing influence of Sasol,

contributed in keeping the level of South Africa's average annual economic growth rate at 3,2 % in comparison with 2,3 % of the OECD countries.

During the period 1973–1982 the increases and fluctuations in the gold price in particular played an important role. While world trade slowed down, the gold price, that averaged \$58,14 per ounce in 1972, reached an average of \$612,94 per ounce in 1980. The higher price counteracted the fall in production from 1000,4 tons in 1970 to 664,2 tons in 1982 so that the Republic's income from gold increased from R1 770 million in 1973 to R10 141 million in 1980 and to R8 627 million in 1982 when it contributed 10,80 % to the gross domestic product and made a growing contribution to the balance of payments.

At the same time exports of goods, excluding gold, also rose during the period 1973–1982 from R2 517 million in 1973 to R9 766 million in 1980 and R10 142 million in 1982.

The period following 1973 was for a number of years characterised by high prices of certain other products, especially those with a high energy content like ferro-alloys and coal, and this improved South Africa's position relative to other countries. During these years South Africa's exports of platinum, iron, manganese, chrome, coal, ferro-alloys, steel and aluminium increased considerably while *agricultural exports* fell as a percentage of total exports.

If the result of gold price fluctuations is taken into consideration, total South African exports, as a percentage of the gross domestic product, fell from about 35 % in 1960 to $\pm$ 30 % in 1973 and to 25 % in 1982 while exports grew at an average of only 1,9 % annually during the period 1973–1982.

During the period 1973–1982 the average deficit on the current account of the balance of payments was only 1 % of the gross domestic product and that indicated less dependence on the influx of foreign capital. The smaller percentage deficit arose mainly from the higher gold price, and the greater value of metals, mineral and coal exports on the one hand, and import substitution on the other; but the deficit has been decreased especially since 1976, by foreign loans by the public sector.

During the period 1973–1982 South African—

- ☆ exports increased by an average of 1,9 % per annum as against 5,6 % per annum for 1946–1973, and
- ☆ imports rose at an annual average of 0,4 % compared with 4,5 % per annum for 1946–1973, mainly as a result of the import substitution policy which gave rise to Alusaf, arms manufacture, an expanded chemical industry, and Sasol 2 and 3.

The average economic growth rate of 3,2 % per annum for 1973–1982 resulted from—

- ☆ high consumer and State spending, because of inter alia easier bank credit and sharply rising black wages with the detrimental effect of
- ☆ a decrease in the net reserves, and
- ☆ a high inflation rate.

After the oil crisis the trends were as follows:

- ☆ The cost of maritime transport per ton increased considerably.
- ☆ Railway tariffs in the Republic increased from an index of 100 in 1963 to 109,3 in 1970, 160 in 1974 and 415 in 1983.

Electricity prices in the Republic—

- which had increased by 3,21 % per annum during the period 1967–1974
- increased by 19,32 % per annum for the period 1974–1982 so that the price rise exceeded the inflation rate during *this period* by almost 5 % per annum.

- ☆ Operating costs in the mining industry increased sharply during the period 1970–1980 because—

- the operating costs per ton of ore crushed in the South African gold mines *increased more than six times*, while the consumer price index increased *3,6 times*, and
- the average wages of Black workers in the gold mines among other things increased from R17,32 per month in 1970 to R247,99 per month in 1983, an increase of 1 330 %.

- ☆ The general rate of inflation was 3,57 % per annum during the sixties and 14,4 % per annum during the seventies.

These trends in inflation, electricity and railway tariffs and sharply rising mining costs per ton of ore changed South Africa's strong competitive position in the late sixties and early seventies to a *relatively weaker position* in the competitive world market.

Under inflationary pressure a balance of payments problem and the loss of reserves caused the recession of 1981 which was considerably aggravated by the drought, and at the same time the fluctuating gold price complicated matters further.

The sustained high inflation rate under present world conditions has now resulted in part of the country's exports being threatened. It is precisely those exports that contributed so much to limit the influence of the oil crisis on the South African economy.

The high inflation rate of 14,4 % per annum in South Africa after the oil crisis had a strong negative influence during the late seventies and early eighties. Having already emerged in the sixties, high inflation rates came to the fore strongly only during the seventies.

During the period 1970–1982 the retail price index increased from an index of 100 to 276,4 in South Africa, 231 in the USA and 403,9 in the United Kingdom.

Since 1981 a further trend in the inflation rate that has a profound influence on the South African economy became evident. While the Republic's inflation rate raced on at a level of over 14 % per annum for 1981, 1982 and the greater part of 1983, that of South Africa's trading partners fell to between half and a third of this figure.

The change in the rand exchange rate during the post-war years can briefly be summarised as follows:

- ☆ The traditional dollar/rand exchange rate of 1,40 before the oil crisis declined to 1,15 in the years after the oil crisis so that the rand lost ± 18 % of its value relative to the dollar.
- ☆ Since 1980 the exchange rate has declined sharply to 0,924 and even 0,80 dollar per rand which in terms of the position before the oil crisis means a decrease of between 34 % and 43 % in the value of the rand relative to the dollar.

The effect of the weakening competitive position and the fluctuating gold price was and is of the utmost importance to the South African economy.

A cardinal question, seen against the background of the inflation rate, exchange rate and balance of payments tendencies of the past decade, and the change in the influx of foreign capital, is whether South Africa's export of goods and gold income can fulfil the requirements of a relatively higher economic growth rate without an appreciable further devaluation of the rand.

Before this question can be investigated further, it is necessary firstly to analyse certain structural changes and restrictive factors in the economy.

Structural changes and restrictive factors in the South African economy

The most important structural changes in the South African economy during the past decades have been the following:

☆ *Concerning the mobilisation of capital—*

- total investments as a percentage of the gross domestic product since 1973 have amounted to more or less 29 % as against 25 % for the period 1946–1973;
- foreign capital influx changed from more than 10 % of the total investment during the period 1946–1976 to a net outflow after the Soweto riots;
- during the periods 1946–1960 and 1961–1972 the private sector drew 87,7 % and 61,9 % and the public sector 12,3 % and 38,1 % respectively of the total influx of foreign capital;
- these trends were radically changed during the period 1973–1976 when the private sector drew only 3,3 % and the public sector 96,7 % of the total influx of foreign capital;
- during the period 1977–1982 R2 897 million flowed out of the country. The outflow from the private sector was R5 178 million while the public sector experienced an influx of R2 281 million.

These trends also clearly indicate the structural change that has taken place in the South African economy. State corporations and public authorities and certain government departments can negotiate foreign loans with state guarantees while this type of guarantee does not apply to the private sector. Since the late sixties government bodies have consistently drawn more of the foreign capital that flowed into South Africa, and since 1973 almost all of it.

☆ *The nature of foreign capital* that flowed into South Africa has also changed in the process. In the fifties and sixties foreign capital in the form of *direct equity investments* came to South Africa chiefly to the private sector, while it flowed as *loan capital* into the public sector in the seventies.

☆ *Allocation of capital* to sectors has changed considerably since 1955 so that the *percentage* of the total fixed capital supply of the Republic invested in—

- the private sector declined from 57,7 % in 1955 to 41,6 % in 1982, while the share of
- public authorities and public corporations increased from 42,3 % in 1955 to 58,4 % in 1982, and that of
- the public corporations from 4,0 % in 1955 to 6,9 % in 1970 and 14,8 % in 1982.

☆ *Of the total net investment* made during the period 1971–1980—

- 67,2 % was invested in public authorities and public corporations, while
- 22,8 % was invested in public corporations only.

☆ *The efficient utilisation of capital* declined in the post-war period. Total efficiency in the utilisation of capital in the whole economy can be assessed by the capital/output ratio.

In the early years of a developing economy when a high capital cost infrastructure is created, the ratio of capital/gross domestic product (the capital/output ratio) is generally high, but with more efficient utilisation of capital it usually falls to under 2,3 to 1.

The efficient utilisation of capital in South Africa has declined since the second half of the sixties. The increase in the capital/output ratio of 2,28/1 for 1961–1965 to 3,11/1 in 1982 indicates that efficiency in the utilisation of capital in the total economy especially since the late sixties but particularly during the seventies has decreased by about 36,7 %.

- ☆ *The extent of this trend in additional fixed capital investment with regard to the total economy is indicated by the following:*

	Period	
	1946-1972	1973-1982
Marginal additional fixed capital	R44 300 million	R40 202 million
Marginal additional product	R17 146 million	R9 277 million
Marginal capital/output ratio	2,58/1	4,33/1

During the decade 1973-1982, the fixed capital supply increased (by R40 202 million) just less than that in the previous 27 years, 1946-1972, when it increased by R44 300 million, but in the period 1973-1982 the marginal additional product, at 1975 money values, increased by just more than half that of the previous 27 year period, R9 277 million against R17 147 million. A marginal capital/output ratio of 4,33/1 for the period 1973-1982 in comparison with 2,58/1 during the period 1946-1972 emphasises the inefficient utilisation of capital in this period. Although all capital investments, especially those made during the last few years, have not yet made their full contribution to the gross domestic product, a weakening of the capital/output ratio to this extent over so many years is of vital importance and emphasises one of the real economic problems of the Republic, namely that the additional capital utilised in the period 1973-1982 was 60 % less efficient than that invested in the previous twenty-seven years.

- ☆ It must be pointed out that it is difficult, and may take even years to change a misplaced or excessive capital investment into an investment with an adequate return and that it is sometimes impossible to do so. Although there are investments, some high, in the total economy like Sasol 2 and 3 that have not yet made a contribution to the gross domestic product in 1982, it will possibly take years to improve the present weak capital/output ratio.
- ☆ *The allocation during the years since 1946-1950 of an ever-growing percentage of the total additional net investment in the South African economy to service sectors and the low and declining efficiency in the application of capital as portrayed by their exceptionally high and still-increasing capital/output ratios, is one of the major reasons for the weakening efficiency in the application of capital in the economy during these years.*
- ☆ Between 1946-1950 and 1971-1980 the percentage of total investment in—
- community, social and personal services increased from 13,4 % to 28,1 %, in
 - transport, storage and communication from 13,4 % to 16,5 %, and in
 - electricity, gas and water from 6,6 % to 11,2 %.

Concerning the electricity sector, the net investment for the period 1977-1982 amounted in this sector to 18,8 % of the total investment in the total economy.

- ☆ Data about gross domestic savings for the period 1976-1983 and the source and application of the savings cause even more concern. The figures are given below:

GROSS DOMESTIC SAVINGS

Year	Total R million	Depreciation R million	Other savings R million	Escom's capital investment R million	Escom's capital investment as % of other savings
1976	7 504	4 236	3 268	642	19,7
1977	9 796	4 891	4 905	982	20,0
1978	11 575	5 692	5 683	1 218	21,4
1979	15 809	6 704	9 105	1 326	14,6
1980	22 047	7 927	14 120	1 412	10,0
1981	19 815	9 472	10 343	1 895	18,3
1982	18 363	11 633	6 730	2 662	41,8
1983	21 651	13 701	7 950	2 732	34,4

Source: Reserve Bank.

Although depreciation tripled during the period 1976-1983 from R4 236 million in 1976 to R13 701 million in 1983, "other savings" increased from R3 268 million in 1976 to R14 120 million in 1980 and declined sharply during the last three years. Meanwhile Escom's annual capital expenditure steadily increased fourfold from R642 million in 1976 to R2 732 million in 1983 and it is expected that this figure will increase further in the following years. Escom's capital investment as a percentage of other savings was nearly 20 % in 1976-1978, was lower in 1979 and 1980 because of the record levels of other savings, but reached 18,3 % in 1981, 41,8 % in 1982 and 34,4 % in 1983.

Because depreciation in essence makes provision for the replacement of existing assets, "other savings" indicate the availability of new capital resources. The high percentage of these resources which were used by Escom over the past years is informative.

- ☆ While the investment pattern clearly indicates the decreasing role of the private sector and the greater role of the public sector during the past three decades, state expenditure as a percentage of total domestic expenditure has also increased.
- ☆ The government's share of the total real gross domestic expenditure has increased as follows:

Period	Government's percentage share in total real gross domestic expenditure
	%
1949-1959.....	18,9
1959-1969.....	21,2
1969-1979.....	23,0
1979-1983.....	22,9

- ☆ During the period 1972-1980 the 300 million inhabitants of Thailand, Malaysia, Singapore, Indonesia, the Philippines, Taiwan, Hong Kong and South Korea achieved an annual average real economic growth rate of between 6 % and 11 %. One factor that stands out when the performance of these countries is compared particularly with that of the Western countries during this period, is that government expenditure in these countries amounted to only about 15 % of the gross domestic expenditure while in some Western countries it was almost double that percentage.
- ☆ Higher percentage expenditure, both current and capital, by the State, decreases the available sources for private investment and expenditure and progressively restrains the available growth and narrows the *basis* on which taxes can be levied.
- ☆ Rising tax and interest rates then remain the only means of financing the ever-growing state expenditure and requirements.
- ☆ A number of other factors contributed to the lower average growth rate of the South African economy in the late sixties, the seventies and the early eighties, namely—
 - the lack of an overall energy conservation policy,
 - inefficient utilisation of labour,
 - a sharp increase in capital investment per extra worker,
 - the skill shortage,
 - the capital investment problem, and
 - the distorted ratio between interest and inflation rates.
- ☆ The South African economy has been characterised over many years by a relatively low rate of labour productivity. Labour productivity measured in terms of the contribution to the real gross domestic product per economically active person in the economy rose by
 - 1,8 % per annum during the fifties and by
 - 2,0 % per annum during the sixties.

While labour productivity, measured in the same terms in Finland, West Germany, Greece, Italy, Japan, Norway, Spain and Turkey rose by an average of more than 2,5 % per annum during the period 1972-1980, the growth rate in labour productivity in the Republic of South Africa was only 0,07 % per annum.

This poor performance in productivity coincided with the sharp wage increases, particularly during the late seventies and early eighties when the gap between the wages of white and those of non-white workers was narrowed.

- ☆ The labour market in South Africa grows by about 300 000 new workers per annum who must be accommodated. In the past decade the required average investment per worker increased by more than 50 % and at present it amounts to more than R10 000 per worker.

Sharply increasing wages, particularly for unskilled labour over the past number of years, undeniably gave rise to mechanisation and capital intensive production methods as economic alternatives to labour intensive production.

- ☆ The high economic growth rate during 1973-1974 and also in 1979-1980, brought one of the major limiting factors in the South African economy, namely the shortage of skills, sharply to the fore. Although the shortage of artisans was particularly obvious, it became clear that a shortage of entrepreneurs, managers, professional people and skilled labour—the shortage of skills—limited the growth rate of the South African economy.

- ☆ The high inflation rate of the seventies is slowly but surely stifling the South African economy. A policy of domestic stimulation, with easy bank credit and the encouragement of consumer spending in a milieu of sharply-rising black wages without increased productivity so typical of the seventies, has possibly not
 - taken the realities of the post-1973 world conditions into consideration, and has
 - depended too much on increases in the gold price, and on
 - the growth of domestic buying power.

The problems with the management of domestic demand and inflation have come sharply to the fore during the seventies and early eighties.

- ☆ The paradoxical circumstances that in a country that has chronic shortages of investment capital in certain sectors (among others sectors that must create productive capacity and job opportunities) there is in existence at the same time a surplus of institutional funds (of which the major part is controlled by a limited number of big concerns and for which investment possibilities must be found), came strongly to the fore with the accompanying problems in recent years.
- ☆ During the greater part of the period 1973–1983 the ratio between interest rates and the production price index was distorted. The average interest rate on Escom loans was 11,01 % during this period while the inflation rate was 14,21 % in terms of the production price index. Under these circumstances investors lose at a rate of 3,20 % per annum. It was only after 1982 that these circumstances began to change. This factor naturally had an effect on the capital/output ratio too.
- ☆ The easily available bank credit that encouraged high demand despite the high prevailing interest rates since 1982 is an indication that the underlying cause of the imbalance in the economy have not yet been eliminated. Apparently credit instead of savings is applied to an increasing extent to finance consumption and investment. The relative importance that is attached to stock exchange equities originated in these circumstances and to a great extent facilitate the trend in the private sector for business expansion by take-overs on the stock exchange instead of by new ventures.
- ☆ It appears to the Commission that a reduction in the inflation rate and an accompanying restoration of a better balance in the financial sector, in the absence of a significant improvement in the trade balance, necessitate more satisfactory control over consumption and expenditure in the public and private sectors than was the case in the immediate past. *These factors, against the background of the structural changes and restrictive factors mentioned above, must necessarily be taken into consideration when reflecting on the future growth rate of the South African economy.*

The historical and future trend of the balance of payments

The future trends in exports will be determined by the gold price and the contribution of the mining, industrial and agricultural sectors. To estimate the future contribution more accurately, it is necessary firstly to analyse the contributions of these sectors to the South African economy in the post-war years.

The post-war expansion of the *mining industry* can be divided into the following main stages:

- ☆ The expansion of the gold mining industry in the Free State, the Western Transvaal and in the Far East Rand,
- ☆ the expansion within existing mining areas after 1974 as a result of the higher gold price,
- ☆ the expansion of base mineral and metal mines for exporting ore and alloys in the sixties, and early and middle seventies, and
- ☆ the expansion of the coal mining industry, especially in the late seventies, as a result of the demand for coal for export and the expansion of Escom.

This expansion not only had a direct effect on the gross domestic product and on exports, but also had significant secondary effects for example, on higher salaries and wages, profits, dividends, savings, a greater demand for capital goods and higher employment.

South Africa has substantial reserves of precious metals and precious stones particularly gold, the platinum group of metals and diamonds, and also of most of the base minerals and metals that are used in ferro-alloys in the steel industry. The Republic also has large reserves of power station coal, although the reserves of suitable coking coal are limited.

South African metal reserves, even of gold, are largely of a *low grade*; in other words they contain a *low mass* of metal or mineral per ton of ore mined.

This characteristic of most South African reserves necessitates a *greater tonnage* of ore being mined, transported and refined per final tonnage of metal or mineral than in other countries with higher grade ore reserves.

Considering that mining, transport and refining costs are dependent on the tonnage of ore and not on the tonnage or weight of metal or mineral in the ore, it is clear that—

- ☆ the Republic must endeavour the limit its mining costs per ton of ore to be and to remain competitive on the world market,
- ☆ refining must be done as close as possible to the source of the ore thus limiting the tonnage per unit of weight of metal or mineral to be transported to the markets,
- ☆ the transport cost per unit of weight must be limited, and also
- ☆ the cost of refining that to a great extent is closely related to the cost of electricity.

In the case of gold, platinum, diamonds and other gems with a very high value per unit of weight, transport costs after refining are not relevant.

Unfortunately however ore reserves of metals for ferro-alloys in the steel industry as well as coal reserves which are mined for export must be transported by rail over vast distances to harbours and then by sea to consumers.

In the late sixties South Africa occupied a *favourable competitive position in the mineral and metal markets of the world* because of its low mining costs per ton of ore mined; low electricity tariffs, relatively low transport costs, a low inflation rate and a low growth rate in electricity tariffs.

The nature and extent of the major strategically favourable circumstances for the ferro-alloys, steel and smelting industries in South Africa in the late sixties can be summarised as follows:

- ☆ **Firstly**, the unit price of electricity in the Republic during the sixties was particularly low and increased by only 0,88 % annually in this period that was characterised by a *high growth rate in the economies of the industrial countries*. World demand for metals and minerals and particularly ferro-alloys created particularly favourable export opportunities for South Africa during this period. During the period 1967–1974 the South African selling price of electricity increased by only 3,21 % annually.
- ☆ **Secondly**, the *index of railway tariffs* in the Republic was 100 in 1963 and it increased to only 109,3 in 1970 and 160 in 1974.
- ☆ **Thirdly**, the world demand for steel and consequently the market for South African ore and ferro-alloys were particularly attractive during the period of high economic growth in the industrial countries of the world, i.e. during the sixties and early seventies up to the oil crisis in 1973, *particularly because the South African mining costs per ton of ore were still very low*.

During the late sixties and early seventies the South African ferro-alloy and smelting industry was expanded extensively and the Richards Bay and Saldanha Bay harbours were built for the mass export of coal and iron ore. The extent of these steps are portrayed in Table 57 by the rise in the exports of metals and minerals during these years.

South Africa maintained this position in the early seventies, but only for the first years after the oil crisis. The price of electricity in particular increased but slightly in 1974 and 1975 and South Africa was in an exceptionally favourable position on the alloy markets and also for the export of coal. The oil crisis of course created a big new market for coal.

After the *oil crisis* and because of—

- ☆ *changing world conditions* as portrayed above, but also as a result of
- ☆ *domestic tendencies*, South Africa started losing its previously strong competitive position on foreign markets for mining products.

Concerning the changing world conditions with regard to steel, ferro-alloys and other products of the smelting industry, the following apply:

- ☆ Steel production in the Western World has declined considerably since the oil crisis, partly because of lower economic and industrial production growth rates, but also because of the emphasis on the conservation of energy, smaller motor cars, smaller houses, etc. and also as a result of the substitution of lighter plastic materials for steel.
- ☆ Not only does the steel industry of Western countries find itself in a weak competitive position, but Third World countries like Brazil, Mexico and South Korea have entered the shrinking market aggressively. Debt ridden Third World countries must simple export steel and steel related metals, almost at any price, to earn funds in an endeavour to reduce their loan obligations.

The smaller market, over-production and strong competition must be seen as permanent trends in the steel, ferro-alloy and ferro-ore industries.

- ☆ These problems of the Western industrial world also created problems for the so-called Third World. These countries must now also export raw materials at lower prices because of economic pressure.

TABLE 57

A NUMBER OF IMPORTANT PARAMETERS WITH REGARD TO EXPORTS FOR THE PERIOD 1952-1982⁽¹⁸⁾

Important Parameters	1952	1960	1967	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
A Gross Domestic Product at Factor Cost:																
A1 In R-millions		4 983	9 173	12 023	13 255	15 036	18 675	23 083	25 846	29 156	31 975	37 078	44 190	57 765	65 388	73 096
A2 In 1975 money values		12 210	1 822	21 203	22 340	22 340	23 618	25 222	25 846	26 309	26 330	27 067	28 116	31 079	31 644	31 265
B Gross Domestic Product at Market Prices:																
B1 In R-millions		5 304	9 715	12 908	14 245	16 104	19 918	24 472	27 454	31 050	34 338	39 917	47 656	61 834	70 360	79 735
B2 In 1975 money values		12 851	19 419	22 467	23 645	24 111	25 062	26 850	27 454	27 454	27 866	28 665	29 833	32 168	33 796	33 388
C Export of Gold, Goods and Non-factor Services:																
C1 At 1975 money values		4 528	6 583	7 098	7 329	7 964	7 658	7 358	7 388	7 759	8 404	8 785	8 986	8 905	8 388	8 378
C2 As % of Gross Domestic Product (B2)		35.2	33.9	31.6	31.0	33.0	30.6	27.4	26.9	27.9	30.7	30.7	30.1	27.7	24.8	25.1
D1 Gold Production in Tons	367.6	665.1	949.7	1 000.4	976.3	909.6	855.2	758.6	713.5	713.4	699.9	704.5	703.5	672.8	655.8	664.2
D2 Gold Prices in Dollars per Ounce	34.60	35.17	35.19	35.72	40.75	58.14	97.24	159.18	161.05	124.83	147.71	193.26	307.01	612.94	459.85	375.85
D3 Gold Income in R-millions	304	530	775	837	922	1 161	1 770	2 565	2 540	2 346	2 795	3 864	6 003	10 141	8 340	8 627
E Platinum Group Metals—Exports in R-millions	8.3	14.8	55.0	110.8	86.0	130.0	149.0	251.0	237.9	271.9	297.0	454.6	777.0	1 023.6	994.5	1 047.2
F Diamonds—Exports in R-millions	29.6	33.9	59.3	75.5	64.7	90.0	162.4	143.0	174.2	215.1	257.6	445.8	547.4	552.7	339.9	341.6
G Platinum Group Metals and Diamonds—Exports in R-millions	37.9	48.7	114.3	186.3	150.7	220.0	311.4	394.0	412.1	487.0	554.6	900.4	1 324.4	1 573.3	1 334.4	1 388.8
H Iron, Manganese and Chrome Ore—Exports in millions		12.2	40.5	57.9	62.0	57.4	81.1	101.6	137.0	194.9	329.2	312.8	402.2	438.8	386.4	415.6
I Coal—Exports in R-millions	3.5	4.5	5.9	10.3	9.8	8.9	13.9	21.6	37.4	103.4	248.5	324.9	509.1	688.1	977.0	1 177.7
J Sub-total: Gold, Platinum, Diamonds, Iron, Manganese and Chrome Ore and Coal—Exports in R-millions		595.4	935.7	1 091.5	1 144.5	1 446.4	2 176.4	3 082.2	3 126.5	3 131.3	3 927.3	5 402.1	8 238.7	12 751.2	11 037.8	11 609.1
K Ferro-alloys—Exports in R-millions								105.0	161.0	243.1	251.0	205.6	493.4	446.8	487.5	462.1
L Steel—Exports in R-millions				44.1	32.6	55.4	77.0	96.6	67.5	198.6	361.1	429.9	582.6	513.5	450.5	594.0
M Aluminium (Net)										27.5	32.3	43.4	57.7	80.3	75.5	86.4
N Total: Exports of Gold, Platinum, Diamonds, Iron, Manganese and Chrome Ore, Ferro-alloys, Steel and Aluminium—in R-millions				1 135.6	1 177.1	1 501.8	2 253.4	3 283.8	3 355.0	3 600.5	4 571.7	6 181.0	9 372.4	13 851.8	13 051.4	12 751.6
O Agriculture—Exports in R-millions	272	344	508	492	523	813	858	1 047	1 232	1 319	1 430	1 466	1 642	2 107	2 241	2 331
P Total Goods—Exports in R-millions	575	881	1 323	1 453	1 551	2 213	2 517	3 164	3 653	4 899	6 293	7 449	8 813	9 766	9 579	10 142
Q Total Export of Goods plus gold—in R-millions	879	1 411	2 098	2 290	2 473	3 377	4 287	5 329	6 193	7 235	9 088	11 313	14 816	19 907	17 919	18 769
R Percentage Contribution to total export of goods excluding gold and factor services																
R1 Platinum Group Metals		1.67	4.15	7.63	5.54	5.87	5.92	7.93	6.51	5.56	4.72	6.10	8.82	10.48	10.38	10.34
R2 Diamonds		3.85	4.48	5.20	4.17	4.07	6.45	4.52	4.77	4.40	4.09	5.98	6.21	5.66	5.55	5.37
R3 Iron, manganese and Chrome ore		1.38	3.06	3.98	3.99	2.59	3.22	3.21	3.75	4.19	4.56	5.19	4.56	3.57	4.03	4.09
R4 Coal		0.51	0.45	0.71	0.63	0.36	0.55	0.68	1.02	2.11	3.95	4.36	5.78	7.05	10.20	11.61
R5 Ferro-alloys								3.32	4.41	4.97	3.99	4.10	5.60	4.58	5.08	4.56
R6 Steel				3.04	2.10	2.50	3.06	3.05	1.85	5.74	5.77	5.61	5.26	4.70	5.86	5.86
R7 Aluminium (Net)									0.56	0.51	0.58	0.65	0.82	0.79	0.85	0.85
R8 Total in R1 to R7		7.41	12.14	20.56	16.43	15.39	19.2	22.71	22.31	25.63	28.20	31.08	37.23	37.42	38.73	40.68
R9 Agriculture		39.00	38.40	33.90	33.70	36.70	34.10	33.09	33.72	26.97	22.72	19.68	18.63	21.57	23.39	22.98
R10 Sub-total R1 to R7 plus Agriculture		46.41	50.54	54.46	50.13	52.09	53.3	55.8	56.03	52.60	50.92	50.76	56.86	58.99	62.12	63.66
R11 Other goods (excluding gold)		53.59	49.46	45.54	49.07	47.91	46.7	44.2	43.97	47.40	49.08	49.24	43.14	41.01	37.88	36.34
R12 Total		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
S Exchange Rate—Dollars/Rand		1.40	1.40	1.392	1.403	1.290	1.445	1.470	1.365	1.150	1.150	1.150	1.189	1.286	1.149	0.924

⁽¹⁸⁾ Quarterly Magazine of the South African Reserve Bank.

The favourable position of South Africa on the mineral and metal markets during the late sixties and seventies gave rise to high growth rates in—

- ☆ the ferro-alloy smelting industry,
- ☆ the steel industry, and
- ☆ the establishment and expansion of the aluminium smelting industry in South Africa.

After the oil crisis it was also decided to build Sasol 2 and 3 and the establishment of these industries during the late seventies led to considerable industrial growth.

The *industrial sector* not only made a great contribution to South Africa's gross domestic product, but also contributed considerably by South African exports. In even this sector however, and particularly in the ferro-alloy smelting industry, the steel industry and the aluminium smelting industry this contribution is threatened (as is the case in the mining industry) by inflation, electricity and railway tariffs and the sharply competitive world market.

In the past the *agricultural sector* made a very important contribution to the Republic's exports, but the percentage contribution by this sector to the South African economy over the recent three decades has declined considerably.

The competitive position of agricultural products has changed considerably, particularly because of the growing cost of inputs as a result of inflation, the system of price fixing and subsidies, climatic conditions and drought. The fact remains that in 1983 several South African agricultural products were no longer competitive on world markets.

The course of the above-mentioned trends in a number of parameters for the period 1952–1982 are reflected in Table 57.

These parameters are in reality some of the factors that influence exports, the balance of payments and the growth rate of the economy.

The figures in Table 57 show, as mentioned before, that if the effect of the gold price fluctuations were considered, South African exports as a percentage of gross domestic product declined from about 35 % in 1960 to 30 % in 1973 and further to 25 % in 1982.

The gold price and gold income increased respectively from \$97,24 per ounce and R1 770 million in 1973 to \$612,94 per ounce and an income of R10 141 million in 1980, but dropped back to an average of \$375,85 per ounce and an income of R8 627 million in 1982.

Total exports of goods excluding gold increased from R2 517 million in 1973 to R9 766 million in 1980 and to R10 142 million in 1982.

The export of goods (excluding gold) constituted 58,7 % in 1973 and 49,1 % in 1980 of the total export of *goods plus gold*, but it increased again to 54 % of the total in 1982.

It is clear that the export of goods other than gold played a significant role in the years from 1973 to 1982. There exists a tendency, particularly in the mineral industry, to underrate this contribution during that period.

Unfortunately, statistics of the percentage contribution to export of goods by the ferro-alloy industry in 1973 are not available, but if 2 % is accepted as a reasonable figure, the following statements can be made:

- ☆ **Firstly**, the increased volume of exports and high prices under exceptional circumstances increased the contribution of the platinum group of minerals, diamonds, iron, manganese and chrome ore, coal, ferro-alloys, steel and aluminium as a percentage of the export of goods from 21,2 % (19,2 + 2) in 1973 to 40,68 % in 1982.
- ☆ **Secondly**, agricultural exports as a percentage of the export of goods, excluding gold, fell from 34,10 % in 1973 to 18,63 % in 1979 and 22,98 % in 1982.
- ☆ **Thirdly**, the contribution particularly of the coal industry, which increased exports from R13,9 million in 1973 to R1 177,7 million in 1982, must be highlighted because it helped considerably by almost *doubling* the percentage contribution of the above-mentioned group of metals and minerals to the export of goods, excluding gold, during this period.

The export of high energy-intensive products was of advantage to South Africa immediately before and during the period after the oil crisis.

When the sharp increase in the gold price after 1973 is added to this it is understandable why the Republic maintained an average growth rate during the period 1973–1982 that was 1 % higher than that of the OECD countries.

However, certain of the trends that were highlighted in the previous analyses, particularly the high inflation rate itself and those in other countries, levelled off the growth rate of the South African economy during recent years. In the process South Africa started losing its exceptionally favourable position with regard to the export of minerals and metals, coal and ferro-alloys.

To what extent these circumstances surrounding the balance of payments will determine the future growth rate remains an open question.

In the second half of the seventies, when the influx of equity investment capital from abroad dropped sharply, South Africa started borrowing more and more from abroad.

There are, of course, limits to the amount that can be borrowed from abroad and also when and in what amounts loans are available for specific times. Higher loans also require higher interest payments and make the Republic more dependent on world interest rate fluctuations and exchange rates.

Only exports protect South Africa against these circumstances and dangers. Concerning the future extent of exports, the Republic is particularly dependent on the gold price, the growth of foreign markets and the competitive ability of the country's agricultural, mining and industrial sectors.

Clearly the future course of the *current account* of the balance of payments is of cardinal importance for the future economic growth rate of the Republic.

The future growth rate of the South African economy

Graph 21 reflects the growth pattern of the gross domestic product in real terms at factor cost in 1975 rand, and Graph 22 a regression fitting of five years' sliding averages of the gross domestic product for the years since 1960.

Real gross domestic product at factor cost that measures the value of production is used in these cases.

The growth pattern curve on Graph 21 and 22 indicates—

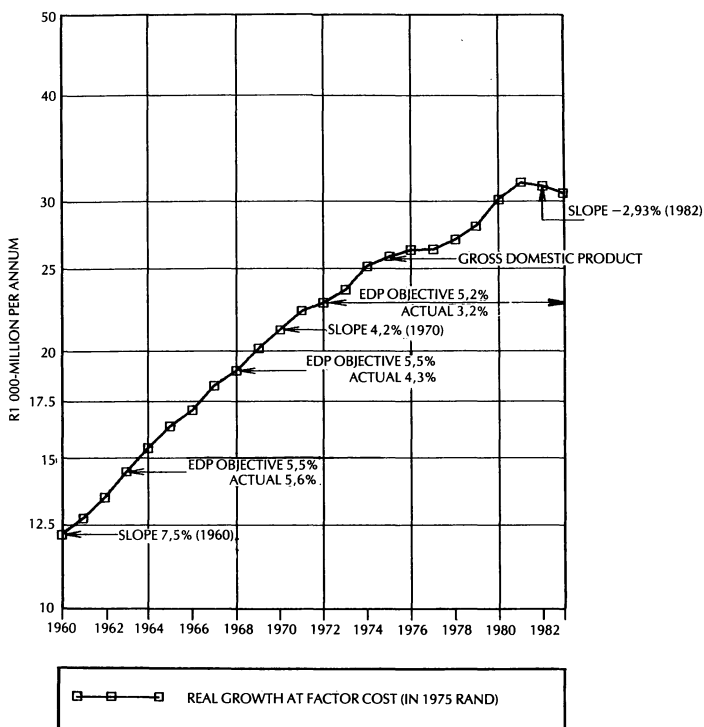
- ☆ a slope of 7,5 % in 1960, that decreases
- ☆ to 4,29 % for 1970,
- ☆ to -2,93 % in 1982, and also that
- ☆ the annual growth rates since 1973 show considerable deviation from previous tendencies.

The regression fittings of the five year sliding averages of the percentage growth of the gross domestic product since 1960, as indicated on Graph 22, show—

- ☆ a clear downward trend between 1962 and 1982, that had an even
- ☆ sharper downward trend between 1972 and 1977, but
- ☆ brought the higher growth rate figures for 1978, 1979, 1980 and 1981 back to a more gradually decreasing trend.

The regression fitting indicates an average growth rate of around 2,7 % per annum for the Republic.

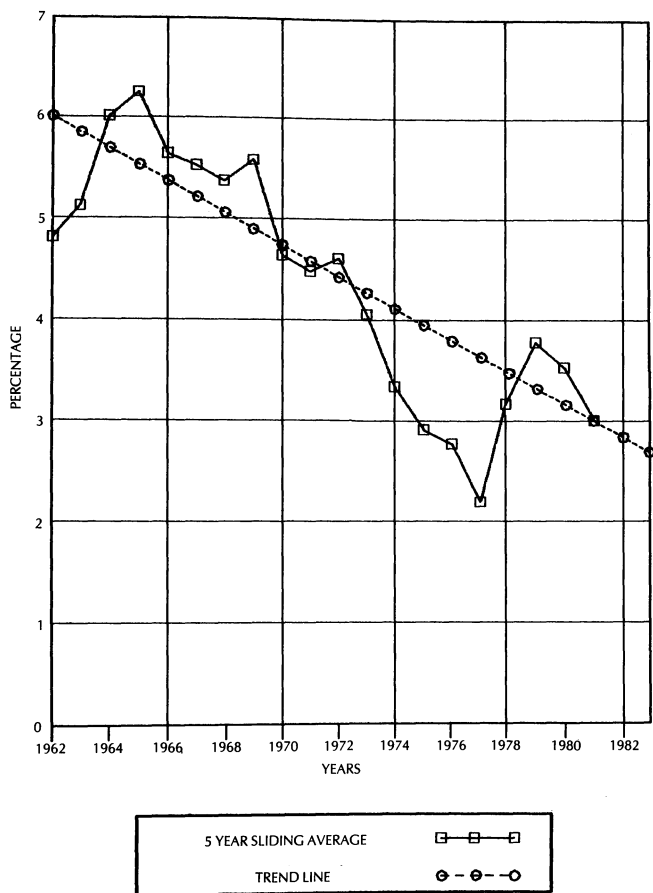
GRAPH 21
GROWTH PATTERN OF GROSS DOMESTIC PRODUCT
 INFORMATION AS IN 1983



GRAPH 22

GROSS DOMESTIC PRODUCT—REGRESSION FITTINGS

INFORMATION AS IN 1981



When all the circumstances in the South African economy, the investment patterns, the inefficient utilisation of capital and labour and the total change that was brought about in the world economy by the energy crisis, are taken into consideration, the key question is whether the South African economy too has not reached the post-oil crisis long-term growth phase with a low economic growth rate of between 2,5 % and 3 % per annum when cyclical fluctuations are eliminated.

This is a difficult question to answer as a revised EDP target is not available. The trends already pointed out themselves too impede a determination of the target and may be one of the reasons for the 1,9 % negative deviation between the EDP target and actual economic growth rates for 1972-1982.

At the same time the Commission is thoroughly aware of the measures adopted by the Government, particularly in improved labour utilisation and organisation, to make the economy in general more market-orientated and increasingly adaptable and competitive.

The political initiatives to stabilise Southern Africa as a whole can also instil greater confidence for investment and create possibilities of higher growth in contrast with the sombre picture of the world economy in the long term. Although a steep increase in the dollar price of gold can result in higher growth rates, it is doubtful whether future planning can rest on the *premise* of a considerably higher gold price which in turn can result in higher economic growth rates.

If the dollar price of gold increases even substantially, it must be taken into consideration that—

- ☆ despite the more adaptable monetary and fiscal policy and measures that are already being applied,
- ☆ the present exceptionally difficult circumstances in the world economy,
- ☆ the problems since 1981 to curtail domestic spending and inflation, and
- ☆ the adaptation of the industrial structure to the new realities of competition on the world market,

created difficult problems that will take a long time to solve.

These facts emphasise the impression that the average annual growth rate of the economy during the period 1973-1982 was higher than could be afforded by the country, particularly when the declared policy of not depending too much on foreign loans is accepted. Events since 1982, although strongly influenced by the decline in the gold price and the drought, have deepened this impression.

Against this background it appears to the Commission that an average annual economic growth rate of 2,5 % to 3,5 % is all that can be predicted for the realistically foreseeable future. The Commission of Inquiry is thoroughly aware of the implications of this average annual growth rate in the South African economy, and its bearing particularly on the creation of job opportunities and higher living standards as well as the accompanying implications of unemployment and possible unrest. Although the Commission would prefer a much higher economic growth rate, it is essential to face present circumstances realistically and then against this background to plan the best possible improvement. If factors change radically in the medium term, there will be enough time to evaluate the potential improvement that could be brought about.

When the effect of the economic growth rate on the growth rate of electricity sales is determined, the *margin* between these two growth rates becomes relevant.

As already shown, considerable success has been achieved in other countries in the conservation of energy, particularly electricity.

The success or failure of these conservation measures has a marked effect on the margin mentioned above.

Possible future conservation of electricity consumption

If all the circumstances of the South African economy are taken into consideration, the following is clear:

- ☆ There is such a shortage of capital that strict economic priorities must be observed, while
- ☆ intensive utilisation of capital, particularly existing capital, is imperative,
- ☆ productivity must be increased, and
- ☆ inflation must be lowered.

An energy conservation campaign is a vital part of such a programme.

In South Africa the emphasis after the oil crisis and the oil boycott did not fall on the conservation of energy but rather on the conservation of oil. Sasol 2 and 3 were built, speed limits were introduced, the power station in the Cape Town harbour was decommissioned, smaller municipalities changed over from diesel generation to Escom power and farmers lowered their diesel consumption by using electricity for irrigation.

The issue however is that this campaign concentrated chiefly on the conservation of fuel—petrol, diesel and heavy oils—and *not* on energy consumption and therefore not on electricity consumption. In fact, in the first few years after the energy crisis, the South African electricity price was low and there was a tendency to replace oil with electricity. It was only in 1976 that the very low price of South African electricity started increasing very sharply.

In the light of the foregoing certain facts must be faced:

- ☆ **Firstly** the electricity tariff increases since 1976 should encourage the more efficient use of electricity.
- ☆ **Secondly** it is imperative, in the light of South Africa's economic realities, that an intensive energy and electricity conservation campaign be launched with all the necessary support.

It was previously pointed out that total energy consumption per unit of real gross domestic product in the OECD countries decreased by 16 % between 1973 and 1982 and in America by nearly 23 % between 1972 and 1982. Conservation of energy and structural changes have lowered energy consumption per unit of industrial turnover in the OECD countries by 26 % between 1973 and 1982, while substantial savings were made in the domestic/commercial and transport sectors.

A good yardstick for measuring the electricity consumption already conserved in other countries, South Africa's relative position is the difference between the average annual growth rate of electricity consumption and that of the gross domestic product.

In Table 58 these figures for various countries over a number of periods are compared with the South African figures.

If France, Canada, Australia and South Africa are ignored, it appears that the effect of sharply-rising electricity prices and conservation campaigns after 1973 have reduced the difference between growth rates of electricity consumption and the economy in some of the other countries by between 1 % and 2 % and almost eliminated it in some countries.

As indicated in Table 58 the difference between the annual growth rates of electricity consumption and the economy of the Republic of South Africa during the period 1964–1971 was only 2,53 % per annum which, by the way, compares favourably with that of other countries, for example with + 2,68 % of West Germany for the same period.

In West Germany this difference narrowed to an average of 0,6 % per annum for the period 1974–1981 while in South Africa it broadened to an average of 3,44 % per annum for the period 1974–1982.

In South Africa the long-term growth rate in electricity consumption depends on—

TABLE 58
GROWTH IN ELECTRICITY CONSUMPTION MINUS GROWTH IN ECONOMY OF VARIOUS COUNTRIES FOR DIFFERENT PERIODS

Period	Countries concerned	Difference in growth rates
1960–1970.....	West Germany	2,68 % per annum.
1964–1971.....	South Africa	2,53 % per annum.
1962–1973.....	Japan	1,7 % per annum.
1962–1973.....	Canada	1,5 % per annum.
1962–1973.....	France	1,6 % per annum.
1962–1973.....	United States of America	2,7 % per annum.
1962–1973.....	United Kingdom	2,1 % per annum.
1960–1969.....	Australia	2,6 % per annum.
1970–1973.....	Australia	1,6 % per annum.
1974–1981.....	Australia	2,2 % per annum.
1974–1982.....	South Africa	3,44 % per annum.
1974–1981.....	Japan	-1,1 % per annum.
1974–1981.....	West Germany	0,6 % per annum.
1974–1981.....	Canada	1,2 % per annum.
1974–1981.....	France	2,9 % per annum.
1974–1981.....	United States of America	0,2 % per annum.
1974–1981.....	United Kingdom	0,2 % per annum.

- ☆ the average growth rate of the gross domestic product, and
- ☆ the effect of conservation measures that
- ☆ will determine the difference between the growth rate in electricity consumption and the gross domestic product.

Graph 23 reflects five year sliding averages for the gross domestic product of South Africa and for the total electricity consumption.

The growth pattern for the periods 1960–1982 and 1952–1982 for the gross domestic product and electricity consumption respectively both indicate downward trends and in 1982

- ★ the gross domestic product reached a regression value of 3 % and
- ★ electricity consumption a regression value of 7 %.

The 1972–1982 electricity consumption trend line which, against the background of the effect of the energy crisis, is of course the most important, indicates a regression value of 5,7 % in 1982.

The graph also shows that the difference between the growth rate of electricity consumption and the economic growth rate increased from around 2,5 % in the late sixties to even 4 % in 1972, but narrowed to 2,7 % in 1981–1982. The trend lines indicate a further narrowing of this margin in the future. The reason for the increase in this margin in *the early seventies*, namely the sharp increase in electricity consumption by high energy-intensive industries and this single exceptionally high increase in electricity consumption, has already been pointed out in the previous analysis.

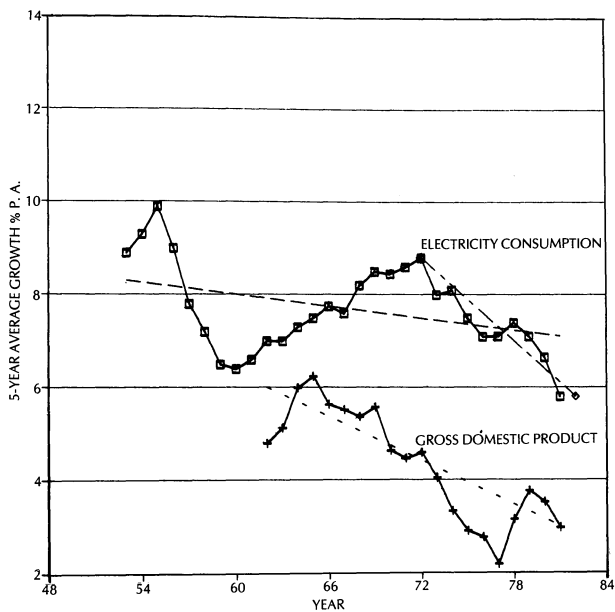
Since the margin in the early eighties tended to return to the 1964–1971 averages, and other countries through conservation moved from the $\pm 2,5$ % margin in the early seventies to a $\pm 0,5$ % margin, it appears that South Africa should be able to narrow this margin considerably by means of an intensive electricity conservation campaign.

With even a reasonable measure of success in comparison with that of other countries, South Africa should be able to narrow the margin to 1,5 %. If this can be achieved, it appears that the average annual growth rate of electricity consumption can be fixed at between 4,0 % and 5,0 % per annum in comparison with an economic growth rate of between 2,5 % and 3,5 % per annum.

With the unreliability of the econometric method of forecasting electricity consumption after the oil crisis, an analysis of and estimates based on the growth rates in electricity sales in the past are important.

GRAPH 23

TRENDS WITH REGARD TO ELECTRICITY CONSUMPTION AND GROSS DOMESTIC PRODUCT



Trends in the growth rate of electricity sales in South Africa since the sixties and the impact of the energy crisis.

During the period—

- ☆ 1950–1970 the average annual growth rate of electricity sent out in South Africa was 7,8 %, while it was
- ☆ 8,54 % for 1967–1974, and
- ☆ 6,64 % for 1974–1982.

In Table 59 certain trends in the average annual growth rate of electricity sent out by Escom for the periods 1967–1974 and 1974–1982 are depicted. During both periods the growth rates of Escom sales were higher than those of the total South African sales as is clear from the last two lines of Table 59 which indicates a rise in Escom's market share.

The Escom market share of national sales increased from 71,1 % in 1967 to 85,9 % in 1974, chiefly because of the higher average annual growth rate of 14,6 % in bulk sales as a result of the following municipalities becoming more dependent on Escom or being connected to the Escom system during this period:

Johannesburg, Pretoria, Bloemfontein, Cape Town, Durban, Port Elizabeth, Sutherland, Vredendal, Oudtshoorn, Mossel Bay, George, Knysna, Plettenberg Bay, Albertinia, Riversdale, Still Bay, Heidelberg (Cape), Upington, Rouxville, Smithfield, Zastron, Aliwal North and East London.

Some of these municipalities operate their own power stations and buy only part of their requirements from Escom. Because Escom must supply the requirements that are added annually to the existing demand, the growth in this type of sale, especially at the initial stage, is exceptionally high.

During the period 1974–1982 Escom's market share increased to 93,6 %, chiefly as a result of the high average annual growth rate of 9,61 % in bulk sales.

In the period 1974–1982 the following municipalities became more dependent on Escom or were connected to the Escom system:

Cape Town, which had to curtail power generation during 1973/74 at its Table Bay power station because it was using crude oil at that time, Queenstown, Umtata, Hankey, Pantensie, Kareedouw, Springbok and Oranjemund.

It is clear that almost all South African towns and cities are now supplied by Escom and that the annual growth of bulk sales will essentially represent only the *normal growth* of sales in these areas. In other words, Escom is now near the end of its period of rapid market share growth.

TABLE 59

TRENDS IN ELECTRICITY SALES BY ESCOM TO SECTORS OF THE SOUTH AFRICAN ECONOMY DURING THE PERIOD 1967–1982

Sector	Year					
	1967		1974		1982	
	Thousand Millions kW.h	Percentage of Total	Thousand Millions kW.h	Percentage of Total	Thousand Millions kW.h	Percentage of total
Mining.....	11,45	42,9%	16,96	32,2%	27,44	28,5%
Growth rate	← Average 5,77% p.a. →		← Average 6,22% p.a. →		← Average 30,93 →	
Industrial....	6,73	25,2%	16,11	30,6%	30,93	32,2%
Growth rate	← Average 13,27% p.a. →		← Average 8,5% p.a. →		← Average 32,35 →	
Bulk Supplies	5,96	22,4%	15,52	29,5%	32,35	33,6%
Growth rate	← Average 14,64% p.a. →		← Average 9,61% p.a. →		← Average 4,44 →	
Traction.....	1,96	7,6%	3,11	5,9%	4,44	4,6%
Growth rate	← Average 6,8% p.a. →		← Average 4,6% p.a. →		← Average 0,98 →	
Escom Domestic	0,56	2,1%	0,91	1,7%	0,98	1,01%
Grand Total	26,66		52,61		96,14	
Growth rates of Escom sales	← Average 10,19% p.a. →		← Average 9,0% p.a. →		← Average 6,64% p.a. →	
Growth rate of South African sales	← Average 8,54% p.a. →					

Bulk sales by Escom to municipalities can be expected to increase in the future in accordance with the growth rate of electricity sales to the municipalities of Johannesburg, Cape Town and Port Elizabeth in recent years. During the period 1970–1981 electricity sales to these three municipalities

increased jointly by 5,6 % per annum. Therefore, the average future annual growth rate of bulk sales will apparently be about 6 % after allowing for a relatively limited annual increase in the market share. This growth rate is nearer to the growth rate that the municipalities obtain independently. To this a further factor must be added.

In the past urbanisation was encouraged by—

- ☆ pressure of population,
- ☆ availability of central energy systems,
- ☆ railway system with tariffs based on "what the traffic can bear", transporting raw materials cheaply to central points and processed goods at high tariffs to decentralised areas, and—
— dominating production technology in industry that requires big central factories.

The future could however be completely different:

- ☆ Large-scale manufacturing becomes uneconomic because of restraints and environmental factors,
- ☆ manufacturing technology changes to smaller-scale production units,
- ☆ electric power distribution systems make energy available on a decentralised basis, and
- ☆ land and housing are cheaper on a decentralised rather than on a centralised basis.

Then there is also the cardinal question whether the State can continue, under the changed economic circumstances, to subsidise commercial and industrial concerns in urbanised areas by the paternalistic policy of subsidising housing, transport, hospital services, etc. for non-whites while the cost should be debited to the users of those commodities. A successful regional development policy based on labour-intensive employment can limit the growth rate of electricity consumption in urban areas.

In the industrial sector the low electricity prices of the late sixties and early seventies and attractive foreign markets gave rise to rapid expansion of the ferro-alloy and aluminium smelting industries. The period 1967–1982 was characterised by the establishment of high energy-intensive primary industries.

During the period 1967–1974—

- ☆ Metalloys installed new furnaces at Meyerton,
- ☆ Iscor at Vanderbijlpark and AE & CI expanded their plants considerably,
- ☆ Alusaf commissioned its factory at Richards Bay,
- ☆ Iscor started its activities at Newcastle,
- ☆ Ferralloys, Holland Electro and Ferrometals increased their consumption considerably,

and the annual growth rate in electricity sales to the industrial sector grew by 13,27 %.

This trend was continued in the period 1974–1982 when the other large electricity consumers were connected:

- ☆ Sasol,
- ☆ Richards Bay Iron and Titanium Plant,
- ☆ Tubatsi Ferrochrome and Consolidated Metallurgical Industries,
- ☆ Transalloys and Ferrometals, and
- ☆ Highveld Steel and Vanadium grew considerably, and

the annual growth rate of electricity sales to the industrial sector increased by 9,37 %.

The *energy-intensive primary industries* experienced an absolute boom period from 1967 to 1982. A similar boom period for these industries is not foreseen for many years in the Republic.

The ratio of the economic growth rate of the industrial sector to the growth rate of electricity consumption in this sector for a definite period indicates the nature of the industries that started and grew during this time.

This ratio was 1,13/1 for the period 1960–1967, 1,19/1 for 1967–1973 and 1,93/1 for 1973–1982. The increase in this ratio since 1967 indicates the growth in electricity consumption, the expansion of high energy-intensive primary industries, and to what extent this type of industry originated and grew after 1967.

The economic growth rate of the industrial sector of the South African economy averaged—

☆ 7,28 % annually for the period 1960–1973, and

☆ 4,80 % annually for the period 1973–1982.

When the future economic growth rate of South African industries and the growth rate of the industrial sector's electricity consumption are reflected on, the following must be taken into consideration:

- ☆ The low growth rates of the industrial sector and the economy of the OECD countries since 1973 and their expected future growth rates. These countries are the major markets for the Republic's high energy-intensive primary products.
- ☆ Rationalisation of "smoke-stack industries" in the seven biggest OECD countries, and the competition for markets in the Third World countries will limit the growth rate of the Republic's exports of high energy-content primary products.
- ☆ Access to the foreign markets for these high energy-content primary products will be difficult for the next decade because of lower consumption and higher production capacity of these products in other developed countries.
- ☆ An analysis of the economic growth pattern of South Africa indicates that in order to comply with the requirements of employment, lower capital/output ratio, lower investment per job opportunity and high investment in the industrial sectors, and higher labour productivity, the emphasis must be on labour-intensive secondary industrial growth in the following decades. In this type of industry the ratio of growth in electricity consumption to economic industrial growth is low; this was also true of the fifties and sixties.
- ☆ During the period 1973–1980 energy consumption *per unit of industrial output* dropped by 26 % ^(a) in the seven biggest OECD countries.
- ☆ At present as much as 70 % of the electricity supplied to the *industrial sector* in South Africa is to *energy-intensive primary* industries.

If future industrial growth in only—

- ☆ 50 % in high energy-intensive primary industries, and
- ☆ 50 % in low energy-intensive, labour-intensive industries, and
- ☆ the economic growth rate of the industrial sector for the following decades is the same as for the period 1973–1982, i.e. an average of 4,8 % per annum, then the average growth rate of electricity consumption in the industrial sector could be an average of 7,2 % per annum for the next period. This estimate does not take conservation of energy consumption per unit of industrial output, as has been accomplished in the OECD countries, into consideration.

The average annual growth rate of electricity sales of 5,76 % during the period 1967–1974 in the mining sector was lower than the growth rate of 6,55 % for the period 1974–1982.

In the seventies the rate of exploration in South Africa by domestic and foreign companies increased considerably. Against the background of the intensity of the exploration and its success, it seems doubtful whether further large new mineralised areas will be discovered in South Africa.

In 1982 and 1983 the gold mining industry was responsible for ± 74 % of all the electricity sales to the mining sector while the platinum, coal and copper mines together took 16 % of the total electricity sales in this sector.

The growth rate of electricity consumption by the gold and uranium mines during the period 1978–1983 averaged 5 % per annum. During this period a number of new gold mines and plants like Beatrix, Deelkraal, Unisel, Beisa and Ergo started production. Although increasing depth leads to higher electricity consumption in the gold mining industry for the hoisting of materials, the pumping of water and for cooling, the production rate over the next decade will probably decrease because of mines becoming worked out. Against this background a growth rate of electricity consumption of 3,3 % for 1982/83 by the gold mines is not surprising.

During the period 1978–1983 the coal industry, which consumed 6,2 % of all electricity consumption in the mining sector in 1982, grew by an average of 9,4 % per annum. During this period coal exports rose tremendously and more coal had to be supplied to Escom from electricity-intensive open-cast mines. It is doubtful, however, whether the Republic will again experience such a boom period for coal. In the year 1982/83 there was no growth in electricity consumption in the coal mining sector.

^(a) World Energy Outlook, International Energy Agency OECD, Paris 1982.

Present and future conditions on world markets and also on the South African market do not indicate a rapid increase in the demand for base metals and minerals. If even a marked improvement should take place, it must be remembered that electricity consumption in the mining sector is dominated, to the extent of 74 % of the total, by the gold mining sector, with an expected low growth rate.

When prospects in the mining sector are taken into consideration, it appears that growth rates of electricity consumption in this sector will increase by an average of 5 % per annum during the first five years and later by only 3,6 % per annum.

Traction sales which in 1982 constituted only 4,6 % of Escom's total sales, increased during the period 1967-1974 by an average of 7,62 % per annum and during 1972-1982, when the major railway lines had already been electrified, by 4,54 % per annum. An even lower growth rate can be expected in this sector in the future. The growth rate of electricity sales in this sector will probably be close to the economic growth rate.

Domestic sales, which constituted only 1,02 % of Escom's total sales in 1982, increased by an average of 7,62 % per annum during the period 1967-1974 and by 4,54 % per annum for the period 1974-1982.

Against this background, *the approach* to future electricity sales can be summarised as follows:

ESTIMATES OF GROWTH IN ELECTRICITY SALES

Sector	Year					
	1982		1987		1995	
	Million MW.h	Percentage of Total	Million MW.h	Percentage of Total	Million MW.h	Percentage of Total
Mining	27,44	28,50 %	35,00	27,3 %	46,57	23,3 %
	Average 5 % p.a.			Average 3,6 % p.a.		
Industries	30,39	32,2 %	43,03	33,6 %	75,00	37,6 %
	Average 7,2 % p.a.			Average 7,2 % p.a.		
Bulk	32,35	33,6 %	43,30	33,8 %	69,00	34,5 %
	Average 6,0 % p.a.			Average 6,0 % p.a.		
Traction	4,44	4,6 %	5,28	4,1 %	6,92	3,5 %
	Average 3,43 % p.a.			Average 3,5 % p.a.		
Escom Domestic	0,98	1,01 %	1,48	1,2 %	2,09	1,1 %
	Average 4,4 % p.a.			Average 4,5 % p.a.		
Grand Total	95,4		128,09		199,58	
	Average 5,9 % p.a.			Average 5,7 % p.a.		

This approach indicates a growth rate of less than 6 % per annum in electricity sales for the rest of the century with a possible downward trend as a sectoral estimate of the future demand.

This estimate of the future electricity demand in the different sectors of the South African economy disregards the effect of conservation. If a saving of 1 % were considered, the estimated growth rate would fall to 5 % per annum.

This growth rate of electricity consumption differs substantially from the Escom forecast.

The Escom long-term forecast

For many years Escom had obtained its long-term estimates for required generating capacity by the extrapolation of short-term forecasts based on consumer surveys. In course of time, with the use of bigger sets and longer lead times, it was found that this method had become inadequate because the forecast of load 10 years into the future changed considerably as the cycle fluctuated between high and low points. For example, it was forecast towards the end of 1975 that the 1984 maximum load would be 20 800 MW, while the forecast in 1977 was 16 400 MW. Escom⁽²⁰⁾ states that an analysis of historical data indicates a typical pattern in electricity consumption growth that shows relatively small oscillations in a long-term trend and also that ratios among gross domestic products and net energy and electric energy consumption are relatively stable.

⁽²⁰⁾ Information supplied by Escom in June 1984.

As already indicated in this report, this pattern and the ratios also applied in various countries before 1973. Escom's econometric method of determining long-term trends based on historical data was developed and refined in the late seventies.

The Escom procedure starts by analysing the historical data and then finding ratios between parameters by regression-analysis.

Escom makes 21 forecasts by using historical data for the last 10 years, the last 11 years and so on until the last 30 years. The final forecast for each of the future years is determined by taking the average figure of the 21 forecasts for the year. This method of long-term forecasts is heavily loaded with trends for the past 10 years because the data for the last 10 years occurs in each of the 21 forecasts while those for longer periods occur progressively less in the forecast.

To take short-term trends further into consideration, the short-term or sectoral estimates for the first two future years are accepted as historical data and included in the 21 forecasts, which then give a new long-term forecast.

Two sets of Escom forecasts—

- ★ the forecasts of *maximum system demand* that were accepted by the Electricity Supply Commission on 5 October 1983, and

- ★ a re-estimate that the Commission of Inquiry received in June 1984,

are based on the above approach and are summarised below.

In Escom's approximations of future electricity demand the following parameters are accepted:

	October 1983 forecast	May-June 1984 forecast
Percentage growth of gross domestic product	3,49 % in 1983 3,56 % in 2005	3,37 % in 1984 3,45 % in 2004
Net energy consumption growth rate	3,8 % per annum	3,9 % per annum
Growth rate of electricity demand	7,48 % in 1983 6,41 % in 2005	7 % in 1984 6 % in 2004
Difference in the annual growth rates of electricity demand and the economy	3,99 % in 1983 2,95 % in 2005	3,63 % in 1984 2,55 % in 2004

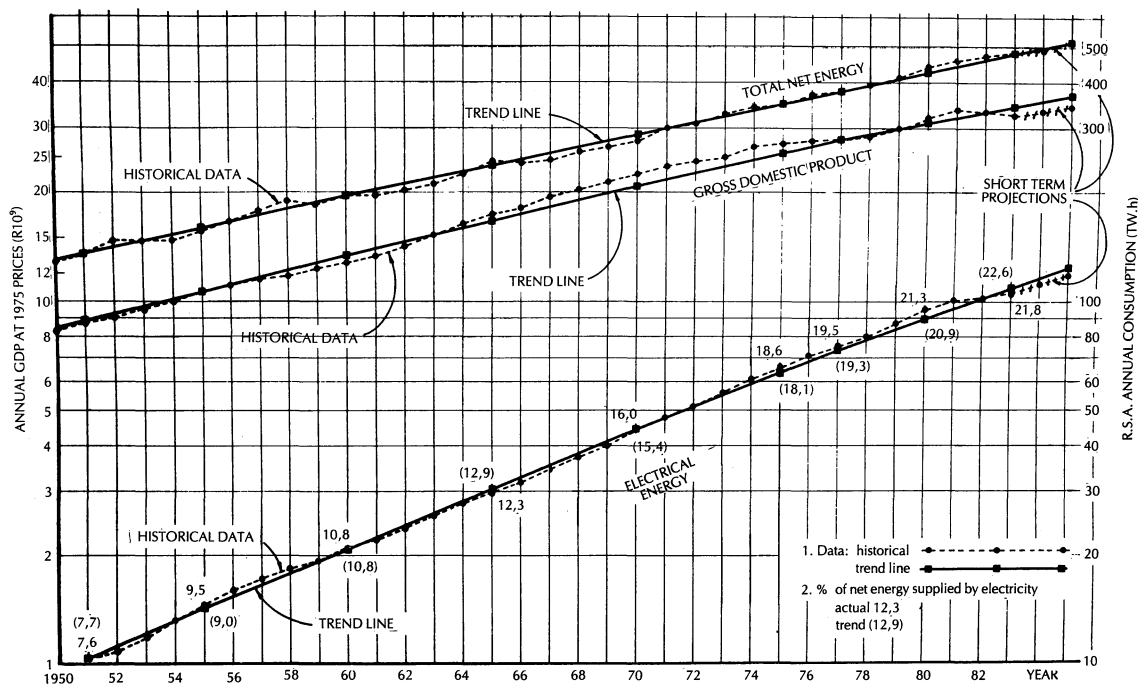
The most critical parameters in this method of estimating is most probably, according to Escom, the gross domestic product, the ratio between these factors and net energy consumption and whether the historical ratio between the two factors will still apply in the future.

Graphs 24 and 25 reflect the figures on which the May-June 1984 forecasts are based.

When a closer look is taken at the graphs and trends in Graph 24, the following is clear:

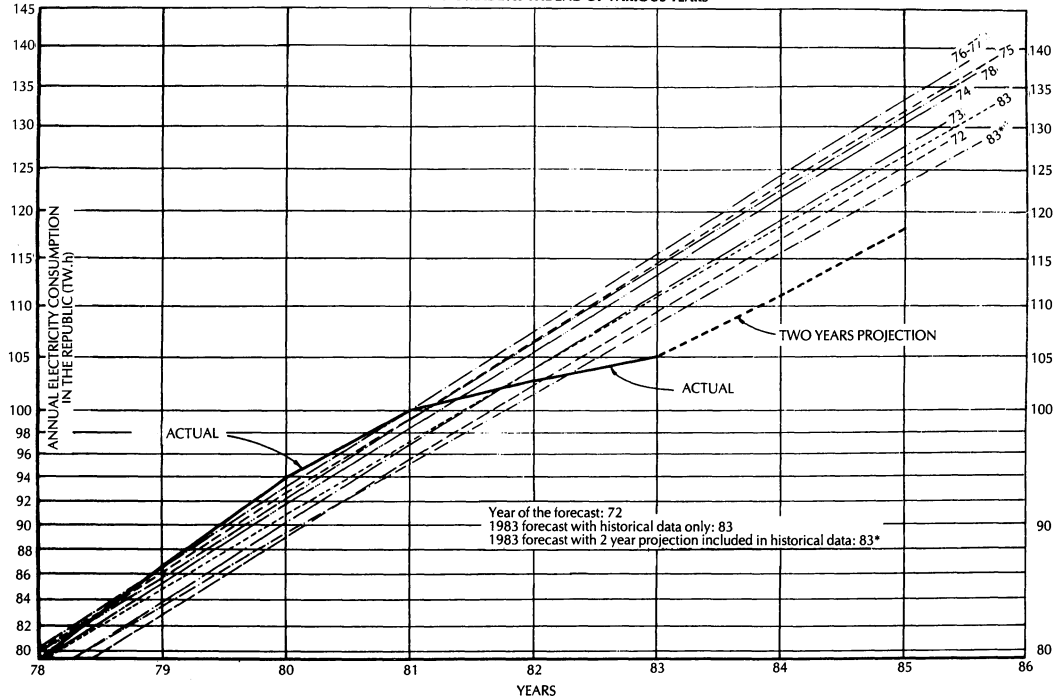
- ★ the trend line and the historical data for *gross domestic product* show the following important deviations:
 - In the sixties and early seventies the historical data line falls above the trend line. In reality it indicates the high economic growth rate of the sixties. During the period 1946–1973 the growth rate of the South African economy averaged 5 % per annum.
 - During the periods 1973–1982 and 1981–1985 (projected) there were also marked deviations between the historical data line and the trend line. During the period 1973–1982 the average economic growth rate was only 3,2 % per annum and for the period 1981–1985 a still lower growth rate is predicted.
- ★ The trend line and the historical data for the *total net energy consumption* also show significant deviations:
 - The growth rate of net energy consumption for the period 1967–1981 was clearly substantially higher than that indicated by the trend line.

GRAPH 24
REAL GDP, TOTAL NET ENERGY AND ELECTRIC ENERGY CONSUMPTION IN R.S.A. SINCE 1950



GRAPH 25

COMPARISON OF ACTUAL VERSUS FORECASTED
ELECTRICITY CONSUMPTION IN R.S.A. WITH
FORECASTS MADE AT THE END OF VARIOUS YEARS



- On the other hand the growth rate of net energy consumption for the period 1981–1985 (projected) indicates a lower growth rate than that indicated by the trend line.
- These deviations in total net energy are also shown in broad terms by the growth rate trends for the same period of electricity consumption.

To test the sensitivity of its econometric method, Escom⁽²⁰⁾ indicated on Graph 25 data for the 30 years to 1972, 1973 and for the years following.

These graphs clearly reflect how the forecasts of electricity consumption which were made in the years

- ☆ 1972, 1973, 1974, 1975, 1976 and 1977 still increased, but that those made for
- ☆ 1978 and 1983 decreased, while
- ☆ the actual consumption in 1982 and 1983 reflects much lower growth rates.

When Escom's econometric forecasts as in the foregoing table and in Graphs 24 and 25 are evaluated, the circumstances in South Africa, that have changed rather radically since 1973, as indicated, must be taken into consideration.

Major factors in this regard are, inter alia, the following:

- ☆ The economic growth rates of the OECD countries declined to less than *half* in comparison with the *post-war period before 1973*, while their industrial growth rate after 1973 declined to about 36 % of the post-war growth rate until 1973.
- ☆ The growth rate of South Africa's exports like the industrial growth rate of the OECD countries, dropped to 36 % of the pre-1973 value, while the Republic's economic growth rate that averaged 5,0 % per annum for the period 1946–1973 decreased to 3,2 % for the period 1973–1982.
- ☆ The increased exports and high prices of the platinum group of minerals, diamonds, and iron, manganese and chrome ores, coal, ferro-alloys, steel and aluminium raised their percentage of goods exported from ± 20 % in 1973 to ± 40 % in 1982.
- ☆ The export of high energy-intensive products stood the Republic in good stead immediately before and after the oil crisis. The energy-intensive primary industries experienced a boom between 1967 and 1982.
- ☆ It cannot however be foreseen that the Republic will experience a similar boom in its energy-intensive primary industries. In fact, the electricity and rail tariff increases, wage increases and structural changes in the South African economy as well as the high inflation rate during the past several years make such a boom in this sector almost impossible. In recent years the inflation rate was *two to three times* higher than that of the Republic's trading partners.
- ☆ Despite the substantial contribution by the energy-intensive primary industries and by gold production, exports as a percentage of the gross domestic product have decreased from about 35 % in 1960 to 30 % in 1973 and 25 % in 1982.
- ☆ The Republic enjoyed a favourable competitive position on the metal and mineral markets of the world in the late sixties and early seventies because of its low mining costs per ton of ore mined, low electricity tariffs, relatively low transport costs and low inflation rate, but these cost factors increased sharply in the late seventies and early eighties, while the markets will grow at a lower rate due to the low industrial growth rate of the OECD countries and strong additional production that competes on the world markets.
- ☆ Since the beginning of the eighties the Republic's competition in the export markets has weakened.
- ☆ Unless the inflation rate is reduced considerably or the price of gold is increased substantially the Rand will most probably weaken against other monetary units and the South African economy will experience a low growth rate.

This analysis explains the deviation of the trend lines from the historical data lines on the Escom graphs. The fundamental reasons for these deviations and their implications, particularly the vitally important influence of the oil crisis that changed previous trends radically, make a forecasting method

⁽²⁰⁾ Information supplied by Escom in June 1984.

based on statistics of the past thirty years controversial. It is for this reason that the Commission of Inquiry requested Escom to calculate forecasts based on information for the 10 years from 1973 to 1983 with forecasts for 1984 and 1985, according to Escom's models. This information is indicated below.

The data used and the key results are the following:

Forecast	Table 1	Table 2	Table 3
Historical data	1974-1983	1974-1983	1976-1983
Estimated data	—	1984-1985	1984-1985
Period in years	10	12	10
Growth rates % per annum:			
GDP	2,75	2,44	2,50
Net energy	3,72	3,55	3,35
RSA electric energy	6,03-5,53	5,74-5,30	5,32-4,96
Escom maximum demand	6,42-5,66	6,13-5,42	5,71-5,14

For the sake of comparison the data for 1984 and 1985 in Tables 2 and 3 are the same as those used in Escom's load forecast previously referred to.

The following figures, derived from this table, are particularly informative:

- ★ The figures tabulated above indicate that a one percent rise in the average annual economic growth rate coincides with the following growth rates in energy consumption: 1,35 % according to Table 1, 1,45 % according to Table 2 and 1,34 % according to Table 3. These figures compare with the historical values of—

- 0,79 % for the period 1964-1971,
- 1,10 % for 1967-1974, and of
- 1,25 % for 1974-1982.

- ★ The periods 1967-1974 and 1974-1982 were the era of high growth rates for the energy-intensive industries.

- ★ The figures also indicate the following differences between the growth rates of electricity consumption and those of the economy:

	Table 1	Table 2	Table 3
Difference in growth rate of electricity consumption and that of the economy as % per annum	3,28-2,78	3,30-2,86	2,82-2,46

The previous analysis of the Commission of Inquiry indicates that the margin had increased historically from about 2,5 % in the late sixties to as much as 4,3 % in 1972, but again narrowed after that to 2,7 % in 1981-1982, and that if a conservation campaign is only reasonably successful in comparison with that in other countries, the South African margin should narrow to 1,5 %.

Should a conservation campaign narrow the margin to this degree, it ought to reduce the growth rate of electrical energy, as indicated in Tables 1, 2 and 3 above as follows:

Growth rates % per annum RSA electrical energy	Table 1	Table 2	Table 3
As per Escom estimate	6,03-5,53	5,74-5,30	5,32-4,96
With margin narrowed to 1,5 % by conservation	4,25-3,25	3,94-4,00	4,00-4,40

These figures indicate the following:

- ★ If it is accepted that the energy crisis of 1973 caused a discontinuity in the world economy, but particularly in industrial growth patterns, and if the trends since 1973 in particular are taken into consideration, Escom's econometric method indicates growth rates of between 5 % and 6 % per annum in electric energy consumption.
- ★ With reasonable conservation of energy consumption these growth rates could fall to 4 % or 4,5 % per annum.

The Commission of Inquiry strongly doubts, as a result of the above figures, whether the econometric methods of forecasting applied by Escom since 1979 are suitable.

More emphasis on end consumption would be a more direct approach. A forecast of end consumption concentrated specifically on the requirements and behaviour of consumers has the advantage that it can be more accurate and that the consumer and supplier can co-operate to determine the consumer's requirements.

At the same time there could be co-operation to limit peak demand while endeavouring to increase the load factor. An additional factor of extreme importance that flows from a close relationship between supplier and consumer is that the consumer can decide on alternative sources of energy, his capital investments, and their time scheduling on the basis of knowledge of future trends obtained from the supplier.

It was previously pointed out that conservation measures can result in a reduction of $\pm 1\%$ per annum in electricity consumption for a number of years.

If this can be achieved, the "adjusted" econometric approach as well as the sectoral approach that emphasises the requirements of end consumers indicate a growth rate of $\pm 5\%$ per annum in electricity consumption for the period 1982-1992. When such low growth rates in electricity sales for the future are compared with those of the past, the following factors in particular must be taken into consideration:

- ☆ The expected low economic growth rate that will force South Africa, in the light of its problem with job creation, to
- ☆ encourage less energy-intensive and less capital-intensive industries in the future,
- ☆ an expected lower growth rate in electricity consumption in the mining sector,
- ☆ the necessity for conservation of electricity so as to be competitive on the world market, and
- ☆ Escom's market share of over 93 % established during the high growth years.

The implications of electricity growth rates used for planning

Escom⁽²⁰⁾ states this case as follows:

"It must be borne in mind when considering what future electricity requirements to plan for, that it is preferable from two points of view to plan the addition of new power stations on a realistically high forecast.

First, Escom contracts for power station plant fixes the commercial operation dates for sets comprising the first half of a new station but reserves the option to defer the dates for the remaining sets or to cancel them completely with a notice period of about five years. Since a commitment to construct a new power station has to be made about eight years before the expected commercial operation date of the first set it is easier to reduce generation in future years than to increase it. Reduction in power generation can be achieved by giving five years' notice of deferment or cancellation of sets at stations under construction but new stations can be added only after eight years.

"Secondly, if we plan for a growth rate of 7 % but get 5 % we incur capital expenditure unnecessarily early, but the economic implications are not great if as has happened in recent years escalation and interest rates are comparable. On the other hand, if we plan for a growth rate of 5 % and get 7 % we will not be able to supply all the electricity required. If this unsupplied electricity is evaluated at the 1984 figure of 75 c/kW.h, which is considered conservative for South Africa on the basis of the value to consumers as established by overseas surveys, it can be calculated that the cumulative cost to the country will be equal to the cumulative reduction in capital expenditure in about eight years and many times this value for any longer period."

It is clearly necessary to determine the long-term growth rate on a realistic basis and to *reconsider it regularly each year*.

The difference between Escom's estimate of future electricity consumption and that of this Commission has clearly profound implications.

AN EVALUATION OF THE EFFICIENCY OF ESCOM'S EXPANSION PROGRAMME WITH REGARD TO GENERATING CAPACITY AND THE APPLICATION OF TECHNOLOGY AND CAPITAL COSTS

Against the background of the country's electricity needs and thus the required additional power generating capacity, the following must be evaluated:

- ☆ Present power station capacity and also planned capacity in operation in 1989.
- ☆ The trend of the historical capital cost per MW.
- ☆ The reasons for the increases.
- ☆ The efficiency of the application of capital and technology.

Present power station capacity, and power stations in operation and capacity planned for 1989

Table 19 reflects Escom's operating statistics and shows that its capacity was 20 523 MW in 1982. Table 60 reflects Escom planning until 1989 and also the cumulative capacity that should be installed and in operation annually.

⁽²⁰⁾ Information supplied by Escom in June 1984.

According to this plan Escom's installed capacity of 20 523 MW in 1982 will increase to 34 953 MW in 1989 after—

- ☆ planned new power stations with a combined sent-out capacity of 15 985 MW have been commissioned, and
- ☆ power stations with a combined sent-out capacity of 1 555 MW have been decommissioned during this period.

In the light of the preceding analyses the question arises whether it is planned to commission excessive sent-out capacity too soon.

Apart from the estimated growth rate of demand, two cardinal questions arise—

- ☆ what the ratio of assigned sent-out capacity/Escom system peak demand, and
- ☆ what the availability of Escom power stations should be.

When peak demand is considered, it must be remembered that Escom has sets with considerable generating rating that are sometimes not in operation because of unavailability.

Table 61 reflects Escom's total assigned power station sent-out capacity in MW, the assigned sent-out rating divided by the Escom system peak demand, the availability of Escom power stations, the number of large sets in operation, the heat value of coal burnt and the average power station load factor on the basis of sent-out rating for the period 1960–1982 with estimates of peak demand and the required assigned power station sent-out rating for different growth rates of peak demand on the Escom system.

The figures in Table 61 indicate the following:

- ☆ During the period 1960–1966 the average ratio assigned sent-out rating/Escom system peak demand was 115,4 % while it was 112,1 % in 1966.

TABLE 60

ESCOM PLANNING OF PRESENT POWER STATION CAPACITY AND POWER STATIONS THAT MUST BE COMMISSIONED BEFORE 1990 AND POWER STATIONS DECOMMISSIONED BEFORE 1990

Year	Power stations and number of sets	Assigned sent-out capacity of sets MW	Power Station decommissioned Name and MW	Capacity in MW	
				Assigned year	Sent-out capacity cumulatively
1982.....	Present capacity.....				20 523
1983.....	Matla 1, Duvha 1.....	$1 \times 575 + 1 \times 575$		+ 1 150	21 673
1984.....	Koeberg 1, Duvha 1.....	$1 \times 920 + 1 \times 575$		+ 1 495	23 168
1985.....	Tutuka 1, Lethabo 1, + Koeberg 2.....	$1 \times 582 + 1 \times 593 + 1 \times 920$		+ 2 095	25 263
1986.....	Tutuka 2, Lethabo 1, Matimba 1.....	$2 \times 582 + 1 \times 593 + 1 \times 615$		+ 2 372-395 = 1977	27 240
1987.....	Tutuka 1, Lethabo 1, Matimba 1, Kendal 1, Palmiet 1	$1 \times 582 + 1 \times 593 + 1 \times 615 + 1 \times 630 + 1 \times$ 200	Klip and Colenso 325 + 70 = 395 Vaal—270	+ 2 620-270 = 2 350	29 590
1988.....	Tutuka 2, Lethabo 2, Matimba 1, Kendal 1, Palmiet 1	$2 \times 582 + 2 \times 593 + 1 \times 615 + 1 \times 630 + 1 \times$ 200	Hex River and Vierfontein 111 + 336	+ 3 795-447 = 3 348	32 938
1989.....	Lethabo 1, Matimba 1, Kendal 1, Majuba 1.....	$1 \times 593 + 1 \times 615 + 1 \times 630 + 1 \times 630$	Umgenti and Wilge 222 + 221	+ 2 468-443	34 953

TABLE 61

TOTAL POWER STATION CAPACITY: ESTIMATED PEAK DEMAND AND CALCULATED EXCESSIVE CAPACITY

TOTAL POWER STATION CAPACITY: ESTIMATED PEAK DEMAND AND CALCULATED EXCESSIVE CAPACITY																								
Calendar Year	Total power station rating Assigned sent-out capacity in MW	Peak demand on Escom's system in MW	Assigned sent-out rating + Escom system peak demand as %	Percent-age avail-ability of Escom's power stations		Percent-age load factor of all Escom power stations	Number of 500 and 600 MW sets	Heat value of coal MJ/kg	Estimated peak demand		Required Power Station Capacity						Assigned sent-out capacity							
				All power stations	Coal-fired power stations				Escom estimated electricity sales growth rate basis	Growth rate estimated at 5% electricity sales	Escom-estimated sales growth rate with availability of			Electricity sales estimated at 5% growth with availability of			Excess capacity with availability of							
											70%77%80%			70%77%80%			77%				80%			
																	Without Cahora Bassa		With Cahora Bassa		Without Cahora Bassa		With Cahora Bassa	
																	Escom	5%	Escom	5%	Escom	5%	Escom	5%
1960.....	3 091	2 605	110,7			65,2																		
1961.....	3 226	2 733	118,0			66,2																		
1962.....	3 406	2 925	116,4			65,8																		
1963.....	3 788	3 183	119,0			65,7																		
1964.....	4 077	3 460	117,8			65,2																		
1965.....	4 181	3 669	113,9			67,4																		
1966.....	4 377	3 906	112,1			67,1																		
1967.....	5 328	4 227	126,0			66,8																		
1968.....	5 800	4 658	124,5			62,9																		
1969.....	6 441	5 055	127,4			62,1																		
1970.....	7 060	5 622	125,6			62,9																		
1971.....	8 373	6 115	136,9			61,3																		
1972.....	9 849	6 630	148,6			59,6																		
1973.....	9 482	7 350	129,0	82,5	82,3	62,5		22,47																
1974.....	10 002	8 552	117,0	83,7	83,6	66,3		22,42																
1975.....	10 552	9 185	114,9	85,0	84,9	68,6		22,21																
1976.....	11 688	10 085	115,9	82,3	82,1	66,8	1	21,87																
1977.....	12 756	10 735	118,8	75,5	77,5	61,9	2	21,78																
1978.....	13 595	11 490	118,3	77,4	76,6	60,7	4	21,61																
1979.....	15 056	12 855	117,1	78,8	77,7	60,9	7	21,22																
1980.....	17 339	13 668	126,9	74,7	73,6	57,8	11	21,34																
1981.....	18 989	14 744	131,2	74,2	73,3	62,2	13	21,25																
1982.....	20 523	15 523	132,1	74,3	73,1	59,3	15	21,39																
1983.....	21 673	15 639	138,1	71,9	69,9	55,6	17	21,11	16 250	15 639	22 360	20 118	19 321	21 520	19 361	18 595	1 555	2 312	2 928	3 685	2 352	3 078	3 125	4 451
1984.....	23 168								17 396	16 420	23 937	21 536	20 684	22 594	20 328	19 523	2 552	3 760	3 925	5 133	3 446	4 565	4 777	5 938
1985.....	25 263								18 614	17 241	25 613	23 044	22 132	23 724	21 344	20 500	2 219	3 919	3 592	5 292	3 131	4 763	4 504	6 138
1986.....	27 240								19 906	18 104	27 391	24 644	23 668	24 911	22 413	21 526	2 596	4 827	3 969	6 200	3 592	5 714	6 945	7 087
1987.....	29 560								21 277	19 009	29 277	26 340	25 298	26 156	23 533	22 602	3 250	6 057	4 623	7 430	3 292	6 988	5 665	8 361
1988.....	32 938								22 731	19 959	31 278	28 140	27 027	27 463	24 709	23 731	4 798	8 229	6 171	9 602	5 911	9 207	7 284	10 580
1989.....	34 953								24 273	20 957	33 400	30 045	28 861	28 837	25 945	24 918	4 908	8 908	6 281	10 381	6 092	10 035	7 465	11 408

Graph 2 reflects the following connection between the percentage annual average availability and the gross capacity factor:

70% availability—capacity factor 37,6%

77% availability—capacity factor 23,8%

80% availability—capacity factor 18,9%

☆ During the period 1967–1973 the following sent-out capacity was commissioned:

- 1967—1 040 MW,
- 1968—500 MW,
- 1969—920 MW,
- 1970—600 MW,
- 1971—1 300 MW,
- 1972—550 MW and
- 1973—750 MW,

a total of 5 660 MW.

The assigned sent-out rating consequently exceeded the Escom system demand in each of these years by a substantial margin. The average assigned sent-out rating/Escom system peak demand ratio was an average 131,1 % for the period and reached 129,0 % in 1973.

The percentage availability of all Escom's power stations and of coal-fired power stations for the years after 1973 are also given in Table 61. The following figures are instructive:

Year	Assigned sent-out rating/ Escom system peak demand	Percentage availability of Escom power stations	
		All power stations	Coal-fired power stations
	%	%	%
1973.....	129,0	82,5	82,3
1974.....	117,0	83,7	83,6
1975.....	114,9	85,0	84,9

Although the assigned sent-out rating/Escom system peak demand ratio declined from 129,0 % in 1973 to 114,9 % in 1975, the percentage availability of—

- all power stations increased from 82,7 % to 85,0 % and that of
- coal-fired power stations from 82,3 % to 84,9 %.

When assigned sent-out rating is appreciably higher than the possible Escom system peak demand, there is less incentive to attain high availability.

According to the figures in Table 35 the arithmetic average percentage availability of the seventeen power stations with 350 MW and smaller sets, that were in operation for the full ten years from 1973–1982, was—

- 84,4 % for the period 1974–1979 when the average assigned sent-out rating/Escom peak demand ratio was 117,0 %, and
- 79,5 % for the period 1980–1982 when the average assigned sent-out rating/Escom system peak demand ratio was 130,1 %.

☆ In 1975 the availability of Escom's coal-fired power stations was 84,9 % but fell sharply to 77,7 % in 1979 although the assigned sent-out rating/Escom system peak demand ratio was 114,9 % in 1975 and 117,1 % in 1979.

☆ The assigned sent-out rating/Escom system peak demand ratio rose sharply and the percentage availability of power stations since 1980 has been the following:

Year	Assigned sent-out rating/ Escom system peak demand	Percentage availability of Escom power stations	
		All power stations	Coal-fired power stations
	%	%	%
1980.....	126,9	74,7	73,6
1981.....	131,2	74,2	73,3
1982.....	132,1	74,3	73,1
1983.....	138,1	71,9	69,9

Although the assigned sent-out rating/Escom system peak demand ratio was exceptionally high in the period 1980–1983, it does not explain the low availability particularly of the coal-fired power stations.

According to Escom⁽²⁰⁾ this reduction in availability was due to several related factors during the late seventies. They were—

☆ the exceptionally high growth of the load. The amount of electricity sent out by Escom increased annually by an average of—

- 10,19 % during 1967–1974, and
- 7,81 % during 1974–1982.

☆ Lower availability of the new bigger sets commissioned.

⁽²⁰⁾ Information supplied by Escom in June 1984.

- ☆ The delayed commissioning of Cahora Bassa, Grootvlei, Kriel and the first sets of Matla and Duvha Power Stations.
- ☆ A chronic shortage of trained personnel.
- ☆ It was also not possible to work according to the planned maintenance programme because of low reserve margins.
- ☆ The declining quality of coal.

As a result of these problems it was often necessary to overload the sets to meet peak demand. Because of inadequate reserves only the minimum repairs due to unforeseen breakdowns were effected; this led to further deterioration in the general condition of equipment. Against the background of new large sets being commissioned simultaneously at a rapid rate, these factors contributed to the further deterioration of availability of all generating units to 74,3 % in 1982. The availability of coal-fired power stations *alone* dropped to 73,1 % in 1982.

During 1983 the availability of all Escom's generating units dropped further to 71,9 % and that of coal-fired units to 69,9 %. Particularly because of the exceptional drought the Umgeni and Ingagane Power Stations were temporarily shut down while the output of Camden Power Station was curtailed considerably. These steps reduced the effective generating capacity of the system by 1 800 MW. If the effect of the drought on the above-mentioned power stations were ignored, the availability of Escom's generating capacity would have been 74,3 % or the same as that in 1982.

The important figures and trends of availability and related facts are summarised and reflected on Graph 26.

It is clear that the *reduction* in availability so marked since 1975 started levelling out in 1980. The thermal efficiency of the system improved as more large sets with higher efficiency were commissioned. The reduction in the heat value of coal burnt in the larger power stations also contributed to the lower availability. Escom realises the necessity to improve availability and thermal efficiency and in the past started projects, among others at Camden, Hendrina, Arnot and Kriel Power Stations, with this improvement in mind.

Availability could be improved if *planned* outages could be reduced by the extension of periods between planned total overhauls and the reduction of overhauling periods. This can be accomplished, inter alia, by working three shifts.

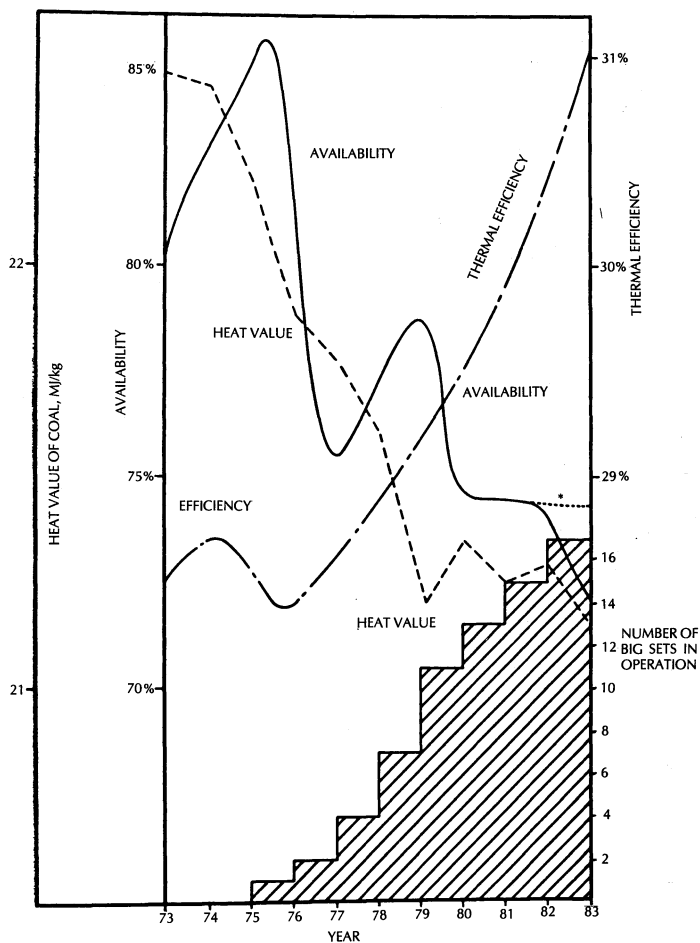
According to Escom⁽²⁰⁾ is was not possible until a short while ago to apply this concept, due to a shortage of manpower. However, the philosophy that had been accepted by a large number of utilities and suppliers of equipment was examined and, as a result of this, it was decided to adapt Escom's own philosophy to a number of new approaches and to use contract labour to augment Escom's own labour force.

Escom's⁽²⁰⁾ objective is now that planned servicing of combined boiler/turbine generator sets should occupy only 8 % of total available time (and that of the total planned outages 10,5 %).

In this connection it is interesting that two big West German electricity supply undertakings have accepted 7 % as the unavailable time for planned servicing of sets while one determined 3 % and the other 7 % as the objective for unplanned servicing. Both reached availabilities of above 80 % on their large sets.

⁽²⁰⁾ Information supplied by Escom in June 1984.

GRAPH 26
PERFORMANCE OF POWER STATIONS



* Availability excludes drought-stricken stations

Escom⁽²⁰⁾ estimates that it will need approximately 300 to 400 men to achieve its objectives with regard to 600 MW sets.

To achieve its objectives in this, Escom established a Generation Maintenance Enhancement Project a few years ago with project teams at each major power station.

Of unplanned outages, forced outages of large sets at the major power stations have the greatest effect on the system⁽²⁰⁾. About 80 % of all forced outages results from ten specific key problem areas in the seven largest power stations⁽²⁰⁾.

If the undependability of the large sets is high, the probability of simultaneous loss of a number of sets is of the utmost importance. It can have a direct effect on the quality of the supply of electricity.

The dependability of the large sets is usually lower because these sets have more critical components that can become defective and also because of the more sophisticated instrumentation and protection systems⁽²⁰⁾.

Escom's objective is to raise dependability by decreasing the number of the larger generating sets taken out of service from four to one a month.

Against this background it is necessary to estimate the future availability of sets.

In this connection, Escom⁽²⁰⁾ has made the following information available:

PERCENTAGE UNAVAILABILITY OF BIG CONVENTIONAL SETS (400-500 MW)

Year	Europe			Russia			USA			Escom		
	G1	G2	G3	G1	G2	G3	G1	G2	G3	G1	G2	G3
1977	13,3	20,1	33,4	12,8	18,8	31,6	15,9	12,1	28,0			
1978	11,1	18,8	29,9	9,8	19,3	29,2	14,7	14,5	29,2			
1979	11,5	14,9	26,4	14,0	15,8	29,8	14,4	14,3	28,7			
1980	10,4	14,1	24,5	9,4	15,4	24,8	15,7	15,3	31,0			
1981	9,6	14,2	23,8				14,6	12,0	26,6			
1982										14,0	17,3	31,3
1983										10,9	17,3	28,2
Average	11,1	16,3	27,4							12,4	17,3	29,7
Availability		72,6			71,7			71,3			70,3	

G1 = Planned servicing rate (%).

G2 = Forced outage rate (%).

G3 = G1 + G2 (not in Escom's original table)
Total outage rate %.

Availability = 100 - G1 - G2.

Sources: 12th World Energy Conference 1983.

Escom PARM System.

Escom figures for Kriel, Matla and Duvha for 1982-1983.

Escom⁽²⁰⁾ makes the following comment in connection with the above figures:

"The best average availability for 400 to 599 MW units is obtained by European utilities (72,6 %) and the worst by Escom (70,3 %) with the USSR (71,7 %) and the USA (71,3 %) in between. If the spread of data is taken into account, the difference between the worst and best availabilities is not very significant. It is therefore concluded that Escom's large units have availabilities which are comparable to average availabilities obtained elsewhere in the world.

"Escom is not satisfied that an average availability of 70,3 % is in fact adequate or optimal for its 400-599 MW units and has set the target availabilities for these stations at between 73 % and 74 % which will ensure an overall system availability of about 77 %."

Escom⁽²⁰⁾ hopes to reach this objective by 1989. An aspect on which Escom does not comment is that the total outage rate as a percentage dropped in—

☆ Europe from 33,4 % in 1977 to 23,8 % in 1981, while in

☆ Russia it dropped from 31,6 % in 1977 to 24,8 % in 1980, and in the

☆ USA from 28,0 % in 1977 to 26,6 % in 1981.

When the average figures for Europe, Russia and the USA are indicated, the real performers, as in the German cases, with a plus 80 % availability are not stressed.

Concerning the improvement in performance of availability in the course of time, the results of Escom at Kriel, Matla and Duvha Power Stations are interesting.

The previous analyses of the figures in Table 35 and the figures for 1983 indicate that the average availability of the—

☆ Kriel sets of 500 MW for the eight years up to and including 1983 was 68 %, while it was

⁽²⁰⁾ Information supplied by Escom in June 1984.

☆ 65,5 % for the Matla sets of 600 MW for the five years up to and including 1983 and 74,1 % for the past three years, and for the

☆ Duvha sets of 600 MW 71,3 % for the four years up to and including 1983 and 69,0 % for the past three years.

In the case at Kriel Power Station, for example, projects to increase availability are undertaken systematically. Five of these projects costing an estimated R11 million over the next five years should reduce the forced outage rate at Kriel from 24 % in 1983 to 12 % in 1988⁽²⁰⁾. This will be equal to a reduction of about 2 % in the total forced outage rate for the whole system by 1988⁽²⁰⁾. A 12 % rise in the availability rate at Kriel can increase the availability of these sets to almost 80 %.

Over the years Matla's availability was increased as follows:

1979—45,9 %

1980—59,5 %

1981—70,1 %

1982—71,2 %

1983—80,9 %

Two other sources in this connection are informative:

☆ In the VGB paper "Technisch Wissenschaftliche Berichte Wärmkraftwerke Verfügbarkeit von Wärmkraftwerken 1970—1981", statistics are given that indicate that an average availability of ± 80 % for all brown coal sets of 400—599 MW and 600 MW and larger sets were obtained in Germany.

☆ In a paper "Economics of Coals Utilisation For Large Central Station Steam Raising", presented in August 1982 by Gerald Blackmore at the Kentucky Coal Conference in Lexington, Kentucky, he argued that there is a reasonable correlation between the ash content of coal and the percentage availability of boilers. High ash content causes extensive corrosion and formation of slag. He states that the American Electric Power Service Corporation (AEP) found that the use of uniform high-grade coal is cost-effective. For this reason they wash coal to reduce the ash content from 10,5 %/18,5 % to 7,9 %/8,2 % at their Tanners Creek Power Station and had thus increased the availability from 70,3 % in 1973—1976 to 85,8 % in 1979.

Since 1975 the average heat value of coal received by Escom has dropped from 22,21 MJ/kg to 21,39 MJ/kg in 1982. This indicates that the heat value of coal at power stations commissioned since 1975 is considerably lower than the previous average heat values. The higher ash content of the coal can be an important contributory factor to the lower availability of the Kriel, Matla and Duvha sets.

Interesting information on the availability of sets is also given in a report "Central Electricity Board: A Report on the operation by the Board of its system for the generation and supply of electricity in bulk"⁽²¹⁾. A number of quotations from the report indicate the real reasons for the problem experienced with the bigger sets and also give an approach to it and the degree of success attained.

"The deterioration of plant is controlled in the following ways:

☆ Routine Preventive Maintenance—which can normally be carried out while the plant is running.

☆ Planned Outage Maintenance—carried out when the plant is not running and therefore, in the case of high merit plant, expensive in terms of consequential outage costs. It thus pays to concentrate the work into the shortest possible time.

☆ Breakdown Repair—unplanned outage but to some extent related to the amount of planned maintenance carried out.

The CEB employs all three kinds of maintenance, the mix being determined by the position of the plant in the merit order."

"Overhauls are scheduled so far as possible during the summer so that all plant is available (apart from breakdowns) to meet the winter peak."

"The availability of 60 MW and 100—120 MW plant was until recently higher than that of larger units. The development from 30 MW to 120 MW units was based on known criteria and characteristics, drawing upon previous operating knowledge for the uprated design. However, the development of 200 MW, 275 MW, 300 MW, 500 MW and 660 MW generating sets each necessitated significant changes in design, and many new designs were developed before the older designs were proved in service. Moreover, competing designs were bought for most of these sizes."

⁽²⁰⁾ Information supplied by Escom in June 1984.

⁽²¹⁾ The Monopolies and Mergers Commission; Central Electricity Generating Board; A Report on the operation by the Board of its system for the generation and supply of electricity in bulk. Her Majesty's Stationery Office, London.

"Designs tended to use higher operating temperatures for the 500 MW plant and to reduce design margins to achieve greater economies of scale. More reliance was placed on sophisticated controls to keep plant within its stated operating characteristics. However, operating closer (to) design limits can lead to either increased failure or reduced performance.

The table below indicates average availability for 60 MW, 120 MW and single-shaft 500/660 MW plant after five years in service:

Normal unit size MW	Weighted mean annual availability in the sixth year of operation	Standard deviation
60 MW.....	87.7	4.2
120 MW	71.2	12.9
500/660 MW	56.1	10.2

These comments must, however, be viewed in the context of the 1960's when economic growth projections indicated that the medium ranges of plant then available would not satisfy the forecast demand for electricity within the required timescale and new designs had to be produced urgently. With hindsight it is clear that inadequate design proving took place. However, the rate of growth was lower than had been projected and the actual demand for energy at that time was met. *The CEBG's efforts over the past ten years have largely overcome the problem of these designs. Winter availability has risen from 56.3 percent in 1968-69 to 83.9 percent in 1979-80.*

The experience outlined above has prompted the CEBG to spend substantial sums of money to rectify design shortfalls and improve quality assurance with manufacturers' works.

The Board includes two specifications in its invitations to tender:

- ☆ A performance specification, against which a manufacturer submits his proprietary design, and
- ☆ a quality specification, relating mainly to materials and workmanship."

"We have been concerned during our investigations about the consequences of the CEBG having power stations with equipment supplied by a large number of manufacturers, each with its own proprietary designs. This multiplies the problem of holding spares, and reduces the possibility of standard maintenance procedures, both because of inherently different operating characteristics of equipment fulfilling the same function and because of major differences in the frequency with which repairs have to be carried out. The number of suppliers of spares cannot be reduced because of the existence of proprietary design rights.

"The CEBG has adopted policies which are intended to make it easier to maintain, and to keep in service, power stations now under construction or about to be ordered. Every station but one ordered since 1966 has turbine-generator sets of 660 MW; and the odd one has sets of the same design as certain existing stations; already advantage has been taken of the interchangeability of important parts between stations under construction and stations in service. The Board also sees advantage in the acquisition of design rights so that different manufacturers can be invited to tender to supply plant to a standard design. Replication of design is also seen as desirable, but almost impossible to attain when there are long intervals between successive orders."⁽²¹⁾

Earlier in this chapter the approach indicating a growth rate in electricity demand over the long-term was motivated.

If a 77 % or 80 % availability is attained and the planned extensions are proceeded with, it will be possible to calculate the excess capacity for the two different cases, the 5 % growth rate, and the Escom estimate as indicated in Table 62.

The importance of—

- ☆ the growth rate of electricity consumption, and
- ☆ the percentage power station availability,

of generating capacity as reflected by the excess capacity in certain cases may be deduced from the figures in Table 62.

⁽²¹⁾ The Monopolies and Mergers Commission; Central Electricity Generating Board; A Report on the operation by the Board of its system for the generation and supply of electricity in bulk. Her Majesty's Stationery Office, London.

If the 1983 expansion programme of Escom is proceeded with and 77 % (the new Escom objective) or 80 % availability should be attained, excessgenerating capacity can increase as follows:

Growth rate of electricity consumption	Percentage availability	Excess MW	Capacity in 1989 % excess
According to Escom's 1983 estimate	77%	4 900	16,3
	80%	6 090	21,1
5 % growth rate of consumption.....	77%	8 900	34,3
	80%	10 030	40,3

These estimates were made on the basis that Cahora Bassa will not be available and that old low thermal efficiency power stations will be decommissioned, as planned by Escom. Should Cahora Bassa be fully available, the excess capacity available with a 5 % growth rate can increase to 45,8 % in 1989.

Current planning is aimed at making available—

- ☆ 9 732 MW generating capacity in the years 1983–1987, and a further
- ☆ 6 263 MW in 1988 and 1989, therefore an additional capacity of
- ☆ 19 995 MW during the period 1983–1989.

In 1983 it was estimated that the capital cost of *power stations plus facilities and transmission*, i.e. required by the Central Generating Undertaking, will amount to R20 036 000 000 for the period 1983–1987 alone. In this period 9 732 MW generating capacity will be created.

TABLE 62

**EXCESS SENT-OUT CAPACITY AVAILABLE FOR DIFFERENT POSSIBLE FUTURE CASES
EXCESS ASSIGNED SENT-OUT CAPACITY AVAILABLE**

Year	Escom estimate with 77% availability				Escom estimate with 77% availability but retaining all power stations				Escom estimate with 80% availability				Escom estimate with 80% availability but retaining all power stations			
	Excluding Cahora Bassa		Including Cahora Bassa		Excluding Cahora Bassa		Including Cahora Bassa		Excluding Cahora Bassa		Including Cahora Bassa		Excluding Cahora Bassa		Including Cahora Bassa	
	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%
1983	1 555	7,7	2 928	14,5	1 555	7,7	2 928	14,5	2 352	12,2	3 125	15,7	2 352	12,2	3 125	15,7
1984	2 552	11,8	3 925	18,2	2 555	11,9	3 925	18,2	3 446	16,7	4 777	23,1	3 446	16,7	4 777	23,1
1985	2 219	9,6	3 592	15,6	2 219	9,6	3 592	15,6	3 131	14,1	4 504	20,4	3 131	12,3	4 504	20,4
1986	2 596	10,5	3 969	16,1	2 991	12,1	4 364	17,7	3 572	15,1	6 945	29,3	3 967	16,8	7 340	31,0
1987	3 250	12,3	4 623	17,6	3 915	14,9	5 287	20,1	3 292	13,0	5 665	22,4	3 957	15,6	6 330	25,0
1988	4 798	17,5	6 171	21,9	5 910	21,0	7 283	25,9	5 911	21,9	7 284	27,0	7 023	26,0	8 396	31,1
1989	4 908	16,3	6 281	20,9	6 463	21,5	7 836	26,1	6 092	21,1	7 465	25,9	7 647	29,5	9 020	31,5

5% Growth with 77% availability				5% Growth with 77% availability but retaining all power stations				5% Growth with 80% availability				5% Growth with 80% availability but retaining all power stations			
Excluding Cahora Bassa		Including Cahora Bassa		Excluding Cahora Bassa		Including Cahora Bassa		Excluding Cahora Bassa		Including Cahora Bassa		Excluding Cahora Bassa		Including Cahora Bassa	
MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%	MW	%
2 312	11,9	3 695	19,0	2 312	11,9	3 685	19,0	3 078	16,6	4 451	23,9	3 078	16,6	4 451	23,9
3 760	18,4	5 133	25,3	3 760	18,4	5 133	25,3	4 565	23,4	5 938	30,4	4 565	23,4	5 938	30,4
3 919	18,4	5 292	24,8	3 919	18,4	5 292	24,8	4 763	23,2	6 138	29,9	4 763	23,2	6 138	29,9
4 827	21,5	6 200	27,7	5 222	23,3	6 595	24,4	5 714	25,5	7 087	24,8	6 109	28,4	7 482	34,8
6 057	25,7	7 430	31,6	6 722	28,6	8 095	34,4	6 988	30,9	8 361	37,0	7 653	33,9	9 026	39,9
8 229	33,3	9 602	38,9	9 341	37,8	10 714	43,4	9 207	38,8	10 580	30,8	10 319	43,5	11 692	49,3
8 908	34,3	10 381	40,0	10 463	40,3	11 936	46,0	10 035	40,3	11 408	45,8	11 590	46,5	12 963	52,0

If the average annual rate of increase in electricity consumption up to 1989 were only 5 % and a 77 % availability could be attained, up to 8 900 MW less sent-out capacity could be required by 1989.

Evidently a considerable amount of capital expenditure could be deferred if this growth rate of consumption and availability were attained.

To complete this evaluation, the increase in capital cost per MW over the previous decades should be determined as well as the efficiency with which capital and technology are applied.

Increase in capital cost

Escom's total assets in operation and under construction increased by slightly more than *twofold* in the period 1967–1974, but *sixfold* from 1974 to 1982, only a year longer than the first-mentioned period.

Escom's fixed assets represented between 90,5 % and 93,6 % of its total assets in the years 1974 to 1982.

In 1982 Escom's fixed assets were *12 times* the figure for 1974.

In the course of years the total *fixed assets in operation required per million kW.h sold* has increased substantially.

As previously shown, Escom's assets in operation per million kW.h sold, amounted to—

- ★ R28 010 in 1960, rising to
- ★ R35 130 in 1974, but subsequently increasing steeply to
- ★ R79 980 in 1982.

The *marginal growth* during the previous five years of Escom's assets in operation per million kW.h sold increased from—

- ★ R36 040 for the period ended 31 December 1975 to
- ★ R166 780 for the period ended 31 December 1982,
- ★ i.e. exceeding 24 % compounded per annum.

The Escom accounting system differentiates between—

- ★ fixed assets in operation, and
- ★ assets under construction.

Servicing costs of fixed assets in operation are regarded as operating costs while interest on assets under construction is capitalised until the specific asset is commissioned at its capitalised value. From that time onwards the asset's servicing costs are treated as an element of operating costs.

From 1974 to 1982 capital invested in—

- ★ *fixed assets* in operation increased by 19,5 % per annum, and capital invested in
- ★ *works under construction* by 40,9 % per annum.

As Escom's assigned sent-out capacity increased by 9,41 % per annum from 5 328 MW in 1967 to 10 002 MW in 1974, and subsequently at the lower rate of 7,83 % per annum to 20 523 MW in 1982, the 40,9 % annual increase in the amount invested in works under construction during the latter period deserves further explanation.

Works under construction as a percentage of assets in operation increased from 17,3 % in 1974 to 64,0 % in 1982 when the value of works under construction was R5 016 600 000 and fixed assets in operation R7 689 400 000.

Capital invested in works under construction in the distribution undertakings, especially in the late seventies and early eighties, comprised only a small percentage of the total.

This general position arose chiefly from the following:

- ★ *Fixed assets in operation* at cost in the Central Generating Undertaking as a percentage of Escom's fixed assets first decreased from 65,9 % in 1972 to 63,3 % in 1977, but subsequently increased to 74,6 % in 1982.
- ★ Since 31 December 1974 *capital invested in works under construction* in the Central Generating Undertaking increased by a factor of 19,8 up to 31 December 1982.
- ★ According to Escom's estimates a further R20 036 000 000 will be invested in the Central Generating Undertaking in the period 1983–1987.

These trends deserve closer attention.

Capital programme of the Central Generating Undertaking

The main reasons for the increasing capital investment in this Undertaking are the exponential increase in sent-out capacity required and the steeply increasing capital costs per MW of coal-fired power station generating capacity. Jointly, these are responsible for Escom's funding problem.

While the generating capacity in Escom's coal-fired power stations amounted to 4 158 MW at the beginning of 1967, and the sets having the greatest capacity comprised seven of 100 MW each—

- ★ *twenty four 200 MW sets* having a combined capacity of 4 800 MW were commissioned in the period 1967–1977,
- ★ *six 350 MW sets* having a combined capacity of 2 000 MW were commissioned in the period 1971–1975,
- ★ *six 500 MW sets* having a combined capacity of 3 000 MW were commissioned in the period 1976–1979, and a further
- ★ *nine 600 MW sets* having a combined capacity of 5 400 MW were commissioned in the period 1979–1982.

The sustained growth in the demand for electricity enabled Escom to apply advanced technology, especially in the commissioning of larger generating sets operating at higher pressures and temperatures, and of higher-voltage distribution networks.

In this respect an investigation into Escom's capital programme for its Central Generating Undertaking has revealed the following:

- ★ Between 1928 and 1972, over a period of approximately 45 years, i.e. approximately the economic life of a power station, capital costs per MW of coal-fired power stations increased to roughly three times the costs in 1928.
- ★ Between 1972 and 1982, over a period of only 10 years, capital costs per MW of coal-fired power stations increased to approximately three times those in 1972.

This phenomenon was not peculiar to South Africa but appeared in other countries as well. An investigation into the construction costs of coal-fired power stations in Germany reveals that an exceptional cost increase per MW took place since the early and mid-seventies and shows that these cost increases were out of proportion to those in other industries. Where the cost increase in other industries rose steadily and remained within reasonable limits between 1950 and 1980, costs of power stations followed this trend up to 1970 only and subsequently increased at a rate two to three times that in other industries. This phenomenon was attributable not only to longer construction periods and delays, but also to higher standards and requirements of safety and protection of the environment.

In the seventies the nature and size of power stations in South Africa changed considerably. Anti-pollution legislation required higher chimneys and higher efficiency precipitators and water purification systems.

Security requirements gave rise to more efficient fencing, and stronger reinforced structures were erected.

Sets of ever increasing size and higher technology resulted in longer construction periods.

Since the middle of the seventies higher technology, inflation, financing costs, long lead times, exchange rate fluctuations, air pollution control, security measures, the premium for supporting South Africa industries and the premium for using Conference Lines added to the increasing capital costs per MW.

Improved technology in newer installations had important cost implications.

The application of improved technology associated with the growth in demand

With the increase in size of the higher pressure and temperature sets the thermal efficiency of 18,5 % of the 33 MW Klip sets was increased to 28,7 % for the 100 MW Ingagane sets during the period 1936–1966, while availability decreased only marginally from 86,0 % to 84,1 %. Undoubtedly economies of scale in these years reflected advantages in capital and operating costs.

Since the commissioning of the Ingagane sets thermal efficiency and availability of sets reflected the following pattern:

Power station	Date commissioned	Size of sets	Steam conditions at turbine inlet	Thermal efficiency of sets	Availability of sets
Ingagane	1966	100 MW	8,4 Mpa 510 °C	%	%
Camden	Set 8 in September 1969	200 MW	10,3 Mpa 538 °C	28,7	84,1
Grootvlei	Set 6 in November 1977	200 MW	10,3 Mpa 538 °C	30,7	75,0
Hendrina	Set 10 in December 1976	200 MW	10,3 Mpa 538 °C	31,6	77,5
Arnot	Set 6 in August 1975	350 MW	15,9/3,98 Mpa 510 °C	31,5	81,7
Kriel	Set 6 in November 1979	500 MW	16,0/3,17 Mpa 510 °C	33,3	72,2
Matla	Set 6 under construction for June 1983	600 MW	16,1/3,68 Mpa 535 °C	34,1	69,1
Duvha*	Set 6 under construction for February 1984	600 MW	16,1/3,55 Mpa 535 °C	35,2	74,1
				34,3	69,0

* Average for 1981, 1982 and 1983

Source: ESCOM.

Thermal efficiency and availability

An analysis of the application of this technological progress indicates that as steam pressure, temperature and size of sets have been increased, the average *thermal efficiency* of individual sets have increased from 18,5 % for the smaller lower pressure and temperature sets to 34,8 % for the higher pressure and temperature 600 MW sets if the results for only 1981, 1982 and 1983 are taken into consideration. At the same time the percentage availability of the different sets dropped from 86,0 % for the older lower pressure sets to 72,1 % on average for the 600 MW high pressure sets over the past three years.

As a result of the higher inlet steam pressure and temperature and the ever-increasing capacity of sets, the general thermal efficiency of all Escom's coal-fired power stations increased from 18,2 % in 1950 to 24,9 % in 1967, 28,7 % in 1974 and to 30,5 % in 1982, while *availability* of all Escom's coal-fired power stations collectively decreased from 82,3 % in 1973 to 73,1 % in 1982 and the average availability over five years dropped from 82,1 % for the period 1973-1977 to 74,9 % in 1978-1982.

In 1983 the general thermal efficiency of all Escom's coal-fired power stations was 31,1 % while their availability had dropped to 69,9 %.

The average annual improvement in the thermal efficiency of the coal-fired power stations was 2,0 % in the fifties and sixties and 0,9 % in the seventies. During 1970 to 1974 this average annual improvement was 1,5 % while it was 0,9 % in the period 1974-1982. Evidently, the rate at which thermal efficiency of coal-fired power stations could improve, has declined since 1970. Since 1974 the trend has developed further in this direction.

The increase in inlet steam pressures and temperatures associated with the increase in capacity of the 200 to 600 MW sets commissioned especially since 1974 caused the thermal efficiency of *individual sets* to increase from 31,3 % to only ± 35 % if the efficiencies attained at Matla and Duvha in 1982 and 1983 are taken into account.

The thermal efficiency of sets having a capacity *exceeding* 350 MW, commissioned since 1974, only marginally exceeded the 33,4 % of the 350 MW sets, namely 34,2 % for the 500 MW and 35,0 % for the 600 MW sets.

Effect of improved thermal efficiency on coal costs per kW.h

During the fifties the improvement in thermal efficiency by 2 % per annum kept the average increase in coal costs, calculated in cents per kW.h to only 7,2 % per annum, while coal costs in rand per ton during the same period increased at an average of 9,2 % per annum.

In this respect an exceptional feature of the sixties was the improvement in the general thermal efficiency by an average of 2 %, per annum while the coal price in rand per ton increased by an average of only 1,08 % per annum, so that the average coal costs in cents per kW.h had in effect *decreased* by 1,1 % per annum. Although the thermal efficiency was in fact improved by 0,9 % per annum on average during the seventies, it contributed only towards lowering the annual average coal price increase in terms of rand per ton from 6,6 % to 5,8 % for the period 1970-1974, and from 19,0 % to 18,7 % for the period 1974-1982.

At current coal prices the improvement in thermal efficiency over the past 30 years enabled Escom to save R250 million per annum on its current coal account.⁽²⁰⁾ The improvement of 0,6 % in thermal efficiency between 1982 and 1983 saved a further R3,5 million in 1983.⁽²⁰⁾

⁽²⁰⁾ Information supplied by Escom in June 1984.

It is generally accepted in the case of large mechanical and electrical plant that there are two cost stages in an endeavour to increase efficiency, thermal efficiency or recovery. While the design is improved to attain greater efficiency the ratio between the increase in efficiency, up to a certain level, and the additional capital to attain this increase is rectilinear. However, if attempts were made to increase efficiency above this level the ratio would change from the rectilinear to an exponential one. In other words, attainment of the same marginal increase in efficiency above a specific level requires an exponential increase in capital costs.

The question arises whether Escom has not already reached the latter stage, because only a slight improvement in thermal efficiency has been attained since the installation of the Arnot 350 MW sets.

Improved high-voltage technique

The Commission of Inquiry has not evaluated the improved technology in high-voltage distribution networks.

However, the following has been noted:

☆ Transmission lines of the Central Generating Undertaking up to 31 December 1982 were as follows:

- 1 030 km of 533 kV DC (monopolar),
- 7 279 km of 400 kV,
- 1 462 km of 275 kV, and
- 108 km of 220 kV.

☆ Both the voltage and the length of high-voltage transmission lines have increased over the years.

Trends of prices per MW installed and available sent-out rating in 1975 money values of sets of various sizes

Since the availability of the installed sets differs considerably, as has been indicated, comparisons of the price of MW sent-out capacity can be made only on the same basis of availability.

In the following table information is given for evaluating trends in the steeply increasing capital costs per MW of coal-fired power stations over the past few years.

PRICE PER MW INSTALLED AND AVAILABLE SENT-OUT RATING IN 1975 MONEY VALUES FOR SETS OF DIFFERENT SIZES

Size of sets		Power Station where installed	Middle-year of commissioning of sets	Price per MW				Price deflator used *	Price per available MW sent-out rating †	
Installed capacity	Sent-out rating			Actual in respect of installed capacity	Actual in respect of sent-out rating	At 1975 money values and sent-out rating	Index		At 1975 values	Index
				R	R	R			R	
100 MW ...	90 MW	Ingagane	5/1966	111 100	123 444	242 047	100,0	0,510	287 809	100,0
200 MW ...	190 MW	Camden	3/1966	96 100	101 105	199 812	82,6	0,506	266 416	92,6
200 MW ...	190 MW	Grootvlei	1/1972	157 500	165 789	274 031	113,2	0,605	353 588	122,9
200 MW ...	190 MW	Hendrina	4/1973	148 800	156 632	223 441	92,3	0,701	273 490	95,0
350 MW ...	330 MW	Arnot	3/1973	119 400	126 635	181 686	75,1	0,697	251 643	87,4
500 MW ...	475 MW	Kriel	3/1978	226 300	238 211	172 492	71,3	1,381	249 526	86,7
600 MW ...	575 MW	Matla	5/1981	463 800	483 965	227 000	93,8	2,132	305 343*	106,1
600 MW ...	575 MW	Duvha	1/1982	521 000	543 652	233 227	97,0	2,331	338 010*	117,4

* Production price deflator (SA Statistical Services) adjusted for specific month on basis of steady increase during specific year.

† Price per MW sent-out rating divided by availability factor.

* Based on average availability factor for 1981, 1982 and 1983.

If the price index is compared on the basis of 1975 money values and availability, it is obvious in respect of the *economies of scale* that *specific capital costs*, i.e. capital costs per available MW, decreased by approximately—

- ☆ 7,4 % when the 200 MW sets at Camden were installed in 1966 as against the 100 MW sets at Ingagane in 1966, and by approximately
- ☆ 8 % when the 350 MW sets at Arnot were installed in 1973 as against the 200 MW sets at Hendrina in the same year, and by
- ☆ 0,8 % when the 500 MW sets at Kriel were installed in 1978 as against the 350 MW sets at Arnot in 1972.

The increase in *specific capital costs*, after allowance has been made for inflation, of—

- ★ 32,7 % and 2,6 % when the 200 MW Grootvlei and Hendrina sets are compared with the 200 MW Camden sets, and of
- ★ 22,4 % and 35,5 % when despite the economies of scale, as shown here, the 600 MW Matla and Duvha sets are compared with the 500 MW Kriel sets,

should however be attributed to other factors.

Escom⁽²⁰⁾ points out that the following factors have also contributed to increase specific capital costs per MW during recent years:

- ★ Lower heat rate in MJ/kg which has to be utilised in some of the newer power stations. The heat rate, ash content and ash fusion point have an effect on
 - capital costs per MW,
 - percentage availability, and
 - operating costs of a power station.

In view of the extent of the coal reserves block required for a large power station and the limited number of suitable reserves available, Escom is continuously investigating methods such as the washing of coal to limit coal costs. Escom's⁽²⁰⁾ calculations of power station costs over the life of a power station have so far indicated that it is uneconomical to wash coal, although the capital costs of a boiler could be increased by as much as 10 % because of the lower quality of coal. Power stations designed to burn low quality coal are more costly to construct than those using average quality coal.

- ★ In order to save water Escom was compelled to switch over to stations using dry cooling. These stations use only one third as much water as stations having wet cooling, but have a 1,5 % lower thermal efficiency. Escom⁽²⁰⁾ estimated that over the life of a power station the costs associated with a 4 000 MW power station having dry cooling exceed those of a station having wet cooling by approximately R400 million, excluding water costs.
- ★ Escom⁽²⁰⁾ also pointed out that in countries where fuel costs exceed those in South Africa by three of four times there are economic incentives to apply higher final steam temperatures and pressures (582 °C, 24 Mpa and double reheating). This, *according to Escom*, is not justified in South Africa and is the reason why Escom has not yet accepted a steam temperature and pressure exceeding 538 °C and 16 Mpa for a single reheating cycle.
- ★ When Escom decided on 600 MW sets, this decision was not based only on the relative life cycle costs of the power station, but also on the experience and commitment of manufacturers throughout the world. It was then found that Escom's traditional suppliers were moving towards 600 MW sets.⁽²⁰⁾

Regarding the *evaluation of economies of scale* Escom⁽²⁰⁾ rightly pointed out that—

- ★ the evaluation must be done over the entire life cycle of the power station in respect of working costs, maintenance costs, fuel costs and capital costs, and that
- ★ due to the numerous changes in economic factors and requirements of a power station, an absolutely reliable comparison of specific costs between sets of different sizes is extremely difficult.

Because Escom, when adjudicating tenders, takes into consideration the total financial package based on *target* percentage availability, thermal efficiency and estimated heat rate at design, as well as the *estimated* cost of coal and the basic capital costs, and as these target design and estimated values are seldom or never realised in practice, the calculations should be considered only as rough indicators.

In view of the trends of thermal efficiency and percentage availability mentioned above and the substantial increase in *real capital costs per MW sent-out and available sent-out capacity* since the 500 MW sets at Kriel Power Station were commissioned, it would appear that Escom, particularly so with its generating sets that make a substantial contribution to total capital costs per MW of new capacity, has reached the stage where economies of scale will make only a very small contribution, if any, towards limiting cost escalation of electricity in the future.

Leswis J. Perl of National Economic Research Associates Inc. puts it as follows for the American case:

"Economies of scale have come to an abrupt end."

Although he said this about conditions in America, it would appear that his statement is also true of South Africa although America has installed even larger sets in the past.

⁽²⁰⁾ Information supplied by Escom in June 1984.

Factors that in this respect play an important role in South Africa as opposed to America are the availability of the larger sets and associated construction and escalation costs.

It has already been pointed out that for a typical coal-fired power station (6×575 MW) under these circumstances—

- ★ basic costs comprise only 54 %,
- ★ escalation 24 %,
- ★ overheads 5 %, and
- ★ interest 17 %,

of total capital costs, and that—

- ★ the first set is commissioned $\pm$ eight years after it is decided to build, while
- ★ the last set is taken into service approximately 14 years after that decision.

If these periods can be shortened considerably, especially in the light of the previous analysis, capital costs per MW sent-out rating can be curtailed considerably. Standardisation can contribute substantially, not only in curtailing capital costs per MW, but also in shortening construction periods.

Escom⁽²⁰⁾ claims to standardise in—

- ★ the number of sets per power station (6),
- ★ the physical layout where possible of power stations constructed since Matla, and
- ★ the size of sets.

Since Matla all the new sets are in the 600 MW category.

Escom⁽²⁰⁾ points out that up to now it has not been possible or practicable to standardise on plant of specific suppliers as Escom depends on suppliers world-wide for the optimum supply of its requirements. Over the past few years financing has become a very important requirement in this respect. Although local manufacture plays an important part in the commercial adjudication of tenders and local content of power stations currently amounts to approximately 70 % of the value, the higher escalation rates in South Africa in contrast with the lower rates of the traditional suppliers count against local manufacturers.

These conditions and the Escom policy caused Escom to adapt and combine boilers and turbines that have been based on different design philosophies (e.g. Benson once-through boilers and GEC turbines that normally operate with drum type convection circulation boilers) and resulted in little standardisation of sets at the various power stations. In contrast with this the CEBG of Britain has purchased only 660 MW sets in all but one case since 1966 to gain the distinct advantage of interchangeability of vital spares for power stations sets.

The aspects of the problems, highlighted above, must be thoroughly investigated in order to determine—

- ★ whether the policy of installing progressively larger generating sets with higher inlet pressures and temperatures, and requiring high technological standards, should be abandoned and not taken further because the marginal improvement that can be achieved has levelled out, and
- ★ if this is the case, whether sets and boilers should not be standardised, and to
- ★ identify and carry out what is needed to curtail escalation of capital costs.

In addition Escom will have to do anything within reason to increase the availability of power station sets, hopefully by 10 %, in the following three to five years. This can be achieved through planned maintenance and planning during maintenance periods, the use of materials with a longer life and the training and retention of personnel.

Escom planning of current power station capacity and power stations to be commissioned before 1989

This evaluation of the efficiency of Escom's expansion programme suggests that, in view of—

- ★ Escom's present reserve capacity and the extent to which the economic growth pattern during recent years fell short of the assumptions on which Escom's programme of capital expenditure was based,
- ★ the prospects of a modest consumer growth pattern for at least a number of years,
- ★ the potential of greater availability of generating sets, and
- ★ the possibility of a saving in electricity consumption as a result of an effective saving campaign,

⁽²⁰⁾ Information supplied by Escom in June 1984.

Escom will have to reconsider seriously any further commitments in respect of its expansion programme for power generating capacity.

It should be pointed out once more that power generating capacity now being installed was planned ten or more years ago and that commitments have been made. Ten years ago growth prospects of the South African economy were completely different from current prospects.

In this respect it is extremely important that Escom should endeavour to defer the commissioning dates of certain sets to which it is contractually bound even at a cost but possibly at an eventual saving.

AN EVALUATION OF ESCOM'S PERFORMANCE IN RESPECT OF WORKING COSTS

The chief elements of Escom's working costs are—

- ★ capital-related, and
- ★ fuel costs, and
- ★ other expenditure.

Table 63 gives the relevant figures for certain items in Escom's income and expenditure account, indicating their relative importance and changes during the years 1973 and 1982.

Capital-related costs amounted to 51 % of total costs in 1973 and to 50 % in 1982 while fuel costs constituted 23 % and 26 % and other expenditure 27 % and 26 % of total costs in the two years.

Trends of capital-related costs

Capital-related costs increased by an average of 27,2 % per annum, from R155 million in 1973 to R1 352,7 million in 1982, while the average annual growth rate of electricity sales (physical units) was only 8,3 % during the same period.

Annual interest debited against income, according to Escom's income statement and as reflected in Table 63, increased from R101,9 million in 1973 to R721,9 million in 1982.

However, the above interest does not include interest on loans for assets under construction. This interest is capitalised. In this way interest of R15,9 million on assets under construction was capitalised in 1973 and R583 million in 1982. The information for 1982 is contained in Note 12 on the financial statements in Escom's 1982 Annual Report.

These notes also show that total interest and financing charges amounted to R1 305 million in 1982 which comprised—

- ★ R873 million paid to external stockholders,
- ★ R432 million paid as interest on Escom stock held in Escom funds.

The amount of R432 million is calculated as follows from the statement of source and application of funds for the year ended 31 December 1982:

TABLE 63
CHANGES IN ESCOM'S INCOME AND EXPENDITURE ACCOUNTS DURING THE YEARS 1973 AND 1982

Item	R (million)			
	1973	%	1982	%
Interest	101,9	34	721,9	27
Redemption, etc.	34,2	11	154,8	6
Reserve Fund	3,8	1	26,0	1
Capital Development Fund	15,4	5	450,0	16
Capital related costs	155,3	51	1 352,7	50
Purchase of electricity	—	—	3,6	—
Fuel	68,6	23	694,0	26
Other expenditure	82,3	27	703,0	26
Total costs	306,2	101	2 753,3	102
Deficit	4,0	1	57,9	2
Total income	302,2	100	2 695,4	100

Interest credited to Capital Development and Reserve Funds	R 365	million
Interest credited to Redemption Fund	76	million
	441	million
Less interest capitalised on fuel financing	(9)	million
	<u>R432</u>	

Because of this method of dealing with the accounts, contributions to the Redemption, Reserve and Capital Development Funds, as shown in Table 63, cannot be reconciled with the increases in these funds in the years concerned unless the fact is taken into consideration that interest is credited to these funds and is shown under the heading "interest" (in so far as this is not capitalised).

The annual contribution to the *Capital Development Fund* has increased from—

★ R15,4 million or 5 % of total income in 1973, to

★ R450 million or 16 % of total income in 1982.

The reasons for the steep increase in capital-related costs are fully dealt with and evaluated later.

Trends of fuel costs

Fuel costs increased by an average of 29 % per annum from R68,6 million in 1973 to R694,0 million in 1982 although electricity sales increased by only 8,3 % per annum during the same period.

The increase in the coal price in rand per ton of 19,0 % per annum on average for the period 1974–1982 followed periods of particularly low price increases, namely an average of—

★ 1,08 % per annum for 1960–1970 and

★ 6,6 % per annum for 1970–1974.

The steep increase in the coal price for the period 1974–1982 is due to structural changes in the coal mining industry.

In 1973, the year of the oil crisis, the coal mining industry in South Africa supplied—

★ an almost monopolistic buyer's market of Escom and Iscor,

★ a price-controlled internal market, and

★ a relatively small export market.

These factors, together with the Government's policy of cheap energy and low wages which applied to unskilled labour, contributed towards the low price of coal before 1973. The low price of coal achieved particularly by labour-intensive mining methods before 1973, resulted in low recovery of coal reserves, low labour productivity and low mining costs during the decade when wages for Blacks were low.

In this respect a team investigating the activities of 49 coal mines reported to the Minister of Mines as follows in 1977:

★ In even 1976 only ± 10 % of South Africa's coal was mined from open-cast mines, 14 % through longwall mining methods and 76 % from mines where chamber and pillar extraction methods were applied.

★ The average recovery of exploitable coal reserves in South Africa was only 30 % at the time.

★ The labour-intensive chamber and pillar extraction method, with or without the removal of pillars, was applied because with this method, against the background of the low level of capital investment per ton sold annually and the low wage levels, the lowest selling cost per ton could be achieved. With these mining methods the recovery of exploitable ore reserves in various mines varies between 15 % and 30 %, whereas with longwall mining a figure of 40 % to 60 % is achieved and with open-cast mining the figure can exceed 90 %.

★ If the *average recovery rate* by capital-intensive mining methods could be increased from only 30 % to 45 %, South Africa's exploitable coal reserves would be increased by 50 %, so that the rather dark picture of the Petrick report in this regard would be improved appreciably.

★ As far as *labour productivity* is concerned, the following figures applied to the December quarter of 1976:

Mining method	Tons mined per unskilled labourer per annum		
	Mechanised, capital-intensive Method A	Manual labour, labour-intensive Method B	Ratio
Chamber and pillar	2 186	653	AB
Chamber and pillar with pillar removal	1 942	400	AB
Longwall mining	2 500		A3/B1
Open-cast	10 404		A4/B1
			3,3
			4,8
			3,83
			15,9

Capital-intensive underground mining methods achieved $\pm$ three to five times higher labour productivity than manual loading methods in the December quarter of 1976. However if open-cast mining in this period is compared with the most productive manual loading mining method, open-cast mining was 15,9 times more labour productive.

- ☆ The undermentioned figures from the December 1976 survey apply to labour costs per ton sold:

Mining method	Unskilled labour costs per ton sold			
	1972	1976	Increase 1976 over 1972	
	Cents	Cents	Cents	%
Chamber and pillar, manual loading.....	75	330	225	340
Chamber and pillar, mechanised.....	13	57	44	338
Open-cast.....	6	14	8	133

It is remarkable that the increase in the cost of unskilled labour during the period 1972–1976 was 255 cents per ton for manual loading mines as opposed to 44 cents per ton for mechanised underground mines using the *same chamber and pillar layout*, and 8 cents per ton for mechanised open-cast mining. The steep increase in wages for Black mineworkers in the early seventies increased mining costs considerably, particularly for manual loading mines.

- ☆ Before 1973 there were hardly any financial incentives to invest additional capital in advanced mining equipment in order to achieve higher labour productivity, higher recovery and lower wage costs per ton mined.

The investigation team came to the following conclusion in 1977:

“The trends detailed above are in direct conflict with the long term objectives of the optimum utilisation of the national coal resources by an efficient coal mining industry and must be seen against the major expansion of annual production capacity required in this industry.”

The investigation team estimated that an additional 32,8 million tons of coal per annum had to be mined between 1977 and 1981 to satisfy the requirements of Escom, Sasol, exports, Iscor and the price control market, and remarked as follows:

“It therefore becomes quite clear that a new approach is indicated.”

The oil crisis, the rapidly increasing world demand for coal, the resultant increase in coal prices and the commissioning of the Richards Bay railway line and harbour in April 1976, enabled the South African coal industry to sell to an ever-increasing extent on the export market, under free-market conditions, while the domestic market as shown above has also expanded considerably.

Against the background outlined above, high annual average increases in the coal price were almost inevitable in the seventies and early eighties and were necessary in the interests of the country for the recovery of reserves.

Since 1974—

- ☆ the selling price of coal increased appreciably, chiefly because of steeply-rising Black wages and inflation,
- ☆ capital-investment per annual ton new production was increased appreciably, and
- ☆ the increased price created the opportunity to mine considerably more coal by open-cast mining methods from the same reserve areas.

These trends can clearly be seen from the figures in Table 64 which indicate the following:

- ☆ The percentage of the total amount of coal burnt in Escom power stations originating from open-cast mines increased from
 - 1,10 % in 1970, to
 - 13,46 % in 1974, to
 - 38,15 % in 1982, and will according to estimates reach
 - 47 % in 1990.
- ☆ In 1982 the average cost/ton coal supplied to Escom was—
 - R11,69 for all coal,
 - R14,53 for coal mined underground, and
 - R7,08 for coal from open-cast mines.
- ☆ The cost per ton of coal for *open-cast* mines therefore was already in 1982 less than half the figure for coal mined underground, and in respect of the *recovery* of reserves two or three times as high.
- ☆ Where the average annual growth rate for the period 1974–1982 of the

TABLE 64

DATA OF COAL BURNT IN ESCOM POWER STATIONS DURING PERIOD 1970-1982

Year	Coal burnt, thousand tons	Average heat rate	Average costs per ton	Percentage of total		Average cost/ton	
				Underground mined	Open-cast mined	Underground mined	Open-cast mined
1970.....	21 630	22,97	2,26	99,90	1,10	2,27	1,44
1971.....	23 416	23,30	2,25	94,03	5,97	2,30	1,53
1972.....	24 952	22,89	2,25	91,98	8,02	2,28	1,90
1973.....	27 906	22,47	2,39	88,49	11,51	2,45	1,99
1974.....	30 891	22,42	2,92	86,24	13,76	3,05	2,07
1975.....	34 233	22,21	4,02	79,52	20,48	4,49	2,21
1976.....	37 258	21,87	5,34	78,52	21,48	6,09	2,60
1977.....	37 561	21,78	6,12	77,05	22,95	7,03	3,07
1978.....	39 588	21,61	6,61	79,16	20,84	7,46	3,38
1979.....	43 310	21,66	6,96	73,18	26,82	8,21	3,56
1980.....	46 753	21,34	8,12	69,39	30,61	9,34	5,36
1981.....	53 928	21,25	9,65	68,30	31,70	11,43	5,83
1982.....	55 485	21,39	11,69	61,85	38,15	14,53	7,08

☆ average price of all coal supplied to Escom has increased by 19,0 % per annum,

☆ the price of coal mined by underground methods increased by 21,5 % per annum, while for coal mined by

☆ open-cast methods it increased by 16,6 % per annum.

The labour-cost component as a percentage of the total costs of open-cast mining is considerably lower than the percentage for underground mining, while certain costs that do not escalate rapidly, viz. capital-related costs, are percentage-wise higher in open-cast than in underground mining. Percentage-wise electricity costs as a component of total costs are higher for open-cast mining than for underground mining.

Viewed against conditions on the world market over the past few years and the factors mentioned above, it would appear that the steep coal price increases during the period 1974-1982 will not apply to the same extent in the future.

The fact that open-cast mining, where this method can be applied, can increase the quantity of exploitable coal from the same hectare reserve up to three times, and the fact that the present cost structure in many cases renders a much lower price per ton by open-cast methods than by underground mining methods, have far-reaching possibilities for the future.

When negotiations are entered into with a mining company on the utilisation of a coal-field by an Escom power station, it is normally agreed against the background of geological information, the accepted mining method and recovery prospects that an area will contain sufficient reserves to supply Escom's needs. The Escom needs make provision not only for the coal consumption of the power station over its entire life, but also for a safety margin that can be considerable.

The reason for this is that during tender negotiations the number of boreholes in the reserve blocks is usually limited, and consequently provision must be made for relatively wide safety margins. After acceptance of a tender the number of boreholes is increased and recovery by the particular stoping method tested so that the exploitable reserve tonnage and the safety margin can be determined to a much greater degree of accuracy. If the mining method, under the changing conditions outlined above, can be modified for economic reasons from underground to open-cast mining methods for the whole or part of the reserve, it is clear that considerable reserves that fall in the particular area can possibly be made available for other uses than for the existing power station.

Two possible applications of this reserve are interesting:

☆ Additional sets can possibly be added to existing power stations having established infrastructures, otherwise older power stations can be renovated to utilise this coal.

☆ The reserve can possibly be used on its own or added to an adjoining reserve to form very large multi-product mines. In a case like this the high-grade product can be exported, the middlings burnt by Escom, and the low-grade product rejected. Economies of scale and a full utilisation of capital-intensive equipment and reserves can have considerable advantages to Escom in the future.

The establishment and operation of a multi-product plant at Optimum Colliery, having results shown below, will enable Optimum to export as much as 3,5 million tons of high-grade coal per annum and will reduce Escom's coal costs as a result of economies of scale.

EFFECT OF MULTI-PRODUCT OPERATION ON THE QUALITY OF COAL AT HENDRINA POWER STATION

	Original supply to power station	Multi-product mine		
		Power station supply	Export	Reject
Quantity/annum-10 ⁶ tons	6,9	6,95	3,5	1,24
Heat rate (MJ/kg)	22,9	23,0	28,9	9,2
Ash %	24,3	22,5	10,0	—
Abrasion index (mgFe)	400/420	250/270	—	—

The reduced ash content and the abrasion index are important.

Trends of other expenditure

Other expenditure apparently increased from—

☆ R82,3 million in 1973 to

☆ R702,0 million in 1982, i.e. at an average rate of 26,6 % per annum.

However, Escom points out that—

“It should be noted that a new accounting system was brought into operation at the beginning of 1975 and this made direct comparisons of expenditure in 1973 with that in the years following 1973 meaningless.” (translation)

Since 1975 expenditure on the components of “other expenditure” was as follows:

Year	Other station operating and maintenance costs	Distribution operating and maintenance costs	General expenditure	Total of other expenditure
1975	44 980 000	18 477 000	71 758 000	135 215 000
1976	62 477 000	19 712 000	92 835 000	175 024 000
1977	76 294 000	19 859 000	133 494 000	229 647 000
1978	89 193 000	23 677 000	138 106 000	250 976 000
1979	95 887 000	28 689 000	188 203 000	312 779 000
1980	117 968 000	36 824 000	240 078 000	394 870 000
1981	170 306 000	43 034 000	273 756 000	486 996 000
1982	261 842 000	59 852 000	381 348 000	703 042 000
Growth 1975-1982	28,6% p.a.	18,3% p.a.	27,0% p.a.	26,6% p.a.

It is evident that “other station operating and maintenance costs” and “general expenditure” have risen rather steeply over the entire period, but particularly since 1978.

High costs of “other expenditure” in 1982 arose from—

☆ power station operating and maintenance costs, excluding fuel costs, which amounted to R261,8 million for the year,

☆ distribution costs which amounted to R59,9 million, and

☆ general expenditure which amounted to R381,3 million.

In 1982 wages and salaries represented—

☆ 20 % of operating and maintenance costs, and

☆ 65 % of distribution costs.

General expenditure amounted to R507,4 million in 1982 and represent head office and other overhead costs. In this year salaries and wages represented 63,7 % of this expenditure. In 1982 R126,1 million of “general expenditure” under overheads was capitalised *in respect of capital projects* while R381,3 million was contributed to operating costs.

In this regard it should be mentioned that the New Works Department comprised a total of 2 633 workers of whom 1 354 were employed at Head Office.

A direct comparison of costs is not possible due to the modified accounting system, but as salaries and wages comprised a significant percentage of “other expenditure”, an evaluation of labour productivity can give an indication of the trends of these costs. The total number of employees per GW.h sold declined from 0,74 to 0,61 over the period 1967-1982 so that Escom's total labour productivity improved by approximately 21 % over the period.

Although *absolute values* in number of employees per GW.h of the Central Electricity Board of Britain cannot be compared with those of Escom, the following labour productivity trends of the utility over the past few years are interesting:

- ☆ If labour productivity in the year 1965/66 is accepted as an index of 100 in terms of GW.h supplied per CEB employee, the index reached 175 in 1979/80.⁽²¹⁾
- ☆ Likewise, taking the 1965/66 labour productivity in terms of GW.h sold per Area Road employee as an index of 100 this index reached 226 in 1979/80.⁽²¹⁾

The increase in productivity achieved by the electricity industry over the period was 3 to 10 times as much as that for Escom as a whole. However, labour productivity of power station workers has declined from 0.93 employees per MW in 1972 to 1.14 per MW in 1982.

In terms of power station workers per TW.h sales the figure was 4 689 in 1972 and 3 865 in 1982, an improvement of $\pm 17.6\%$.

Escom's power station planning and construction programme which in its extent since 1975 was unique in the world undeniably contributed to Escom's reasonably poor performance in increasing labour productivity.

AN EVALUATION OF ESCOM'S GENERAL FINANCING

Escom is a non-profit seeking public utility.

The Electricity Act stipulates that Escom shall neither make a profit nor suffer a loss.

In terms of the Act Escom may—

- ☆ negotiate loans (with the approval of the State President),
- ☆ contribute to a capital development fund (subject to certain maxima and with the approval of the State President),
- ☆ decide the amount to be contributed to a reserve fund for replacement, improvement and extra-ordinary maintenance. (An annual contribution is compulsory, but the amount is not stipulated.)

In terms of the Act Escom *must* also ensure that selling prices cover its current expenditure, provisions for interest on and redemption of any loans, and its contributions to the above-mentioned two funds, at neither a profit nor a loss.

Escom receives no financing or subsidies from the State and it is undoubtedly the intention that Escom shall be financially self-supporting.

However, the State guarantees most of its foreign loans and has made Escom's financial circumstances more favourable in three other essential respects:

- ☆ In the past Escom was largely and at low cost protected by the Reserve Bank against currency fluctuations in its obligations.
- ☆ Escom's local loans are provided by a committed market through the investment obligations of insurance companies and pension funds, and foreign investors in Escom stock enjoy tax deduction privileges.
- ☆ Certain consumers (who cannot afford ruling tariffs) are subsidised by the State to keep them functioning.

There is a possibility that these arrangements may be phased out in the future or made available at a more cost-related (i.e. higher) price.

Escom's powers as a body corporate to issue loans and make contributions to a capital development fund, give Escom a wide variety of options for internal financing, credit and loans.

Internal financing

The annual increase in the Capital Development Fund and the annual contribution to the Fund expressed as a percentage of Escom's gross income from electricity sales are indicated in Table 65.

Up to 1976 the contribution to the Capital Development Fund was reasonably limited. However, these contributions were increased markedly in 1977 when foreign financing was uncertain and capital expansion had to proceed. Table 66 reflects electricity unit price increases during recent years.

During the period 1973–1982 Escom's balance sheet underwent considerable structural changes as indicated in Table 67.

⁽²¹⁾ The Monopolies and Mergers Commission; Central Electricity Generating Board; A Report on the operation by the Board of its system for the generation and supply of electricity in bulk. Her Majesty's Stationery Office, London.

TABLE 65

INCREASE IN CAPITAL DEVELOPMENT FUND

Year	Increase in R million in capital develop- ment fund	Contribution* to Capital Development Fund as a percentage of gross income from electricity sales
1972.....	14,1	5,5
1973.....	17,3	5,7
1974.....	32,3	9,0
1975.....	49,2	10,7
1976.....	68,7	10,5
1977.....	257,2	25,0
1978.....	370,2	28,4
1979.....	491,4	32,1
1980.....	585,9	33,1
1981.....	670,6	31,3
1982.....	800,1	29,7

* Direct amount obtained from tariffs in particular year, plus interest on previous cumulative capital development fund also recovered from electricity sales.

TABLE 66

AVERAGE ANNUAL PERCENTAGE INCREASE IN
ELECTRICITY UNIT PRICES

Year	Percentage rise in the unit prices of electricity
	%
1967-1973.....	2,8
1974.....	5,0
1975.....	16,6
1976.....	30,4
1977.....	48,3
1978.....	16,5
1979.....	6,2
1980.....	6,6
1981.....	12,8
1982.....	22,9

TABLE 67

BALANCE SHEETS OF ESCOM AS AT 31 DECEMBER 1973 AND 31 DECEMBER 1982

Item	Amounts in R millions as at 31 December			
	1973	%	1982	%
Assets in operation.....	1 811	88	8 403	58
Assets not in operation.....	244	12	5 985	42
Works under construction	244	12	5 017	35
Deferred expenditure	—	—	968	7
Total assets	2 055	100	14 388	100
Borrowed capital.....	1 338	65	9 274	65
Own funds	717	35	5 114	35
Capital Development Fund	31	1	3 357	23
Redemption Fund.....	323	16	866	6
Other	363	18	891	6
Capital sources	2 055	100	14 388	100

A comparison between the two balance sheets reveals the following:

- ☆ The apportionment of own funds and borrowed funds remained at 35 % and 65 % of the total funds respectively, but

☆ a massive increase in Escom's *assets not yet in operation* has taken place.

The value of fixed assets not yet in operation has increased from—

☆ R244 million, or 12 % of total assets in 1973 to

☆ R5 017 million, or 35 % of total assets in 1982.

Due to the growth in *assets not yet in operation*, *borrowed capital* represented—

☆ 74 % of assets in operation in 1973, and increased to

☆ 110 % of assets in operation in 1982.

On 31 December 1973 only 1 × 200 MW (Grootvlei), 2 × 350 MW (Arnot) and 3 × 200 MW (Hendrina) sets, a total of 1 500 MW had not yet been commissioned and 6 × 500 MW sets at Kriel were under construction. These were the main reasons why the balance sheet value of assets under construction as at 31 December 1973 was R244 million.

On 31 December 1982 the costs of the following power stations and sets were partly included under assets under construction but not in operation:

	R
• Koeberg.....	2 805,0 million
• Tutuka.....	354,6 million
• Lethabo	283,4 million
• Matimba.....	125,6 million
• Kendal.....	203,4 million
• Palmiet.....	13,5 million
• Mvumase.....	5,0 million
A total of	<u>R 3 790,5 million</u> , while on that date—

• One set of 600 MW at Matla and

• Two sets of 600 MW at Duvha had not yet been commissioned, but were partly included under assets not yet in operation.

The total balance sheet value of assets under construction was R5 017 million as at 31 December 1982.

The S-curve on Graph 13 indicates in both the Matla and Duvha cases that approximately 5 % of the total costs were outstanding as at 31 December 1982. In addition, the costs of 3 sets had to be transferred from works under construction to works in operation so that an additional amount of ± R844 million had to be added to the R3 790,5 million. This brings the total to R4 534 million, that is to more than 90 % of the total of works under construction as at 31 December 1982 for power stations only.

Capital costs of the first nuclear station (Koeberg) represent an amount of R2 805 million in the figure of R5 017 million for *works under construction*. Koeberg's assigned sent-out rating will be 1 940 MW, which could have been provided by a coal-fired power station at a capital expenditure of R900–R1 100 million at ruling prices at the time Koeberg was constructed. To this should be added the costs of transmission lines as the requirements of the Western Cape increase. As Koeberg will supply power in excess of the requirements of the Western Cape for many years and will in effect feed power into the transmission network back to the north, it is difficult to estimate the costs of transmission lines.

Had the alternative of coal sets in the Eastern Transvaal with the most suitable unit sizes and with the necessary transmission lines been chosen, capital outlay could have been considerably lower.

These essential facts about Koeberg are part of the *explanation for the increase in assets not yet in operation* that occurred between 1973 and 1982. The comments do not imply criticism of or justification for the decision to build Koeberg.

The extension of construction periods of power stations by a third, together with inflation and high interest rates, contributed substantially to the increase in the amount shown under "works under construction but not in operation" between 1973 and 1982. If 2½ years were allowed from the time the decision was taken to build and the first acceptance of tenders for turbo-generators, the total period

from the time the decision to build was taken up to commissioning of the last set was nine years for Camden and Grootvlei Power Stations, 11 years for Arnot and Kriel Power Stations and 12 years for Matla.

To sum up—

- ☆ Koeberg nuclear power station,
- ☆ extended construction periods for power stations,
- ☆ stepped-up technological standards,
- ☆ inflation, high interest rates and anti-pollution requirements, and
- ☆ fuel purchased in advance.

possibly contributed up to 50 % to the increase of R4 773 million between 1973 and 1982 in the capital amount invested in works under construction but not in operation which on 31 December 1982 did not contribute to Escom's income.

Changes in the mix of Escom's borrowed capital

Table 68 shows that Escom lessened its dependence on financing through stock issues and short-term loans by encouraging its foreign suppliers of capital equipment to provide suppliers' financing facilities.

Import financing facilities amounted to—

- ☆ R27 million in 1973, or 2 % and
- ☆ R1 547 million in 1982, or 17 % of Escom's borrowed capital which amounted to
- ☆ R1 838 million in 1973, and
- ☆ R9 274 million in 1982, exceeding the figure for 1973 by R7 436 million.

Many of the suppliers' financing facilities are in the medium or even long-term category and interest rates are as a rule much lower than market rates. The real expense and desirability of this type of financing are difficult to determine due especially to the Reserve Bank having safeguarded Escom until recently against detrimental exchange rate fluctuations in foreign liabilities. For this protection the State through the Reserve Bank had to pay R505 million during the period 1973–1982. If Escom had not enjoyed this protection—

- ☆ either its loan account in 1982 would have differed appreciably from the published account,
- ☆ or Escom's decisions on suppliers, foreign or internal, could have differed materially.

The problem set out above about financing of the capital programme, and assets on the balance sheet but not in operation is not a *short-term one of a passing nature* as is illustrated by the figures in Table 69 which give the annual addition to Escom's fixed assets for the period 1973–1982 and Escom's forecast for the following five years.

Capital-related costs and their effect on tariffs

The magnitude of the amount on which capital-related costs are based is determined by the nature and size of the equipment installed and has been dealt with previously.

TABLE 68

CHANGE IN MIX OF ESCOM'S BORROWED CAPITAL DURING THE YEARS 1973 AND 1982

Item	As at 31 December			
	1973 R-millions	%	1982 R-millions	%
Escom stock.....	1 666	87	6 831	74
Import financing	27	2	1 547	17
Short-term borrowings.....	113	9	566	6
	1 806	98	8 944	97
Net current assets	32	2	330	3
	1 838	100	9 274	100

TABLE 69

ANNUAL ADDITION TO ESCOM'S FIXED ASSETS FOR PERIOD 1973-1982 WITH FORECASTS UP TO 1987

Year	Annual addition to fixed assets in R-millions
1973.....	170
1974.....	228
1975.....	398
1976.....	642
1977.....	982
1978.....	1 218
1979.....	1 326
1980.....	1 412
1981.....	1 895
1982.....	2 662
1983 Forecast.....	3 284
1984 Forecast.....	3 992
1985 Forecast.....	4 512
1986 Forecast.....	5 042
1987 Forecast.....	4 957

The manner in which capital-related costs are recovered from the consumer first requires that a choice be made between two philosophies:

- ☆ **Consumer-privileged:** Electricity is a basic ingredient of development and progress. The community would benefit if it were made available as cheaply as possible to consumers and prospective consumers.
- ☆ **Consumer-neutral:** Electricity is a product like any other product, and its price should be determined according to general economic laws (i.e. equal or tending to long-term marginal costs). Such a policy will ensure that the community's resources (whether capital, labour or minerals) are utilised optimally.

The reasons why it was decided to adopt the consumer-privileged philosophy are dealt with fully under "An evaluation of the current electricity tariffs of Eskom". Briefly the reasons are as follows:

- ☆ Historically it has been the policy in South Africa.
- ☆ The vast majority of countries South Africa has to compete with on the export market pursue this philosophy.
- ☆ The economy built on this basis will be disrupted by a change in this philosophy. (Tariffs would have to be increased by approximately 35 % if a price policy tending to long-term marginal costs were pursued.)
- ☆ The possible advantages of more efficient appropriation of resources which have been regarded as an important advantage of the consumer-neutral philosophy are vague and uncertain, and could in any case be defeated by other stumbling blocks in the South African economy which still differs much from a classical free-market economy.

Comments on the philosophy of consumer-privileged are as follows:

- ☆ This philosophy must result in lower unit prices than those under the consumer-neutral philosophy. It is therefore obvious that the growth rate of electricity consumption, especially in times of high inflation, will be higher under this philosophy than under the consumer-neutral philosophy.
- ☆ Privatising of a system which operates under the consumer-privileged philosophy is much more difficult than under the consumer-neutral one as the yield on current values is much lower.
- ☆ However, consumer-privileging can be taken *further* than the equal privileging of *all* consumers. Selectively and for strategic reasons the refining of minerals, for instance, may be more privileged, by lower unit prices of electricity, than domestic consumers. The Electricity Act does not make provision for such selective privileging in South Africa.
- ☆ The extent to which general consumer-privileging is applied eventually depends on the State and its economic policy. The State could for example provide part of Eskom's capital requirements in the form of lower interest rate loans. Where "privileging" stops is inherently a subjective matter and the decision is in essence arbitrary.

There are, however, limits to consumer-privileging. In the further consideration of Eskom's general financing the assumptions were made that the two customary limits would be that the State would wish to see privileging only to the extent that there are not direct costs to the State and that Eskom's financial capacity is stretched to the utmost *safe limits*.

The question of Eskom's financial capacity immediately arises.

Escom's financial capacity

To obtain an idea of the *current net value of Escom's assets* two methods were used:

- ☆ Actuaries were instructed to discount assets and liabilities, with due allowance for their future useful lives, to their current values at interest rates of 14 % per annum and on the assumption that both tariffs (13,44 %) and operating costs (17,96 %) would increase at the rates of the previous five years.
- ☆ Based on Escom's estimates of the present (1983) system replacement value per MW (R1 041 000) and estimated deductions for wear and tear and relative inefficiencies a replacement value for the present system was calculated.

Table 70 gives a summary of the findings in comparison with the official balance sheets as at 31 December 1983.

The differences between the two valuations as at 31 December 1983 are insignificant, considering the assumptions that had to be made, and are due mainly to the assumption of longer remaining useful lives made in the actuarial study than in the replacement value case.

The conclusion is clear:

In terms of current values Escom has a healthy structure and provides a considerable measure of capital security to lenders and creditors.

Nevertheless the extent of the task of acquiring 12 billion rand in foreign currency (and considerably more in the future) and to manage this in the long term should not be underrated. (The internal marketable stock issue of the Central Government itself was only 23 billion rand at the time.) It is to Escom's credit that it performed this task so well.

TABLE 70
CURRENT VALUES OF ESCOM ASSETS AND LIABILITIES

	As at 31 December 1983 (R Millions)		
	Book value	Actuarial	Replacement
Works under construction	6 210	6 210	6 210
Fixed assets in operation	9 381	15 386	13 500
Current assets	1 031	1 031	1 031
Other assets	2 352	87	2 352
Total assets	18 974	22 714	23 093
Less: Liabilities	12 206	10 378	12 206
Loans	11 340	9 512	11 340
Other	866	866	866
Net asset value	6 768	12 336	10 887

Table 71 was drawn up to get an idea of relative debts of similar enterprises elsewhere in the world.

Lenders attach importance not only to capital security, but also to income security. In this respect the acid test is whether current interest and redemption commitments are sufficiently covered by current cash income before interest and whether this will continue in the future.

This interest is not *only* the portion charged to current expenditure, *but also* the portion capitalised, i.e. *total interest* due to external stockholders.

Where, as in Escom's case, the amount owing increases annually, the year-end annual *interest implication* of the debt is a *higher figure* than interest actually paid in the course of the year, and an adjustment has to be made to provide for this.

Another factor that applies to Escom is that part of its current loans cannot be replaced at the same interest rates (because of increases in interest rates) and the interest implication must be increased accordingly.

Table 72 shows the annual cash income for 1982 and 1983, and the figure expected for 1984, as opposed to the interest requirements described above. For the years 1982 and 1983 the ratios of net cash income to liabilities were 1,09 and 1,10 respectively and estimates for 1984 suggest a ratio of 1,08.

This cover must be regarded as adequate, but marginal.

However, Escom has succeeded in retaining a *sufficiently positive position* in three difficult years and this naturally and rightly creates trust by lenders. On Escom's part there is hardly any scope under the current policy and conditions for concessions in electricity tariff increases.

Escom's claim to local capital resources

In view of Escom's relative size, attention must also be paid to the claim it has made and will make on local capital resources. Dr. Straszacker, Escom's previous chairman, always maintained that a growing electricity market implies a growing economy that naturally would give rise to a growing and adequate capital market. The past few years however, were not a good example of this as is illustrated by Table 73. Savings decreased while Escom's requirements increased, resulting in Escom's relative claim to available savings becoming much bigger. Escom has expressed the opinion that it is *currently approaching the maximum* it can draw from this market.

TABLE 71

RELATIVE DEBT PER MW INSTALLED OF DIFFERENT ELECTRICITY UTILITIES AT LATEST BALANCE SHEET DATE

Utility	Country	Debt in Rand per MW
B C Hydro	Canada	857 000
Ontario Hydro	Canada	806 000
SEC of Victoria	Australia	764 000
Queensland	Australia	752 000
Western Australia	Australia	597 000
Escom	South Africa	547 000
E de France	France	397 000
RWE	Germany	154 000
CEGB	United Kingdom	154 000
Vattenfall	Sweden	146 000

Notes

1. Of the utilities in this table only Electricité de France (R31 billion) and Ontario Hydro (R20 billion) had absolute debts greater than those of Escom.
2. All the debts per MW of the utilities with debts exceeding those of Escom are guaranteed by their governments in one way or another. To a certain extent this also applies to Electricité de France.

TABLE 72

ESCOM'S INCOME COVER TO SATISFY LOAN COMMITMENTS

	R millions		
	1982	1983	1984*
Gross income	2 695	3 302	3 782
Less: Working costs	1 401	1 691	1 889
Net income	1 294	1 611	1 893
Adjustments	(16)	(30)	(23)
Net cash income (A)	1 278	1 581	1 870
Interest paid to outside stock holders	872	1 071	1 310
Plus: Adjustment for debt increases	119	149	153
Interest implication of year-end debt	991	1 220	1 463
Plus: Allowance for higher interest rates on replacement loans	68	76	89
Long-term interest implication	1 059	1 296	1 552
Plus: Redemption of year-end debt over 20 years at 13% p.a.	115	146	185
Commitments (B)	1 174	1 442	1 737
Ratios $\frac{(A)}{(B)}$	1,09	1,10	1,08

* ESCOM estimates.

TABLE 73

ESCOM'S CAPITAL EXPENDITURE AS A PERCENTAGE OF GROSS DOMESTIC SAVING LESS DEPRECIATION

	Saving less depreciation R millions	ESCOM'S expenditure R millions	%
1976.....	3 268	642	19,7
1977.....	4 905	982	20,0
1978.....	5 683	1 218	21,4
1979.....	9 105	1 326	14,6
1980.....	14 120	1 412	10,0
1981.....	10 343	1 895	18,3
1982.....	6 370	2 662	41,8
1983.....	7 950	2 732	34,4

If these divergent factors are a temporary phenomenon, the gap could be bridged for the time being by the banking system; this would naturally have other implications for the broader monetary policy. *In the long-term continuing growth by Escom under the present mechanisms is possible only if savings increase.* The present imbalance naturally also has an effect on the high interest rate structure.

The Commission of Inquiry requested forecasts to be made for essential variables in Table 73 and the results appear in Graph 27. The curves show a definite decrease in the pressure Escom's requirements will have on the local market for some time. This decrease in pressure will continue for six years in the case of economic growth rates of between 4,5 % and 5,5 % per annum and a growth rate of electricity consumption of 7 % per annum, and for 10 years in the case of economic growth rates of between 2,5 % and 3,5 % per annum and a growth rate of electricity consumption of 5 % per annum. After the six year and ten year periods pressure on the market will in both cases increase fairly rapidly.

The main reason for the first period of decreasing pressure on the market, is presumably—

- ☆ Escom's saving campaign in capital expenditure.
- ☆ The measure of reserve capacity developed in the past three years of low growth that has to be absorbed.
- ☆ Future capital expenditure estimates do not include further nuclear reactors that result in extremely heavy capital expenditure.

As the forecasts for Escom loan requirements could possibly be too low, the data for the graph were calculated on a low inflation forecast of approximately 4 % less than the built-in inflation in the capital expenditure forecast. However, higher inflation rates do not change the basic picture.

Should this improvement materialise, Escom's negotiating power in this market should grow stronger, and this might enable it to improve its borrowing conditions. Here it is not so much interest rates that are considered, but rather three other possibilities:

- ☆ Part of local financing can possibly be acquired in the form of commitments that would rank only after the claims of other creditors. Local lenders are not concerned about Escom's creditworthiness; should such a component be added to the balance sheet, it should reassure foreign financiers even more, and at an insignificant cost.
- ☆ Part of local financing can possibly be acquired in the form of annuity loans. Instead of the more general situation in which the lender receives his capital back in a lump sum at the end of the period and interest on the full amount throughout the period, the loan can be redeemed in payments that include capital. The material difference to Escom is that in the (latter) case of the annuity loan it does not require to establish a redemption fund. In regularly pays back the capital to the original lender and avoids the danger of borrowing at less favourable times.
- ☆ Part of local financing can possibly be over a longer period. It is a healthy practice to let the period of a loan coincide as far as practicable with the useful life of an asset that is acquired with the loan. Escom loan periods materially fall short of the lives for example of power stations built with loans. This has several disadvantages. Redemption of the loan over a shorter period requires higher instalments (and tariffs) with an "under-borrowed" position that builds up and is meaningless in an enterprise such as Escom that always requires capital.

Alternatively, if the redemption fund for a short-term loan is based on the longer asset life, funds could be lacking to redeem the loan on maturity and there is a risk that replacement loans may not be readily available or may be available only at a higher interest rate than originally agreed upon.

Extent of Escom's internal financing

After the basic analysis in the previous paragraphs the controversial subject of the extent of Escom's internal financing can now be considered.

Electricity supply is a capital intensive industry and substantial investments have to be made in works under construction while any specific project in the industry will yield an income and profits only after a number of years.

When favourable credit terms are available financing by means of loans can result in a materially lower tariff level than when capital has to be built up from tariffs, and the former method of financing is therefore clearly preferable. Escom as a well-managed, financially healthy monopoly that supplies an essential product to a captive market, offers a *safe* investment outlet to the local investor who should offer Escom favourable loan terms. Foreign investors may regard an investment in Escom as less favourable due to the possibility of alternative investments and their view of political risks. This has in fact happened. Under these circumstances Escom should be able to help itself, so that a degree of self-financing is unavoidable, and funds for this eventuality should be built up timeously.

The evidence on internal financing was in agreement on the following matters:

- ☆ Recommendations of the Franzsen Commission are no longer applicable.
- ☆ The maximum legally possible limit of self-financing by Escom is unnecessarily high.
- ☆ A certain degree of self-financing should take place. (No one was in favour of a percentage less than 25 % of annual requirements.)
- ☆ The ideal degree of self-financing should have a scientific basis that is not arbitrary. (Certain witnesses are working on this but up to now have not been able to make any suggestions to the Commission.)

In an endeavour to determine a scientific basis for the degree of self-financing by Escom, the Commission applied the earlier-mentioned actuarial investigation to determine future tariff levels which would involve certain ratios between current values of gross assets and liabilities and assumptions on future cost increases. (All at an interest rate of approximately 14 % per annum.)

With an increase of approximately 18 % per annum in operating costs, which has been applicable for the past five years, it was found that only small deviations from the actual *average* tariff increase of 13.44 % which has also been applicable for the past five years can cause a marked variance in the assets/liability ratio expressed as

$$\frac{\text{Assets Evaluation} - \text{Liabilities Evaluation}}{\text{Assets Evaluation}} \%$$

The conclusions drawn from these calculations are very important:

- ☆ A certain sustained increase in working costs requires a certain long-term increase in tariffs which can be calculated for any degree of solvency required.
- ☆ *Small long-term deviations from such a required increase have considerable solvency implications.* Although Escom's capital security is more than sufficient, and can endure a few years of low tariff increases if necessary, such actions will have to be balanced by years of higher increases (as has often happened—refer Table 66) or will very soon lead to an unsatisfactory position.

In Annexure B the actuarial approach is set out in more detail in the hope that this can be developed in the future.

At the empirical extreme of the spectrum of approaches to the question of internal financing consideration must also be given to Escom's present policy. This has developed under the influence of practical experience of consumer resistance, and under constant pressure from the State for lower tariff increases, especially in the last five years. As set out in Annexure B, it now represents approximately 30 % of annual and cumulative requirements, but this does not exceed by much the minimum suggested by any witness.

Escom itself feels that this percentage of internal financing should be higher (say, an average of 35 % with extreme annual limits of 30 % and 40 %) and gives excessive pressure on the capital market as the main indicator that the 30 % average currently is too low.

As a result of the decrease in savings in the economy since 1980, Escom's demand on local savings has increased greatly. Although Escom itself cannot change this, it might be compelled to react (at least temporarily) to this by increasing internal financing. As indicated by Graph 27—if savings recover—the prospects are good that Escom's requirements will put less pressure on the local loan market for the following six to ten years.

In its search for a synthesis of all the inputs it has received, the Commission of Inquiry was struck by the degree of similarity that in this respect existed over the last five years between—

- ★ that which is advocated by witnesses—not less than 25 % of requirements;
- ★ that which from an actuarial viewpoint agrees with an assets/liabilities ratio of 3:2–12,98 % tariff increase necessary, close to 13,44 % which was achieved over the past five years;
- ★ what was necessary to provide an income cover of slightly more than one;
- ★ what actually happened, and the manner in which the Capital Development Fund policy developed.

On these grounds the Commission recommends that—

- ★ future tariff increases be tested for an income cover of at least 1,05, and
- ★ for the expected average future increase in working costs the required tariff increase be calculated actuarially to give a 3:2 assets/liabilities ratio,
- ★ this method be refined and applied annually, and
- ★ the degree of internal financing achieved in this manner be accepted.
- ★ The provision in the Act regarding the making of a profit or a loss by Escom should fall away, subject to this substituted discipline. In this way the level of the Capital Development Fund as a standard for self-financing will disappear.

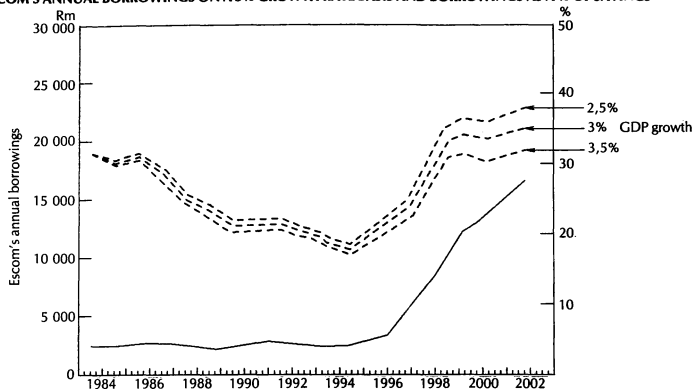
This approach will result in more even tariff increases and can also be logically presented to the consumer public to the extent regarded as desirable.

Future potential tariff levels

Since the income cover can easily be calculated, it has enabled the Commission of Inquiry to make forecasts of future tariff levels on the basis of certain assumptions.

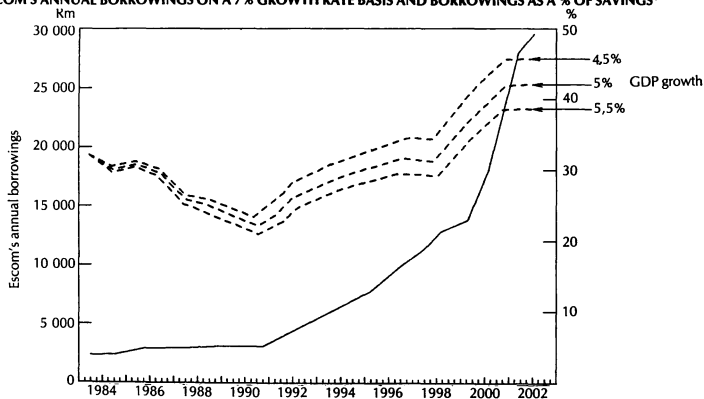
GRAPH 27

ESCOM'S ANNUAL BORROWINGS ON A 5% GROWTH RATE BASIS AND BORROWINGS AS A % OF SAVINGS*



* Gross domestic savings less depreciation

ESCOM'S ANNUAL BORROWINGS ON A 7% GROWTH RATE BASIS AND BORROWINGS AS A % OF SAVINGS*



* Gross domestic savings less depreciation

The basic data and assumptions as well as their effects are set out in Tables 74 and 75, and it may be commented as follows:

- ☆ After 1990 the tariff level is in all instances at an optimum in the sense that capital expenditure and sales are in harmony.
- ☆ Up to 1990 the increase in tariffs is the highest where sales vary most from planned generating capacity.
- ☆ If construction rate and consumption rate are in harmony, the rate of increase in tariff level will not vary significantly, but in the long-term a higher growth rate will result in increased tariffs.
- ☆ The amount owing by Escom grows initially and eventually at more than 15% per annum with a drop to 12 % in the interim. Naturally it will grow even faster if inflation in capital expenditure exceeds 11,7 % per annum accepted for the calculation.
- ☆ Actual tariffs will have to be somewhat higher as the indicated tariffs provide income coverage of only 1 instead of the desired minimum of 1,05.
- ☆ In general a growing harmonised industry will require tariffs just below the inflation rate. If harmony is lacking, they will exceed this rate.

The basic reasons for the fact that—

- ☆ tariffs are highest up to 1990 when sales vary most from planned capacity, and that
- ☆ a growing harmonised industry will require tariffs *just below* inflation rate, are that the motivation for the capital-related cost component in the tariff is a debt management one. (In the modern idiom "the tariff is debt management driven".)

Table 76 shows the increase in Escom's outstanding debts per installed MW over the years (which is of course influenced by excessive increases in the prices of capital assets). Undoubtedly these figures will increase even further. Considering the effects of these figures for the period for which Escom has negotiated factual commitments

- ☆ the debt per MW in operation in 1990 will be close to R1 million, which
- ☆ means *an average increase of + 12 % per annum* for this period.

As capital-related costs represent approximately 50 % of total costs, a tariff increase of ± 6 % per annum is required to cover only the *unavoidable* increase in capital costs already incurred and therefore necessary. Provision has still to be made for cover for increased working costs.

TABLE 74
SINGLE INCOME COVERAGE FOR CREDITORS

Load growth 7 % p.a.—Interest rate 14 % p.a.

Year	Basic assumptions			Forecasts					
	Millions units sold	Capital expenditure (excluding interest) (R mill)	Working Costs (R mill)		Tariff level cents per unit		% Increase		Debts outstanding year-end (R mill)
			(a)	(b)	(a)	(b)	(a)	(b)	
1983.....	98 251	2 342	1 691	1 691	3,36	3,36			11 458
1984.....	105 129	2 891	1 990	2 081	3,75	3,83	11,5	14,06	14 220
1985.....	112 488	3 041	2 343	2 560	4,22	4,42	12,75	14,30	17 050
1986.....	120 362	3 526	2 757	3 151	4,72	5,05	11,81	14,30	20 260
1987.....	128 787	3 833	3 245	3 877	5,22	5,71	10,47	13,03	23 684
1988.....	137 802	4 041	3 820	4 770	5,69	6,38	9,03	11,75	27 139
1989.....	147 448	4 399	4 496	5 870	6,17	7,11	8,54	11,41	30 899
1990.....	157 770	4 416	5 292	7 223	6,64	7,87	7,61	10,72	34 656
1991.....	168 814	4 722	6 228	8 888	7,13	8,71	7,36	10,68	38 683
1992.....	180 630	5 761	7 330	10 936	7,70	9,70	7,97	11,36	43 670
1993.....	193 275	7 406	8 628	13 457	8,38	10,88	8,86	12,22	50 163
1994.....	206 804	9 096	10 155	16 559	9,17	12,26	9,34	12,69	58 189
1995.....	221 280	10 410	11 953	20 376	10,02	13,82	9,24	12,70	67 384
1996.....	236 770	11 785	14 068	25 073	10,92	15,57	9,08	12,67	77 795
1997.....	253 344	13 901	16 558	30 852	11,93	17,58	9,23	12,86	90 087
1998.....	271 078	15 853	19 489	37 964	13,02	19,84	9,12	12,87	104 094
1999.....	290 053	16 820	22 939	46 714	14,14	22,33	8,57	12,59	118 895
2000.....	310 357	20 201	26 999	57 482	15,40	25,22	8,91	12,91	136 722
2001.....	332 082	25 185	31 778	70 731	16,85	28,58	9,45	13,34	159 020
2002.....	355 327	30 202	37 402	87 035	18,48	32,45	9,66	13,52	185 763
2003.....	380 200	33 761	44 022	107 097	20,21	36,80	9,34	13,40	215 559

(a) Inflation at 10 % in working costs; Capital 11,7 %.

(b) Inflation at 15 % in working costs; Capital 11,7 %.

TABLE 75
SINGLE INCOME COVERAGE FOR CREDITORS

Load growth 5 % p.a.—Interest rate 14 % p.a.

Year	Basic assumptions				Forecast				
	Millions units sold	Capital expenditure (excluding interest) (R mill)	Working Costs (R mill)		Tariff level cents per unit		% Increase		Debts outstanding year-end (R mill)
			(a)	(b)	(a)	(b)	(a)	(b)	
1983.....	98 251	2 342	1 691	1 691	3,36	3,36			11 458
1984.....	103 164	2 891	1 953	2 042	3,78	3,87	12,55	15,11	14 220
1985.....	108 164	3 028	2 256	2 466	4,31	4,50	13,83	16,30	17 038
1986.....	113 738	3 500	2 605	2 977	4,86	5,18	12,79	15,20	20 225
1987.....	119 425	3 728	3 009	3 595	5,40	5,89	11,29	13,74	23,552
1988.....	125 396	3 724	3 476	4 341	5,91	6,60	9,37	11,97	26,718
1989.....	131 666	3 742	4 015	5 242	6,41	7,34	8,43	11,22	29 882
1990.....	138 249	3 564	4 637	6 329	6,88	8,11	7,41	10,45	32 875
1991.....	145 161	3 810	5 355	7 643	7,39	8,96	7,33	10,56	36 099
1992.....	152 420	4 212	6 186	9 228	7,94	9,94	7,47	10,85	39 711
1993.....	160 041	4 072	7 144	11 143	8,49	10,99	6,95	10,61	43 216
1994.....	168 043	3 674	8 252	13 456	9,03	12,13	6,35	10,35	46 391
1995.....	176 445	3 752	9 531	16 248	9,61	13,42	6,38	10,61	49 693
1996.....	185 267	4 962	11 008	19 619	10,31	14,96	7,34	11,52	54 177
1997.....	194 530	6 410	12 714	23 690	11,16	16,80	8,16	12,27	60 045
1998.....	204 257	8 394	14 685	28 606	12,16	18,98	9,03	12,98	67 784
1999.....	214 470	11 755	16 961	34 541	13,41	21,61	10,28	13,87	78 644
2000.....	225 193	13 716	19 590	41 709	14,79	24,62	10,30	13,91	91 301
2001.....	236 453	14 283	22 627	50 363	16,22	27,95	9,63	13,54	104 467
2002.....	248 275	16 491	26 134	60 813	17,79	31,76	9,68	13,63	119 675
2003.....	260 689	18 631	30 184	73 432	19,50	36,09	9,60	13,63	136 860

(a) Inflation at 10 % in working costs; capital 11,7 %.

(b) Inflation at 15 % in working costs; capital 11,7 %.

TABLE 76
INCREASE IN DEBT PER MEGAWATT—INSTALLED BETWEEN 1973 AND 1983

	Net borrowed capital R millions	Sent-out capacity MW	Debts per MW installed
1973.....	1 338	9 482	141 000
1974.....	1 517	10 002	151 000
1975.....	1 875	10 522	178 000
1976.....	2 435	11 688	208 000
1977.....	3 119	12 756	244 000
1978.....	3 899	13 595	287 000
1979.....	4 727	15 056	314 000
1980.....	5 571	17 339	321 000
1981.....	6 997	18 989	369 000
1982.....	9 274	20 523	452 000
1983.....	11 846	21 673	547 000
1984.....			600 000

Should working costs, which comprise the remaining 50 % of total costs—

☆ increase by 15 % per annum, tariff increases would *broadly viewed*, be 6 % + 7½ % or 13½ % per annum, and should working costs

☆ increase by 10 % per annum, tariff increases would be 6 % + 5 % or 11 % per annum.

Accounts and accounting systems

Various witnesses criticised Escom's accounting systems. These criticisms can be divided into two groups:

☆ Criticism of what is permissible or should be allowed in the computation of Escom's tariff level (from a legal or national economic viewpoint), and

☆ criticism of ambiguities, anomalies and information gaps.

These two groups overlap in a number of respects and in a sense the second group of criticisms can be dealt with only when a final decision has been taken on the first group. Subject to this reservation an endeavour is made in what follows to highlight the more important objections to ambiguities, anomalies and information gaps, and certain proposals for improvement are made. What is or should be permissible in the computation of Escom's tariffs has already been dealt with.

What is Escom's current net asset valuation?

It is required from companies in which the public has an interest to give an indication of current values of fixed assets at least every three to five years. Escom has not yet done this. Such a revaluation should in Escom's case also take note of the reduced burden represented by outstanding low interest rate loans in today's climate of higher interest rates.

Such a valuation can only strengthen Escom's creditworthiness and comparisons from year to year or over a number of years give the *only reliable answer to the extent to which Escom has in real terms increased or decreased equity*.

The basis of asset revaluation can be one of the following:

- ☆ Discounted current value of future expected net income after assumptions were made on—

demand,
availability,
tariffs,
costs, etc.

- ☆ Replacement value reduced for wear and tear and relative inefficiencies of older sets. (Similar to the basis used by CEEB⁽²¹⁾).

The two valuations should not differ much, especially if the assumptions under the first method are made on such a level that a new power station is estimated at about current replacement value.

This general valuation approach should also cast light on the valuation of the increasing intangible assets Escom has shown in its balance sheet. (This resulted in a partial appreciation of its other reserves).

Determination of Escom's profitability

The application of the fund accounting system whereby interest (as well as self-redemption provisions) on Escom's own capital is dealt with in precisely the same manner as interest on external funds is probably the most important single confusing factor in the determination of Escom's profitability. However, a further factor is that the contribution to the Capital Development Fund, which is decided on an administrative basis, is dealt with as costs, to the point where it can result even in a net "deficit" on the income statement.

Critics agree that Escom's gross surplus on its equity capital should be readily identifiable from the accounts and that items subsequently subtracted (depreciation, whether historical or on a replacement basis, provision for future capital expenditure, etc.) should be shown as applications of this surplus and motivated separately.

The Commission of Inquiry supports this approach.

How efficient is Escom?

As Escom is not in a competitive environment, *profit as such is not a sufficient indicator of efficiency*. Consequently it is desirable that Escom should report annually on the efficiency of the organisation with regard to various aspects, e.g.

⁽²¹⁾ The Monopolies and Mergers Commission; Central Electricity Generating Board; A Report on the operation by the Board of its system for the generation and supply of electricity in bulk. Her Majesty's Stationery Office, London.

Utilisation of manpower:

- ☆ number in different categories with productivity indices, preferably on the basis of kW.h sold per man,
 - ☆ changes in remuneration (including fringe benefits),
 - ☆ training, etc.
- Availability of plant.
- Fuel and water consumption (already dealt with to a certain degree).
- Capital cost per MW, etc.,

with suitable five or three year objectives announced annually in advance for the period and compared with international equivalents or criteria (where these are available).

Escom should also compare its cost increases with the general experience of other industries in the Republic and the electricity supply industry in overseas countries for each type of cost, possibly in the form of a scientifically weighted index figure.

For such comparisons Escom's annual capitalised expenditure (e.g. 80 % of head-office expenditure) will have to be added again so that the comparisons are not nullified by *administratively-determined changes in policy*.

Escom's reaction to this criticism

On the tariff level itself Escom has always taken a strong stand and the justification for this over the last five years, given the environment and institutional framework within which it operated, is confirmed in broad terms by the Commission's investigations.

Concerning the current net asset valuation, determination of profitability and reporting on efficiency Escom has indicated its willingness to act in a positive and constructive manner. In this respect Escom has pointed out that its annual report has improved virtually every year as far as scope and coverage of information are concerned, and that in a number of areas it is at present seeking the advice of local and international consultants.

The Commission does not believe that it can make an independent contribution of any value in this respect, but would like to see that this positive process is continued at a faster rate.

AN EVALUATION OF THE CURRENT ELECTRICITY TARIFFS OF ESCOM

Against the background of general principles this evaluation covers the broad constraints of the Electricity Act, the four current categories of tariffs, the effects of the constraints of the Electricity Act on tariffs and the suitability of Escom's tariff structures under present circumstances.

Determining prices of products of public utilities in general and of electricity in particular is a delicate problem. The Commission of Inquiry is aware of the theoretical argument that the equalisation of the electricity price with the long-term marginal costs will create optimum conditions, in so far that the consumer will then pay the actual social opportunity cost of his consumption and therefore satisfy the requirements for the efficient allocation of resources in the economy.

The Commission also knows that the traditional accounting approach to tariffs does not satisfy the requirements for the efficient allocation of resources. The traditional accounting approach is particularly adjusted to what happened in the past and does not reflect the *incremental costs of new consumption*. This creates the illusion, therefore, that the costs of current and future resources will be the same as in the past.

However, the application of marginal cost principles for the determination of electricity tariffs can create considerable problems for South Africa, especially for its exports.

The fact is that marginal cost principles are not applied, except to a degree in Britain and France, by South Africa's trading partners.

The obvious conclusion is that the marginal cost principles give a useful indication of the trends of the most important factors to be considered when determining tariffs and are very useful and important in that sense, but should not be applied as a basis for determining tariffs in South Africa. Determining tariffs in the Escom case should however be subject to the two limits of consumer "privileging" as set out previously. Methods to achieve maximum savings with a relatively low average tariff are dealt with later.

The present tariff structure

Escom's tariffs are determined within the following broad constraints of the Electricity Act:

- ☆ Prices to be charged by Escom for electricity are laid down in Section 14 of the Electricity Act. This Act requires that prices should make provision for recovering the following:
 - the costs of electricity generation, distribution, maintenance and administration,
 - interest, redemption and other capital-related costs,
 - specific and controlled contributions to the Capital Development Fund (and the Reserve Fund).

Section 14 (4) provides:

"It shall be a general principle of the commission that its undertakings shall, as far as practicable, be carried on neither at a profit nor at a loss, and that its charges shall be adjusted accordingly from time to time."

☆ Section 16 of the Act requires that separate accounts be kept of the expenditure of each undertaking. The general principle that no profit should be made nor losses be suffered applies to each of Escom's seven distribution undertakings.

☆ One group of consumers shall not be subsidised by another.

Escom has four categories of tariffs—

☆ a large power user tariff, generally applicable to loads exceeding 100 kV or kVA (Tariff A);

☆ a small power user tariff, generally applicable to loads not exceeding 100 kV or kVA (Tariff B);

☆ a domestic tariff, generally applicable to proclaimed townships or within an area which Escom regards as similar to such a township (Tariff C). This tariff does not apply to domestic consumption on a farm; and

☆ a tariff for rural consumers whose loads do not exceed 100 kVA.

The large power user tariff (Tariff A) is applicable to industries, mines, municipalities and farmers, and comprises—

☆ a monthly service charge (a fixed amount) which reimburses Escom partly for consumer-related costs,

☆ a fixed demand charge per kVA (or kV in the Rand and OFS Undertaking) based on the maximum demand during a particular month to recover load-related costs or part thereof, and

☆ an energy charge per kW.h of electricity consumed.

The small power user tariff (Tariff B) is applicable to small power users (especially farmers and also domestic users not situated in urban areas) and comprises—

☆ a monthly service charge for every supply point to cover consumer-related costs,

☆ a charge at a high rate for the first 500 kW.h consumed per month (for every supply point) and

☆ a charge at a lower rate for the balance of kW.h consumed during the month.

Farmers receiving a supply exceeding 100 kW.h or kVA can apply for large power user tariffs, but then every supply point will be regarded as a separate consumer and the higher service charge in Tariff A will apply except in the Rand and Orange Free State Undertaking where minimum charges apply.

In addition to the above, extension charges are also levied in certain cases.

As far as farmers are concerned it is Escom's practice to provide the necessary capital to erect the power line to the farm and to equip it up to the connection point. If distribution and transmission costs to supply a group of consumers exceed the amount provided for these in the general tariff, extension charges are levied.

Extension charges cannot be recovered by the undertaking through the standard tariffs, as there is only one tariff structure for an undertaking. Because capital expenditure normally covered by the standard tariff is low compared with that for individual farmers while the quantity of electricity used by them is limited and relatively little in relation to the capital costs of the connection, extension charges are levied.

As far as tariffs are concerned the following is important:

☆ The average cost per kW.h sold by Escom. Total annual working costs comprise capital-related, fuel and general costs and the average cost per kW.h can be calculated by dividing these costs by the total kW.h sold during the year. To arrive at the lowest average cost per kW.h, the average cost mentioned above should be as low as possible and the loading of the total system as high as possible. These objectives are extremely important to keep average tariffs as low as possible.

☆ The broad constraints imposed by the Electricity Act in respect of separate accounts, no surpluses or deficits in the various undertakings and the requirement that one group of consumers should not be subsidised by another have a marked effect on tariffs. These limitations should be reconsidered in the light of changed conditions.

☆ The question is whether current tariff structures, which have been developed over the years against the background of constraints by the Electricity Act and other environmental conditions, are the most suitable for South Africa under present circumstances.

Tariffs as a means of achieving the lowest cost per kW.h sold by Escom

Different aspects of the problem to achieve the lowest average cost per kW.h by keeping fuel costs and general costs as low as possible have been dealt with previously in this report.

Tariffs can be used in supplementing methods to limit the above costs per kW.h by—

- ★ keeping capital-related costs per kW.h as low as possible. Capital-related costs basically comprise two components:

- Costs related to present works in operation, and
- costs related to works under construction, but not yet in operation.

Both these components of capital-related costs per kW.h must therefore be restricted.

- ★ Giving consumers an incentive to—

- limit their demand at the time when the Escom system experiences its maximum load,
- encourage consumption at suitable times, and
- to save *electricity* and in this manner limit the growth rate of the system and capital-related costs associated with works under construction but not yet in operation.

Capital-related costs associated with *current works in operation* should undeniably be recovered from current tariffs.

Capital-related costs are associated with the maximum demand or peak load that is reached for a period of one hour during the year and for which sufficient sent-out capacity must be available.

The load duration graph for 1982, Graph 10 (Step 1 of Phase 2) indicates the following *in this respect*:

- ★ The maximum demand on the Escom system was 15 532 MW at 11h00 on 2 July 1982 and the minimum demand for one hour was 7 024 MW.
- ★ For 95 % of the hours in 1982 demand was less than 14 500 MW, for 90 % less than 13 650 MW and for 50 % less than 11 830 MW.
- ★ If the 1 882 MW of the gas-turbine, hydro-electric and pumped-storage stations had been utilised at the time of the one-hour peak demand of 15 532 MW, the coal-fired power stations would have had to supply only about 13 650 MW. Capital-related costs per MW of the gas-turbine, hydro-electric and pumped-storage stations are high, but their utilisation for peak-demand only is low and therefore costs per kW.h are high.

Average capital-related costs per kW are therefore determined by—

- ★ total capital costs of generating capacity required to supply the maximum demand, and
- ★ the *average utilisation* for this demand.

$$\text{kW.h sold} \times 100$$

The system load factor $\frac{\text{assigned sent-out rating} \times \text{hours in year}}{\text{kW.h sold} \times 100}$, measures the average utilisation of the sent-out capacity of the system.

The integrated load factor of the Escom system during the period 1967–1983 varied between the exceptionally high percentages of 75,1 % and 77,6 %. This high system load factor is of the highest in the world and can be attributed to the high base load and load factor of the South African gold mining sector.

Apart from this factor the high load factor results from the following:

- ★ The typical summer-day and winter-day load patterns with a relatively even plateau demand between 08h00 and 21h00, a minimum demand period from 24h00 to 06h00, steeply rising and declining demand between 05h00 and 09h00 and between 21h00 and 24h00 respectively and a summer-day peak that is reached at about 09h00 but does not rise far beyond the plateau.
- ★ The typical winter-day load pattern that holds for approximately 5 months a year exceeded the typical summer-day load pattern by 1000–1 500 MW during the period 1980–1983 and normally has two distinct peak demand periods, namely at 09h00 and at 19h00.
- ★ The maximum load demand patterns for all four years indicate that the two daily winter peak demands, i.e. at 09h00 and at 19h00, can exceed the “average” typical winter-day peaks by 800 to 1 350 MW.
- ★ The load patterns for Saturdays and especially Sundays are in summer and in winter much lower than the patterns for Mondays to Fridays which incidentally show a load factor of 90 % for these days.

Despite the high load factor and the circumstances indicated by the various load patterns, it would appear that three possibilities exist either to improve the high system load factor or to maintain it in the future, namely—

- ☆ special tariffs for large power users who at Escom's request will immediately decrease their demands on an agreed basis,
- ☆ switching-off of domestic geysers when necessary during periods of peak load,
- ☆ tariffs to encourage electricity consumption in valley periods during evenings and over week-ends.

In various countries, e.g. Australia and the United Kingdom, a three-tier tariff structure is applied to industries, domestic and commercial consumers. The structure for Australia is shown in Graph 19.

This three-tier tariff structure is based on industries (and mines) using electricity throughout the day and night, domestic consumers to a less extent during the day and night, and commercial consumers especially during the day, and on capital-related costs differing for electricity generated during different times of the day and night.

The inclusion in electricity tariffs of capital-related costs associated with works under construction but not in operation (as a whole or partly) is a subject on which there is considerable difference of opinion. The argument raised is that the present generation pays for electricity generating plant for future generations. The counter-argument is that past generations have also paid for electricity generating plant for the present generation and that the utility must acquire funds for the establishment of capacity for the future.

The most important reason why this difference of opinion has become vitally important during the past few years, is that the *percentage of electricity tariffs* contributed to the Capital Development Fund has increased from

- ☆ 5,6 % in 1973, to
- ☆ 32,5 % in 1979, and
- ☆ 29,1 % in 1982.

It is clear that the extent to which future consumers are financed by present consumers from tariffs has changed radically since 1973, and forms the *basis* for the current differences of opinion.

Methods of limiting this addition to tariffs are to save electricity, thus restricting the growth rate of the system and keeping the capital costs per MW of new capacity in check.

Saving electricity and restricting the growth rate of the system can possibly be achieved most effectively by a price policy.

Electricity tariffs should be implemented to achieve efficient consumption and also to make possible the *financing of new capacity for the future*. The more efficient use of electricity reduces the degree of investment in additional future generating capacity.

Regarding the approach to electricity tariffs, different principles and ideas have come strongly to the fore in various countries, especially since 1973.

Two of these principles and ideas are the following:

- ☆ The electricity supply industry in Britain is of the opinion that long-term marginal costs of supplying electricity should as far as practicable be reflected in electricity prices, so that the total costs of the supply industry can be recovered and a reasonable return on investments obtained. This view is supported by the very strong argument that in an era of energy conservation it is wrong to subsidise energy. The reasons why this approach is unacceptable to South Africa have been dealt with previously.
- ☆ It is now generally accepted that electricity tariffs are an important means to establish load management through time-of-day tariffs and contractual load management by consumers who at the time of peak load react to instructions from the supplier to limit peaks and to ensure a high load factor.

Effects of the broad constraints of the Electricity Act on tariffs

The constraints of the Electricity Act on tariffs in the various undertakings have a historical background.

Over the years the boundaries of the Escom undertakings have developed with the Escom system. These boundaries were originally determined as strips adjacent to railway lines and circles around towns. A switch-over to the present system of determining areas by farm boundaries was made only later. The boundaries of the various undertakings were therefore determined subjectively—mainly for historical reasons.

Over the years circumstances in the various undertakings have developed to such an extent that the position at the end of 1982 and the changes during 1972-1982 can be summed up as follows.

The supply areas of the Rand and Orange Free State and Cape Northern Undertakings were at the end of 1982 of comparable size in terms of square kilometres, namely 264 400 and 244 100 respectively, while the Natal, Cape Western and Eastern Transvaal Undertakings supplied areas of the same size, namely 106 700, 116 800 and 95 100 square kilometres respectively. The Orange River Undertaking which is 146 800 square kilometres in size currently supplies an area one and a half times the size of the Cape Western Undertaking, while the Border Undertaking of 55 400 square kilometres supplies an area approximately half the size of the Cape Western Undertaking.

Network length in kilometre per GW.h sold is a good indicator of the order of differences in the regional densities of electricity demand. In 1982 this indicator varied between 4,41 for the Border Undertaking and 0,80 for the Rand and Orange Free State Undertaking.

The system load factor of a distribution undertaking has a major effect on the cost per unit of electricity consumed. Although the load factors of Cape Northern, Rand and Orange Free State, Eastern Transvaal, Cape Western and Orange River Undertakings varied only between 69,3 % and 71,9 % in 1982, the figures for the Natal and Border Undertakings were 73,1 % and only 58,8 % respectively. Escom's undertakings were grouped as follows by an analysis of the market share:

- ★ Rand and Orange Free State Undertaking with 56,2 % of the total Escom sales in 1982 was the biggest seller.
- ★ The market share of the Natal Undertaking was 16,6 % in 1982, and
- ★ the market share of the Eastern Transvaal Undertaking was 14,6 % in 1982.
- ★ *The above-mentioned three undertakings in 1982 were responsible for 87,4 % of the total electricity sales by all undertakings.*
- ★ The market share of the Cape Western Undertaking was 7,3 % of Escom sales in 1982, while
- ★ the Cape Northern Undertaking had a market share of 2,8 % in 1982, and
- ★ the Orange River and Cape Eastern Undertakings shared only 1,4 % of the total Escom market in 1982, while the *market share* of the Border Undertaking was only 1,1 %.

Total costs to consumers of electricity in cents per kW.h sold by the various undertakings in 1972 and 1982 were as follows:

Undertaking	Total costs to consumers in cents per kW.h			
	1972	1982	% increase	
Rand and Orange Free State	0,5222	2,634	1	404
Natal.....	0,7140	2,724		288
Eastern Transvaal	0,5360	2,763		416
Cape Western.....	1,0948	3,614	2	230
Cape Northern.....	0,9059	3,860		326
Orange River and Cape Eastern		3,477		
Border	1,2724	4,323	3	239

Although total costs to consumers in cents per kW.h sold increased at different rates during the period 1972-1982, namely between 230 % and 416 %, *three average tariff structures* as indicated above emerged for the various undertakings in 1982.

For many years before 1972 Escom's undertakings were mutually independent and the provisions of the Electricity Act regarding separate accounts were appropriate.

Currently the undertakings are interconnected by a national grid and the question arises whether these provisions should still apply.

Since 1972 when the Central Generating Undertaking was established electricity has been supplied by this undertaking to the distribution undertakings.

Although the major portion of the power for the Central Generating Undertaking is generated by coal-fired power stations in the Eastern Transvaal and transmission costs are added to generation costs to determine selling prices to the distribution undertakings, the position has changed now that Koeberg nuclear power station has been commissioned since power will also be fed into the grid from the South from 1984.

Although it is accepted that the cost of power to the consumer should be related as closely as possible to the actual cost of supply to him to avoid cross-subsidising, information submitted to the Commission demonstrates that in practice there is a material departure from this principle.⁽²²⁾

An important reason for this is the provisions of the Electricity Act regarding separate undertakings.

"Die gevolge van die huidige beleid ten opsigte van tariefbepaling kan geïllustreer word deur na van die uiterste verskille te kyk, nl. dié tussen die Oostelike Transvaal en die Grens. Vir die doel kwoteer ek hierna syfers afgelei van Evkom se Elektrisiteitsvoorsieningsrekening vir 1982. Die syfers gee 'n aanduiding van gemiddelde koste van elektrisiteit in sent per kilowatt-uur:

DEBIETE IN c/kW.h VAN VERKOPE

	Oos-Transvaal	Grens	Verskille
Ondernemingskoste			
Bedryf	0,22	0,81	0,59
Lenings	0,27	0,50	0,23
Transmissie	0,00	0,11	0,11
Subtotaal	0,49	1,42	0,93
Verpoelde koste			
Opwekking	1,79	2,15	0,36
Hoofkantoor	0,01	0,02	0,01
Fondsbydrae	0,47	0,47	0,00
Subtotaal	2,27	2,64	0,37
Groototaal	2,76	4,06	1,30 ⁽²²⁾

The following statement was also made:

"Die gemiddelde verbruiker in Oos-Londen betaal dus ongeveer 47 % meer vir sy elektriese krag as die gemiddelde verbruiker in Witbank.

Van die verskil van 1,30c/kW.h word slegs 0,11c verteenwoordig deur bykomende transmissiekoste. Dit kos EVKOM dus in werklikheid slegs ongeveer 0,11c/kW.h meer om krag in Oos-Londen te lewer as in Witbank, wat minder as 4 % van die gemiddeld vir EVKOM in sy geheel (2,864c/kW.h) bedra.

Om verskeie redes is bostaande syfers nie direk toepaslik op vergelykbare verbruikers op die twee plekke nie. 'n Groot nywerheidsverbruiker in Oos-Londen betaal eger in die tweede helfte van 1983 ongeveer 38 % meer as 'n ooreenstemmende groot nywerheidsverbruiker in Witbank, terwyl die werklike verskil in koste van lewering deur EVKOM aan die betrokke nywerars slegs van die orde van 4 % is.

Die rede vir die werklike groot verskil is hoofsaaklik dat die verhouding tussen *plattelandse en stedelike verbruik* in die geval van die Grens-onderneming veel hoër is as in die geval van die Oos-Transvaalse Onderneming. Die relatief *hoë bedryfskoste van plattelandse voorsiening*, en die leningskoste verbonde aan die deel van die *plattelandse netwerk* wat nie by wyse van uitbreidingsgelde van verbruikers verhaal word nie, het dus 'n veel groter uitwerking op die basiese tarief vir die Grens as vir Oos-Transvaal.

Tweedens was die totale kragverbruik in die Grens ongeveer 7,4 % van die kragverbruik in die Oos-Transvaalse Onderneming. Die Oos-Transvaalse verbruiker geniet dus die voordeel van ekonomie van skaal.

Derdens is die gemiddelde lasfaktor in die Grens laer as dié in Oos-Transvaal omdat myne en nywerars in verhouding met die leweringskapasiteit meer krag verbruik as plattelandse verbruikers."

Mr Malan voiced the opinion that the above circumstances had in fact little to do with the difference in costs to Escom to supply identical consumers in Witbank and East London.

He phrased it as follows:

"Opsommend kan gesê word dat die vernaamste rede waarom die nywerheidsverbruiker in Oos-Londen meer vir sy krag moet betaal as 'n ooreenstemmende verbruiker in Witbank, nie die verskil in koste van lewering vir EVKOM is nie, maar eerder die indeling van ander kostes, wat eintlik niks met sodanige nywerars te doen het nie, binne die bestaande ondernemings van EVKOM.

⁽²²⁾ Commissioner D. J. Malan.

The figures quoted by Mr Malan were furnished to him by Escom, but do not necessarily agree with the figures on the previous page due to the method of calculation. However, this does not affect the principles involved.

Dieselfde gevolgtrekking geld t.o.v. 'n vergelyking tussen Wes-Kaap en die Rand, alhoewel ietwat minder sterk. Interessantheidshalwe toon ek hierna die vergelykende syfers vir die Wes-Kaapse Onderneming en die Randse en OVS Onderneming.

DEBIETE IN c/kw.h VAN VERKOPE

	Rand en O.V.S.	Wes-Kaap	Verskille
Ondernemingskoste			
Bedryf.....	0,15	0,56	0,41
Lenings.....	0,21	0,45	0,24
Transmissie.....	0,00	0,25	0,25
Subtotaal.....	0,36	1,26	0,90
Verpoelde koste			
Opwekking.....	1,86	1,96	0,10
Hoofkantoor.....	0,01	0,02	0,01
Fondsbydrae.....	0,47	0,47	0,00
Subtotaal.....	2,34	2,45	0,11
Groototaal.....	2,70	3,71	1,01

Die ekwivalent van waardevermindering in die geval van EVKOM is die voorsiening vir delging van en rente op lenings aangegaan om kapitaalwerke te finansier soos voorgeskryf deur die Elektrisiteitswet.

Dit saamgelees met die vereiste van verpoeling en verhaling van koste in elke onderneming afsonderlik, bring mee dat lenings—en dus alle betalings t.o.v. die lenings—aan spesifieke bates gekoppel moet word. Dit veroorsaak addisionele, en na my mening vermybare, administrasiekoste.

'n Onwenslike resultaat van die huidige basis van verpoeling van sekere koste binne ondernemings, is dat betreklike groot verskille in elektrisiteitstariewe voorkom tussen verbruikers wat naby mekaar opereer, maar in verskillende ondernemings. Dit lyk onregverdig en lei tot griewe."

Mr Malan's chief proposals can be summed up as follows:

"Alle verwysings in die Elektrisiteitswet na afsonderlike ondernemings binne EVKOM moet verwyder word.

Eskom moet 'n tariefbeleid aanvaar wat so na as prakties uitvoerbaar kom aan lewering teen koste. Dit kan langs die volgende weg bereik word.

Enheidskoste word bepaal vir kragopwekking, hoofkantoor koste, transmissie per kilometer teen verskillende spannings, administrasie volgens soort en grootte van verbruikers, ens, die eenheidskoste sal waar toepaslik tussen maksimum aanvraag en werklike verbruik onderskei.

Ten opsigte van transmissie kan die koste van transmissie tot by sekere verwysingspunte bepaal word, en transmissiekoste vir die uiteindelijke verbruiker kan gelyk wees aan die koste tot by die naaste verwysingspunt plus bykomende koste tussen die verwysingspunt en die verbruiker.

Die beginsel van verpoeling van sekere kostes kan behou word, maar slegs wanneer die items wat verpoel word, gelyksoortig is. Administrasiekoste en leningskoste verbonde aan alle plattelandse voorsiening kan vir hierdie doel oorweeg word; dalk moet plattelandse verbruikers egter volgens digtheid in groepe verdeel word met die oog op verpoeling van sodanige kostes.

Die huidige verpoeling op 'n geografiese basis moet egter verwerp word omdat dit, soos aange-toon, ernstige afwykings van die benadering van lewering teen koste meebreng."

Suitability of the current tariff structure

Before the suitability of Eskom's current tariff structure can be evaluated, attention should be given to the so-called extension charges and coal price adjustments. (These extension charges levied in addition to the standard tariff serve a dual purpose, according to Eskom. These charges limit the financial burden placed on current consumers by new consumers and ensure that the development of Eskom's supply system remains on an economic basis.)

Extension charges make a relatively small contribution to Eskom's total income. During 1982 the contribution rate of extension charges to income acquired from the group to consumers concerned was as follows:

	%
Tariff A (large power users).....	3,4
Tariff B (urban small power users).....	6,7
Tariff C (urban domestic power users).....	1,1
Tariff D (rural small power users).....	13,5

For Escom as a whole the income from extension charges for 1982 was R98,4 million which represented 3,7 % of the total income of R2 695,4 million for the year.

Tariff A (large power users) was responsible for approximately 97 % of Escom's electricity sales, while the contribution by other sales was 0,6 % for Tariff B (urban small power users), 1,1 % for Tariff C (urban domestic power users) and 1,3 % for Tariff D (rural small power users).

Because 97 % of all electricity sales in 1982 was made to Tariff A (large power users) it is interesting to note that if *all extension charges were levied on the same contribution-rate-to-income basis*, these consumers would have paid approximately 0,3 % more per kW.h.

Normally Escom's electricity tariffs are adjusted once a year with effect from January and three months notice is given of these adjustments. In exceptional circumstances even more than one tariff increase has been implemented in one year with shorter periods of notice.

However, the standard Escom mechanism for determining tariffs also includes a quarterly adjustment of energy charges in accordance with changes in the average coal price paid by Escom.

To judge their suitability Escom's tariff structures should be rated against the background of policy and objectives in force during the period in which they applied.

Escom's objective in providing an abundant supply of electricity at cost wherever it is needed for the economic growth of South Africa was part of the country's policy of cheap energy which was also responsible, inter alia, for the low coal prices in the sixties and early seventies.

Although this policy has enabled South Africa to build up the energy-intensive industries and exports in the late sixties and seventies, the low electricity prices *were not much of an incentive to save electricity*.

Even when the price of electricity began to rise steeply after 1975, it started from a low level. The chief incentive to save, namely *exceptionally high prices*, did not really play a role after 1975 to eliminate inefficient use of electricity.

However, electricity consumption has grown over the years at a higher rate than that of the economy and this high growth rate was and still is responsible for the ever-increasing capital-related costs per kW.h.

If long-term marginal costs of supplying electricity were to be applied in South Africa now, as is planned by the government in Britain, *price increases would be high over the next few years* and would undoubtedly have the effect of limiting consumption and encouraging saving.

South Africa is compelled to retain a reasonable price of electricity as long as possible, because of its strategic mineral industry.

This emphasises South Africa's dilemma about electricity prices:

- ☆ "Long-term marginal" prices are needed to ensure saving, but the implementation of this method of determining electricity prices will increase prices to such a degree that
- ☆ energy-intensive industries and exports—and because of their strategic importance also the economy—will be harmed to such an extent that it will not be acceptable in the short-term.

Savings

Therefore ways and means should be found to achieve maximum savings as soon as possible in spite of current prices of electricity.

In this respect the following will be of importance:

- ☆ Escom should publish annual electricity tariff increases in January for *each* of the following five years together with previous forecasts and actual figures, so that consumers will know what to expect and how to adapt their calculations and decisions.
- ☆ Electricity price increases must be announced only once a year, in January, must include the coal price adjustment for the following year, and must apply for the whole year.
- ☆ Escom should make every endeavour to persuade consumers to save electricity and should abolish its "*policy of abundant cheap electricity*" if this encourages wastefulness.
- ☆ It is clear that the number of distribution undertakings will have to be reduced from the current seven to three to eliminate administration costs and other irregularities. In this regard it is Escom's objective to amalgamate Border and Orange River Undertakings into "Eastern Cape Undertaking" and Cape Western and Cape Northern Undertakings into "Northern and Western Cape Undertaking". Escom is also considering the amalgamation of Natal, Eastern Transvaal and Rand and Orange Free State Undertakings.

☆ The Commission accepts that although the costs of electricity to the consumer should be closely related to actual costs of supply to him so that cross subsidising is avoided, practice essentially departs from this principle due to the provisions of the Electricity Act regarding separate undertakings. Changed circumstances make it clear that:

- All references in the Electricity Act to separate undertakings within Escom should be removed.
- Unit costs of elements of cost such as power generation, head office costs, transmission costs per kilometre at different voltages, and administration costs should be determined for a small number of consumers of various types and sizes to distinguish where applicable between maximum demand and actual consumption.
- Unit costs of transmission up to a reference point and unit costs of distribution from the reference point to the consumer can be calculated on the basis of costs per kilometre for different voltages and loading.
- The principle of pooling can be applied in accordance with the above guidelines so that tariffs for individual groups of consumers can be based on average pooled costs.
- Administration and loan costs associated with rural supply can possibly be divided into a small number of groups based on density of consumption.

☆ This approach will abolish the pooling of costs on a geographical basis, and takes into consideration developing trends and new circumstances that developed with the switch-over to one system, and is in line with the idea of reducing the number of distribution undertakings.

☆ Escom's two-component electricity tariffs, where *one component* is based on variable costs (such as fuel costs, maintenance and operating costs, i.e. costs associated with energy consumption) and the *other component* is based on the cost of equipment to cope with the load at times of peak demand, have certain shortcomings. Regarding individual consumers on a monthly payment cycle this two-component cost structure (energy and maximum demand) leads to a tariff that can be measured and administered with relative ease. This system suffers the fundamental shortcoming that the consumer does not pay for his contribution to system peak load, but for his own peak demand although these two peaks may be in two entirely different periods of the day or even day of the year. That part of the tariff that is based on maximum demand does have a limiting effect on average demand but not necessarily on peak load. For this reason the Commission of Inquiry suggests that Escom should consider the following tariffs.

☆ Escom, having a small number of large consumers, is in the ideal position to make special arrangements with consumers and to enter into contractual commitments so that load management can be effected, as consumers at the time of peak load can limit their demand on instruction from Escom to limit peaks and ensure a high load factor.

☆ Although time-of-day tariffs would probably have limited application, both Escom and consumers can benefit by increasing electricity consumption during valley periods and decreasing consumption during peak times. Certain large consumers may be able to achieve lower consumption during winter months and peak periods and higher consumption at night and during weekends.

☆ A system must be considered whereby water heaters of domestic consumers are switched off during peak periods by a signal from Escom.

☆ The possibility of special tariffs for irrigation at night must also be investigated.

Amendment of the Electricity Act in respect of the separate accounts, and the profits and losses of every individual undertaking, and a *suitable basis for pooling costs* will provide the necessary flexibility to comply with three requirements, namely:

- ☆ That one group of consumers does not subsidise another.
- ☆ High occupation of generating capacity and lower average electricity price.
- ☆ Saving of electricity.

In the past tariff structures were developed and applied by Escom within the constraints of the Electricity Act. Changed circumstances have caused new tariff structures to be developed. In view of the above analysis it is clear that Escom must be allowed greater flexibility to develop tariff structures complying with the requirements and aimed at the *economic justification* of load management. It should particularly be borne in mind that in the control structure recommended by the Commission of Inquiry the consumer body will be represented and will be consulted in the determination of the tariff structures.

STEP 3: ANALYSIS OF TRENDS AND PAST AND PRESENT BASIS FOR SUCCESS IN THE INDUSTRY

Continuous growth in the demand for electricity has enabled Escom, within the framework of the Electricity Act, to develop over the years into a national and monopolistic electricity generating and supply undertaking that sent out 93,6 % of South Africa's electricity in 1982 over an interconnected grid to most parts of the country.

Escom also took advantage of economies of scale and used the latest improved technology.

The importance of the application of this improved technology becomes evident when it is realised that the distribution of costs to supply electricity was as follows:

- ★ 50 % capital-related costs,
- ★ 25 % fuel costs, and
- ★ 25 % other costs.

Escom's policy to limit coal costs per kW.h by increasing thermal efficiency over the years has born fruit.

However, to achieve this high thermal efficiency with large high pressure and temperature sets, the percentage availability of generating sets was lowered and construction periods were extended considerably.

During the first period, 1950–1974, Escom's policy was applied with particular success and a cheap, reliable and abundant electricity supply was made available wherever and whenever the demand for it arose, while the average price of electricity increased by only 3,8 % per annum and electricity sales by 8,81 % per annum.

The chief reasons for the trend of a slowly increasing selling price during 1950–1974 were the continuously rising thermal efficiency and the slight increase in the price of coal, while inflation and interest rates, and the extent of annual wages increases, were reasonable.

During this period Escom also had great success with its policy of applying improved technology.

Application of economies of scale had the effect that—

- ★ fixed assets in operation required per million kW.h sold, despite inflation, increased from only R28 010 in 1960 to R35 130 in 1974, and that
- ★ fixed capital invested in works under construction in 1974 amounted to only 17,3 % of the total fixed assets.

The period 1974–1982, i.e. the years after the oil crisis, was characterised by changed economic conditions, low economic, growth rates, high inflation rates, high interest rates and, for Escom, by—

- ★ a high average annual growth rate of 19,32 % per annum in the selling price of electricity while electricity sales increased by 7,82 % per annum,
- ★ the price of coal which showed a strong upward tendency from R2,92 per ton in 1974 to R11,75 per ton in 1982,
- ★ compounded wage increases averaging 10,2 % per annum for all employees for the period 1977–1982.

Since the *middle of the seventies* high technology, high costs of inflation, high costs of financing, long lead times, exchange rate fluctuations of the rand against other monetary units, air pollution control, security measures, premium for supporting South African industries and premium for the use of Conference Lines all contributed to the substantial marginal increase, taken over the previous five year period, of Escom's assets in operation per million kW.h sold, from

- ★ R36 040 per million kW.h sold in 1975, to
- ★ R166 730 per million kW.h sold in 1982.

While Escom's total assets in operation slightly more than *doubled* in the nine year period 1967–1974, they increased *sixfold* in the following nine years.

Works under construction as a percentage of fixed assets in operation increased from 17,3 % on 31 December 1973 to 64,0 % on 31 December 1982 when the value of works under construction amounted to R5 016 600 000 and fixed assets in operation to R7 689 400 000.

Assets not yet in operation increased from R244 million, or 12 % of the total assets in 1973, to R5 016,6 million, or 35 % of the total assets in 1982.

In the period 1973–1982 a *massive* shift took place in Escom's application of funds towards assets not yet in operation, with the result that borrowed capital, which represented 74 % of assets in operation in 1973, increased to 110 % of these assets in 1982 and thus caused a considerable weakening of security.

The problem of financing the capital programme, and assets in the balance sheet but not yet in operation, is not a short-term transient one because Escom is planning capital expenditure varying between R3 284 million and R5 042 million per annum for the following five years.

An evaluation of the policy to use improved technology to limit costs and utilise economies of scale reveals that after years of exceptional advances towards the theoretical maximum thermal efficiency of approximately 42 %, only marginal improvement at high cost is now possible.

Up to 1974 exceptional success was achieved with this approach and after 1974 only limited success was possible.

Events since 1974 gave rise to the question whether Escom's objective of providing an abundant and reliable supply of electricity at cost is still valid and appropriate.

Developments in the world and in South Africa required that a policy of energy and electricity conservation be followed.

STEP 4: WITH REFERENCE TO THE PAST BASIS OF SUCCESS BY THE ENTERPRISE AN EVALUATION SHOULD BE MADE TO DETERMINE WHETHER IT IS STILL VALID

It is clear that the previous basis for success in the industry did not give the same results for the period 1974–1982, and it is doubtful whether it would apply to a great extent in the future. This concerns not only Escom, but also America as was revealed by an article which appeared in International Business Week of 23 May 1984 entitled "Are Utilities Obsolete? A Troubled System Faces Radical Change".

"For years utilities prospered by delivering on their promise. As new power plants grew in size from a few megawatts in the early days to 800 MW and more by the 1970s, real electricity prices declined by 70 % from 1945 to 1970. 'In the 1950s and 1960s, it appeared there were enormous economies of scale', recalls Alfred E. Kahn, a professor of economics at Cornell University, former chairman of the New York Public Service Commission, and a dean of utility regulation. 'We became technical optimists in energy'. Spurred by declining prices, electricity demand grew faster than gross lowering rates while keeping utility profits healthy

Encouraged by yearly growth as high as 7 % to 10 % by the late 1960s—and by the lure of the still-cheaper power expected from a new generation of nuclear plants—utilities did what came naturally: They built some more, and they built bigger.

Then came the Arab oil embargo upending the energy world. At the same time, concern over the environmental impact of conventional power plants increased, as did opposition to nuclear ones, reaching a fevered pitch after Three Mile Island in 1979. Controls forced on the industry in response to the outcry started adding greatly to the cost of new plants. As electricity prices began to rise, demand growth slackened.

Diminishing Returns

A more mundane, but equally important, trend also began to show up: Big new plants were no longer delivering greater efficiency than the ones they replaced. After years of impressive strides toward the theoretical maximum in performance, the efforts of power engineers reached the point of diminishing returns. The built-in cost gain they had come to expect simply by putting new equipment to work was gone. Instead, reliability suffered and stretched-out construction undermined expected savings in fuel costs.

Like a gathering storm, these fundamental changes gradually built force. Now, suddenly, the skies have darkened. The blackest cloud: 'rate shock', the sharp price increase that, under traditional regulatory practice, comes when an expensive new plant starts up and is finally added to the capital base used to compute rates. A few coal plants now in the works will cause hikes of 50%. Nuclear plants, with higher front-end costs and massive cost overruns, will deliver far

greater shocks . . . Frequently, the incentive to rein in costs was dulled by cost-plus formulas. Then, too, the money spent to build a plant is traditionally not put into the rate base until—and unless—the plant starts up. Inevitably, some companies plodded on with projects they might otherwise have scrapped . . .

Now, even many utilities promote conservation as a better investment than building a new power plant. Instead of lowering living standards, conservation in the form of more efficient appliances, new forms of lighting, computerized energy management systems, and other technological improvements have hacked away at demand growth without cramping lifestyles.

In the ten years following the first oil shock, electricity demand grew only 2.7 % a year. To be sure, the falloff partly reflected a sequence of serious recessions and demand did jump 8.2 % in the first quarter of this year as a scrambling economy expanded by 8.3 %. But this rebound was from a depressed base, and few forecasters see consumption growing more than 2 % to 3 % a year over the long run; some see a lot less—even a decline. Population growth is still slowing, high-tech and service industries continue to displace energy-intensive ones, and, predicts the EEI's Bauer, 'there will be much more conservation'.

The world of competition is on the horizon, fewer and fewer argue with the proposition that large generating projects are a thing of the past. The numbers speak for themselves: since 1972, some 100 nuclear plants have been cancelled, and so have a few coal plants at early stages of construction. No nuclear plant has been ordered since 1978. Yet nationwide, reserve margins remain about 40 % above the utilities' peak requirements . . .

But even if some utilities need to add capacity, smaller plants—perhaps 200 MW to 300 MW—stand a far greater chance to win approval these days because they require less capital and provide more flexibility in meeting uncertain demand. 'In the past we were bringing capacity into the system in large lumps', says Vepco's Berry. 'Now we can't afford to have the excess'.

Pocket of Strength

Amid all these changes, some utilities have radically altered their attitudes toward growth. In 1974, caught up in what may well have been a harbinger of the present financial crisis, Consolidated Edison Co. of New York shocked Wall Street by skipping one quarterly dividend. It has since become a pocket of strength in the industry. The reason: The utility has seen its demand grow less than 1 % a year—in part because of its efforts to encourage conservation—and has thus not had to raise the money to build more plants. Although, like other power companies, it still has outages caused by equipment breakdowns, Con Ed now has access to practically twice as much power as it needed during last summer's heat wave.

The utility's sticky financial situation would be more apparent were it not for a paper income entry called Allowance for Funds used During Construction (AFDC). This accounting device was created to make up for the profits they are not allowed to earn on money tied up in unfinished projects. Given the conviction that the plants would eventually be rolled into the rate base, the concept was valid enough. But with the new perception that many of these plants may not make it, Wall Street has begun discounting AFDC's by focusing on the 'quality' of a utility's earnings. The more AFDC, the lower the quality. 'For five years Public Service of New Hampshire has had negative cash flow,' notes one analyst. Yet 'the more they borrow—it looks like their income is going up'.

Cushioning Rate Shock

Faced with a growing cash crunch and the prospect of having to spread finished plant costs over a smaller-than-expected customer load, utilities have lobbied hard to put a portion of their costs of construction work in progress (CWIP) in their rate bases before their plants come on line. Hoping to cushion rate shock, a growing number of states have complied. But opponents, charging that CWIP just encourages utilities to continue with poor investments, are trying to kill the idea where it has taken hold . . .

Investors stand to lose even more, of course, if bankruptcies cannot be averted. Thus, a vicious cycle has set in: Fears that some multibillion-dollar project will collapse on the company involved have clobbered the stocks of many utilities now building plants—increasing the chance of failures as investors desert. 'The capacity is there in the capital markets to finish these plants' says Morgan Stanley & Co., principal Robert W. Jones. 'The problem is that investors have been stung'. In the bond market, major banks, with billions in unsecured loans to utilities, have also backed off."

PHASE 3

STEP 1: EVALUATE POTENTIAL EFFECTIVENESS OF PRESENT STRATEGY FOR THE FUTURE

During the years 1950–1974 Escom's policy was implemented with remarkable success.

Since the oil crisis of 1973 conditions have changed radically and affected Escom's performance considerably during the period 1974–1982.

In this period environmental conditions were characterised by high inflation rates, wage, coal price and interest rates increases while greater demands were made regarding pollution-control and the support of South African industries, and exchange rate fluctuations also had a marked detrimental effect increasing capital costs per MW additional capacity and costs per kW.h.

It has also become clear that after these years in which exceptional progress was made to increase thermal efficiency, only marginal improvements at high cost can now be achieved and utilisation of economies of scale as a method of limiting capital costs of generating plant has apparently come to an end. This is the finding in various other countries.

This substantial marginal increase since 1974 in Escom's assets in operation per million kW.h sold and the fact that electricity sales and the creation of generating capacity continued to increase at a high annual growth rate, caused Escom's total assets to increase sevenfold from R2 055 million on 31 December 1973 to R14 388 million on 31 December 1982.

Long power station construction periods together with a steep rise in the price per MW generating capacity caused a massive shift in the application of Escom's funds towards assets not yet in operation.

In the process a funding problem which is not of a transient nature was created and Escom's selling price of electricity increased by an average of 19,32 % per annum during the period 1974–1982 while the average increase in the inflation rate was 14,4 % per annum for the same period.

While Escom's capital requirements have increased, a decrease in savings characterised the South African economy since 1980 and Escom's capital expenditure in 1982 and 1983 amounted to 41,8 % and 34,4 % respectively of the Republic's savings less depreciation. In the long-term continued growth by Escom under current mechanisms is possible only if saving is restored.

It is against this background that the potential effectiveness of the present strategy for the future was determined by the preparation of a zero plan.

The zero plan can be defined as the projected results springing from the current strategic plan which includes only accepted projects. This plan was based on Escom's estimate of a growth rate in electricity consumption slightly exceeding 7 % per annum up to 1990 and thereafter at a lower growth rate.⁽²⁰⁾ Because the forecast by the Commission of Inquiry shows a growth rate of 5 % per annum, a zero plan on this basis was also prepared.

If, under the current economic conditions, it should be decided to accept the 5 % annual electricity growth plan, Escom will have to draw up new construction programmes, capital programmes, and plans for financing and tariff increases taking into account its contractual commitments and possible contract amendment costs.

Two possibilities in this respect have been investigated by Escom:

- ☆ In the first plan it has been assumed that sets 5 and 6 at Tutuka and Lethabo and sets 4, 5 and 6 at Matimba would be deferred to the last date provided for in existing contracts, and that Kendal and Majuba would be cancelled outright and subsequently started afresh. This plan would, due to the cancellation of Kendal and Majuba, result in costs that can be determined only through negotiations with the contractors as existing contracts do not contain cancellation options for sets 1, 2 and 3. As these costs would probably be considerable, and the first three sets of these stations are scheduled for commissioning in three and five years time respectively, Escom is of the opinion that this plan cannot be justified unless the load growth is going to be extremely low.
- ☆ In the second plan for a 5 % load growth it has been assumed that sets 1, 2 and 3 at Kendal and Majuba would be added, as is currently planned, but that sets 5 and 6 at Tutuka and Lethabo, and 4, 5 and 6 at Matimba, Kendal and Majuba, would be deferred to the last dates provided for in the contracts. Consequently this was investigated further.

⁽²⁰⁾ Information supplied by Escom in June 1984.

It must therefore be determined whether Escom's present strategy is in agreement with requirements arising from demands of the environment.

In Tables 77 and 78 data previously used in the evaluation of Escom's general financing are given in rearranged format.

Figures in Table 77 reflecting escalated capital requirements for a 7 % and a 5 % load growth indicate the following trends:

- ☆ Due to existing contractual commitments concluded a number of years ago in view of the long construction periods—
 - the reduction in capital costs that can be achieved over the first few years by postponing contracts, if provision is made for a 5 % instead of a 7 % load growth, is relatively limited and amounts to R3 497 million for the period 1984–1988,

TABLE 77

ESCALATED CAPITAL REQUIREMENTS FOR LOAD GROWTH AT 7 % AND 5 % PER ANNUM INCLUDING INTEREST DURING CONSTRUCTION IN R MILLIONS

Load growth	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
7 % Growth rate:																				
Annually.....	3 314	3 709	4 300	4 674	4 928	5 365	5 385	5 759	7 026	9 032	11 056	12 696	14 372	16 952	19 333	20 512	24 635	30 713	36 832	41 172
Cumulatively.....	3 314	7 023	11 323	15 997	20 925	26 290	31 675	37 434	44 460	53 492	64 548	77 244	91 616	108 568	127 901	148 413	173 048	203 761	240 593	281 765
5 % Growth rate:																				
Annually.....	3 262	3 498	3 679	3 572	3 417	3 356	3 327	3 427	4 360	5 969	7 005	8 477	10 105	10 807	12 295	13 503	14 824	18 659	20 492	21 986
Cumulatively.....	3 262	6 760	10 439	14 011	17 428	20 784	24 111	27 538	31 898	37 867	44 872	53 349	63 454	74 261	86 556	100 059	114 883	133 542	154 034	176 020
Difference between Growth rate of 7 % and 5 %:																				
Annually.....	52	211	621	1 102	1 511	2 009	2 058	2 332	2 666	3 023	4 051	4 219	4 267	6 145	7 038	7 009	9 811	12 054	16 340	19 186
Cumulatively.....	52	263	884	1 986	3 497	5 506	7 568	9 896	12 562	15 625	19 676	23 895	28 162	34 307	41 345	48 354	58 165	70 219	86 559	105 745

TABLE 78

ESTIMATED AVERAGE ELECTRICITY TARIFFS AND ANNUAL RATE OF TARIFF INCREASE FOR LOAD GROWTH RATES OF 7 % AND 5 % PER ANNUM FOR ESCOM

Load growth rate	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
7 % Growth rate:																					
Price in c/kW.h.....	3,36	3,75	4,22	4,72	5,22	5,69	6,17	6,64	7,13	7,70	8,38	9,17	10,02	10,92	11,93	13,02	14,14	15,40	16,85	18,48	20,21
% Increase.....		11,50	12,75	11,81	10,47	9,03	8,54	7,61	7,36	7,97	8,86	9,34	9,24	9,08	9,23	9,12	8,57	8,91	9,45	9,66	9,34
5 % Growth rate:																					
Price in c/kW.h.....	3,36	3,72	4,24	4,78	5,32	5,82	6,31	6,77	7,27	7,81	8,35	8,87	9,43	10,12	10,94	11,93	13,15	14,51	15,90	17,44	19,12
% Increase.....		10,70	13,89	12,83	11,31	9,36	8,41	7,37	7,29	7,43	6,90	6,28	6,32	7,29	8,13	9,01	10,28	10,31	9,62	9,67	9,59
Difference in tariffs in 7 % and 5 % cases in c/kW.h.....		+0,03	-0,02	-0,06	-0,10	-0,13	-0,14	-0,13	-0,14	-0,11	+0,03	+0,30	+0,59	+0,80	+0,99	+1,09	+0,99	+0,89	+0,95	+1,04	+1,09

- after 1989 *annual savings on capital* at a 5 % instead of 7 % load growth can exceed R2 000 million per annum and increase to R3 000 million per annum in 1993, R6 000 million in 1997 and almost R10 000 million in the year 2000.

Table 77 reflects the difference in the escalated cumulative capital requirements for load growth rates of 5 % and 7 % per annum. Data in this table indicate that the reduction in total cumulative capital costs for a load growth of 5 % instead of 7 % per annum can amount to:

- ☆ R3 497 million in 1988,
- ☆ R15 625 million in 1993,
- ☆ R41 345 million in 1998, and
- ☆ R105 745 million in 2003.

The second part of the zero plan for Escom, at a 7 % load growth rate and an alternative 5 % load growth rate, is the estimated average electricity tariffs and annual rate of tariff increases given in Table 78.

The figures in this table indicate that if the assumptions as previously set out are accepted, the increases in electricity tariffs for a 7 % and a 5 % growth rate will not differ much. However, if generating capacity is created at a growth rate of 7 % and a load growth rate of only 5 % is achieved, increases in electricity tariffs will be considerably higher. These figures are based on a working cost inflation rate of 10 % per annum. In both cases it is expected that the price in c/kW.h after 1987 will increase at less than 10 % per annum.

In view of the amount of capital involved, excessive costs of capital and the substantial percentage of South Africa's total capital creation annually absorbed by Escom, it is doubtful whether Escom will be able to apply its present strategy in the future.

STEP 2: ASSESS WHETHER THE STRATEGY IS CONSISTENT WITH THE REQUIREMENTS ARISING FROM THE ENVIRONMENT IN TERMS OF CURRENT AND DEVELOPING CIRCUMSTANCES

The oil crisis of 1973 caused dramatic changes in most countries of the Western world. Totally new world conditions developed; energy policy necessarily became cardinally important and together with monetary and fiscal policy forms an important element of the economic policy of any country.

The oil crisis—

- ☆ brought the growth rate in the demand for electricity in most countries closer to the economic growth rate and disturbed the previous ratio between the growth rate of energy consumption and the economy, and
- ☆ disturbed the econometric basis on which long-term electricity load forecasts have been made in most countries.

South Africa and Australia, having relatively large energy resources, concentrated in the sixties and seventies on energy-intensive industries mainly based on local resources.

In the late sixties South Africa occupied a competitive position on the world market for minerals and metals.

The South African ferro-alloy and smelting industry could therefore expand considerably in the late sixties and early seventies. In addition, coal exports increased considerably in the second half of the seventies and the contribution of platinum metals, diamonds, iron, manganese and chrome ore, ferro-alloys, coal and steel to exports (excluding gold) has doubled from more than 20 % in 1973 to more than 40 % in 1982.

This development gave rise to the still high, though declining, growth rate of electricity consumption in this period.

It appears unlikely, however, that the Republic will have a further similar boom period for its energy-intensive primary industries. Steep increases in mining, transport and electricity costs, while growth of the markets is slow due to low industrial growth rates of the OECD countries, and strong additional production competing on the world markets, has made such a possibility most unlikely.

Exports of energy-intensive products were most beneficial to South Africa immediately before and during the period after the oil crisis. This together with the increase in the price of gold after 1973 explains why the Republic maintained an average growth rate of 3.2 % per annum which on average was 1 % higher than that of OECD countries for the period 1973–1982.

The competitive position of the Republic on export markets has weakened however, and unless the inflation rate is reduced sharply or the gold price increases substantially, the rand will probably weaken against other currencies and the South African economy will experience a low growth rate.

STEP 3: ASSESS REALISTICALLY THE BALANCE BETWEEN AVAILABLE RESOURCES AND PRESENT AND FUTURE REQUIREMENTS OF THE ENVIRONMENT

Analysis of the economic growth pattern of South Africa has revealed that to fulfil the requirements of providing employment, lower capital/output ratio, lower investment per avenue of employment, high investment in the industrial sector and higher labour productivity while energy industries and the mining sector experience a lower growth rate, the emphasis in the following decade will fall on labour-intensive secondary industrial growth with a lower growth ratio of electricity consumption and industrial growth.

It is also clear that South Africa, like most industrial countries, will have to make intensive efforts to save energy and electricity.

If a degree of success can be achieved in the Republic comparable to what has been achieved in other industrial countries over the past decade, it would appear that with an economic growth rate of between 2,5 % and 3,5 % per annum the average annual growth rate of electricity consumption can be set at ± 5 % per annum.

It would therefore appear that under the conditions of the economy after the oil crisis, which now exert a progressively stronger influence on the South African economy in spite of the sharply increased and fluctuating gold price, an average annual growth rate of 5 % in electricity consumption can be predicted as the realistic planning rate for the next five to ten years.

STEP 4: ASSESS WHETHER THE CURRENT STRATEGY IS CONSISTENT INTERNALLY

In die private sector internal consistency of strategy refers to the cumulative effect of all the policies on corporate objectives. As opposed to this, internal consistency in Escom's case must refer to *national objectives*.

The current strategy and policy of Escom stem chiefly from the Electricity Act of 1922. In 1932 Escom supplied only 30 % of South Africa's power, but at the end of 1982 this figure had reached 93,6 % and Escom had virtually become a monopoly. Escom now acts as supplier and predictor of the future demand as well as planner for future electricity requirements. In addition Escom has become the largest capital investor of any industry in South Africa. The extent of Escom's capital requirements emphasises the necessity for accurate load forecasting, but only Escom bears this responsibility. This state of affairs is unsatisfactory as Escom will be blamed for a shortage of electricity, and on the other hand will also bear the blame if capacity is over-provided. When Escom has determined future electricity demand, and the generating capacity and capital requirements, it brings its tariffs into line not only to cover operating and capital-related costs, but also to make a substantial contribution to future capital requirements. Escom is basically geared to provide an abundant electricity supply while circumstances which have developed after the oil crisis require Escom to play a role in determining and implementing the country's energy and electricity policy and to act within the framework of priorities and constraints imposed by the strategy of the Government.

Viewed in this light the Electricity Act and Escom's internal current policy are not necessarily in agreement with the interests, requirements, strategy and policy of the country.

STEP 5: ASSESS WHETHER THE STRATEGY INVOLVES AN ACCEPTABLE DEGREE OF RISK

When strategy and resources are viewed together, the degree of risk taken by the enterprise can be determined. In the private sector the degree of risk the enterprise is prepared to accept is a critical management decision. A wrong management decision of this kind in the *private sector* can result in a loss of markets due to high price or quality of service, overspending or underutilisation of capital and a number of other consequences that can lead to the eventual sanction of liquidation which in

practice is the ultimate deterrent to the board of directors. This deterrent is non-existent in a monopolistic utility. The tendency should therefore be to run the minimum risk of *public and political criticism*. This can lead to over-assurance in many respects, luxury standards and insufficient control because the unnecessary costs that can result from this can be recovered from tariff increases. However, the discipline of liquidation is out of the question.

STEP 6: DOES THE CURRENT STRATEGY HAVE A REALISTIC TIME PERSPECTIVE

An extremely important part of the strategy of the electricity supply industry is the time perspective on which it is based. Current long lead times associated with specification, tendering, tender adjudication, award of tenders, construction and commissioning of power stations, that take 8 years and more for the first set and up to 14 years for the last set to be commissioned, present the *industry with an extremely difficult time perspective*.

Not only must estimates be made of increases in electricity consumption over *long periods* as a basis for the expansion of generating capacity, but decisions for the investment of *thousands of millions of rand* must also be taken on the strength of these predictions.

Decisions on the award of tenders to either external or internal tenderers are to a great extent affected by differences in inflation rates, exchange rates, interest rates, credit rates and credit terms *applicable*. The normal industrial and manufacturing considerations are *overshadowed* by the long period involved, the various rates mentioned above and the fact that these differences can *change* considerably during the period of tender execution.

An Escom power station comprising six sets typically takes 11 years to *build* reckoned from the ordering date to the commissioning date of the last set.

Credit facilities are usually provided by overseas manufacturers for up to 8½ years after commissioning of a set; this means in effect that when sets or equipment are imported final payment is made approximately 20 years after the date of order.

It is seldom expected of businessmen or even governments to take long-term decisions such as these.

The real factors involved, the extent of fluctuations in these factors, the high South African inflation rate, the fact that South African enterprises cannot provide government subsidised credit to Escom, and that the Reserve Bank—and therefore the Government—has sustained the exchange rate losses on Escom's overseas contracts concluded up to a few years ago, had two important effects.

Firstly, viewed in retrospect, it is extremely doubtful whether Escom, or for that matter anybody, always or even in the majority of cases, takes the right decisions when awarding tenders. The Reserve Bank, however, no longer absorbs exchange rate losses on new tenders, and these have to be borne by Escom.

Secondly, imports valued at *billions of rand* over the *past decade* are involved. Owing to the factors mentioned above, over which the industry *can exercise little or no control*, the South African manufacturing industry was in an invidious position as far as competition was concerned, in spite of a preference for local content (indirect subsidising of local manufacturers) and import duty imposed on the foreign competitor. In view of the fluctuating exchange, inflation and interest rates of the past years, it is quite possible that the South African tax payer, through the Reserve Bank and due to changing conditions, has subsidised the foreign manufacturer at the expense of South African industry and that this could have had a marked effect on the balance of trade and balance of payments due to the large amounts involved.

Owing to the enormous amounts of foreign exchange and import duties involved, the continuous nature of Escom's requirements, and the fact that South African industries that have already been established are able to take over the work to a great extent, and as the Republic has to create job opportunities urgently, it is of the utmost importance that this matter be investigated in depth and that an historical analysis be made of the actual course of events as opposed to assumptions at the time of tendering, taking account of foreign exchange losses, in order to determine guidelines for the future.

The Commission did not investigate this particular matter, but is of the opinion that such an investigation is urgent.

Against the background of matters dealt with in this report, the following two aspects crystallise:

- ★ **Firstly**, forecasts of future load must be as accurate as possible and be *adjusted annually to ensure that sent-out capacity is matched with the load*. In this respect it should be pointed out that the lead time of relatively large new consumers can be up to four years in exceptional cases, while the *lead time* for the first generating set in a new power station is eight years or

more than *double* the lead time for new consumer plant. In addition to this the increasing load of existing consumers has to be considered. This difference in present lead times must be narrowed and leads to the following important matter.

★ **Secondly**, lead times for new power stations and sets will have to be *reduced* as far as possible. In this respect the following is necessary:

- *Standardisation* of sets both in respect of boilers, as far as practicable with the type of coal available, and also (and this is even more important) standardisation of turbines and generators and the combination of turbines and boilers in terms of one philosophy in one power station. With an extremely limited possible increase in thermal efficiency with higher steam pressure and temperature sets, marginal future advantages of scale, the availability problems associated with larger sets, South Africa's limitations regarding technical manpower to cope with more sophisticated technology when its application is not necessary, and the *tremendous advantages* it holds for South African manufacture at competitive prices, *standardisation of plant and equipment should be one of Eskom's chief objectives.*

This kind of standardisation, based on performances of current plant after a proper study had been made of it, also has the advantage that power stations of virtually standard design can be constructed. It is interesting that Britain standardised in 1966 as far as generating sets were concerned, and has availed itself of the tremendous benefits for many years. France, which probably is carrying out the most successful nuclear programme in the world, is basically geared for standardisation. By so doing these countries not only limited technical problems, but also reduced lead times and commissioning periods to such an extent that enormous savings have been achieved, safety problems overcome and risks limited.

- *Staggering of commissioning dates* of sets. As Eskom has come to the conclusion that a power station comprising six large sets is appropriate and has already succeeded in obtaining the first part of a contract for three sets with an option to delay commissioning dates and a further option on three sets at commissioning dates to be determined later, it is clear that this system can be extremely flexible if standard units are used. The important point is that currently the mere lead time for the *first set of a new power station* is eight years. Lead times for subsequent sets can be reduced considerably, i.e. can almost be the manufacturing period of new sets, especially if standard sets are used. Therefore if, say, *three* power stations having three sets in the first stage are constructed on the above contract principles, but with staggered starting dates, and if three further sets can be added, considerable flexibility may be achieved for an almost continuous construction programme with shortened lead times.

The shortening of lead times, and the limitation of Eskom's risks in this respect, is an extremely important strategy adaptation that needs to be investigated and brought about.

STEP 7: ASSESS WHETHER CURRENT STRATEGY IS REALLY FEASIBLE

Eskom's current strategy is no longer feasible. This is true of virtually the *same* strategies introduced in most other industrial countries. The American electricity industry, for example, is also in a state of change due to surplus capacity, cost increases, inflation, high interest rates, excessive control and resistance to nuclear energy. Scott A. Fenn of the Investors Responsibility Research Centre of Washington DC recently stated in an article entitled "America's Electric Utilities Under Siege and In Transition, 1983", that the electricity supply industry is now a mature industry in which cost reductions of previous decades due to technical and economical improvement are no longer possible. It is also the opinion that the industry has adapted itself to the new conditions too slowly and too late, and that "high electricity consumption" and growth rate, and construction strategy have served their purpose. An alternative strategy is to minimise future capital by limiting the growth rate of electricity consumption.

There are many electricity utilities in America that are extremely dynamic in the promotion of energy and load limiting programmes by the end consumer. The companies have achieved a net saving or gained advantage from these programmes. Consolidated Edison Co. is a company that has achieved tremendous success in encouraging consumers to save electricity and has kept its load growth rate below 1 % per annum and, in so doing, has avoided the borrowing of money. In this manner it solved its financial problems itself.

Electricity utilities have had tremendous success with their energy and load limiting programmes. According to the statement of the Edison Institute before the Sub-committee on Energy and Power Conservation of the House Committee on Energy and Commerce—February 1984 it is estimated that a total capacity of 127 GW (35 × 3600 MW power stations) has been saved through saving campaigns in the USA since 1973.

The "high electricity growth rate and building strategy" of Escom is geared for the provision of an abundant and cheap electricity supply. However, this strategy study has clearly indicated that Escom, for national strategic reasons—

- ☆ has to play a leading role in a national programme of energy and load conservation by the end consumer,
- ☆ will have to make every endeavour to limit its capital requirements by limiting capital costs per MW, by achieving higher availability and increased efficiency in the utilisation of capital, and by limiting extensions,
- ☆ has to maintain low electricity prices to ensure South Africa's energy-intensive industries of a competitive position on the world market.

It is clear that in future Escom cannot by itself bear the responsibility of forecasting electricity consumption. Because of the importance of an energy and electricity policy under conditions of the world economy after the oil crisis, it is clear that Escom policy will have to be integrated with national objectives and policy.

PHASE 4: PLANNING OF FUTURE STRATEGY

Escom's future strategy will have to satisfy future expectations. When future strategy is planned, it is virtually without exception necessary to concentrate on a *few* items that determine the *basic* characteristics of the enterprise and to pay far less attention to the multitude of activities that do not have a *significant* effect on the enterprise.

STEP 1: ANALYSING THE ENVIRONMENT WITH EMPHASIS ON POTENTIAL FUTURE DEVELOPMENTS

Escom as a monopolistic supplier has an unchallengeable competitive position in the South African electricity supply industry particularly because it is a utility. Escom's role should however be viewed more broadly: the role it has to play in the South African economy under *present conditions*.

During the period before 1973 oil and electricity prices dropped in real terms, but after the oil crisis steep price increases in oil and other energy resources created a strong incentive for the more efficient utilisation and saving of electricity.

Considerable savings, as reflected by energy consumption per real currency unit of the USA and OECD, and by oil consumption, measured in the same terms, were achieved, and this assisted in counteracting the effects of the increase in energy prices.

Against the background of the requirements of the environment, co-ordination of the activities of the Government and of Escom is in the interests of South Africa, and its economy in particular. It is of the utmost importance in determining Escom's strategy.

CO-ORDINATION OF THE ACTIVITIES OF THE STATE AND ESCOM IN THE INTERESTS OF SOUTH AFRICA, AND IN PARTICULAR ITS ECONOMY

Leading questions in this regard are:

- ☆ What should South Africa's energy policy be?
- ☆ How should energy policy together with monetary and fiscal policy be integrated and implemented in the economic policy?
- ☆ In view of the importance of the role energy and electricity play in the growth rate and well-being of the mineral and metal industry and the role these industries in their turn play in the growth rate of the South African economy, how should Escom integrate with the embracing national priority determination process, especially in view of its strong demands for capital resources?
- ☆ How should these aspects, which *should determine* Escom's total policy, be co-ordinated and controlled between the State and Escom.

In order to answer to these questions, the control structure of the Electricity Supply Commission when it was established and subsequent developments in this regard should be reviewed.

ESCOM'S CONTROL STRUCTURE

The position when Escom was established

Escom was originally established in terms of the Electricity Act, No. 42 of 1922. This Act was superseded in its entirety by the Electricity Act, No. 40 of 1958, but the fundamental principles of the 1922 Act were retained.

In 1932 (10 years after the 1922 Act) Parliament reviewed the whole basis of Escom and, as part of this process, Dr Van der Bijl⁽²³⁾ wrote his monumental letter to the Clerk of the House of Assembly setting out the reasons for the establishment and structure of Escom, and dealing with the question whether any changes or modifications were desirable.

Dr Van der Bijl emphasized that Escom had been established at a time during the 1920s when there was a growing tendency in the Western industrial countries to try to structure public utilities in a way that could combine the advantages of state and private enterprise and avoid their disadvantages. He referred to the following organisations which had come into existence during that time: the Central Electricity Board (United Kingdom), the Canadian National Railway Company, the State Iron Works (Holland), the Anglo-Persian Oil Company, the South African Iron and Steel Industrial Corporation Limited (Iscom) and, of course, Escom.

He then went on to say that the critical questions in the structuring of all these bodies had been whether they were to operate as state departments or on business lines; and, if the latter, how they were to be ultimately controlled and, in particular, whether they were to be subject to Parliamentary control and audit.

In all cases the overseas enterprises quoted, although assisted by state funds, had been designed to operate on business lines without Parliamentary interference or control. Similar questions had arisen when Escom (and later Iscom) had been established, and similar solutions had been decided on.

Technically it was recognized that instead of supplying electricity over relatively small areas from small isolated power stations, as had happened in unguided development (e.g. the city of London), it was desirable that power should be supplied over larger areas by new large interconnected power stations. This clearly required the establishment of a central authority and the only question was whether this authority was to be a government department or a corporate body assisted by the state.

After intensive investigation South Africa had also decided, firstly, that such authority was not to be a government department, but an outside corporate body; and, secondly that it was not to be subject to direct Parliamentary control and audit.

Dr Van der Bijl summarised the main reasons for these decisions as follows:

- ★ Electricity was a public utility and an instrument of industry and accordingly should not be generated in order to make a profit but should be supplied at the lowest possible cost.
- ★ It was not intended that all electricity supply undertakings in the country should be taken over by this central body.
- ★ Vested interests had to be considered and it was also considered undesirable to create a huge electricity supply monopoly.
- ★ It was recognised that it would be impossible for a government department to operate with the same efficiency as a private concern run on business lines such as for example the Victoria Falls and Transvaal Power Company Limited. (In 1932 Escom supplied approximately 30 % of South Africa's power. In 1948, when Escom took over the VFP, their respective installed generating capacities were 1033 MW and 298 MW plus the equivalent of 118 MW in compressed air capacity.)
- ★ Departments of State were subject to Parliamentary control and audit and possible political interference.
- ★ Owing to the nature of control the transactions of a government department were discussed in Parliament, that is in public, and its system of organisation and methods of carrying on its business likewise became public. This naturally placed it in an invidious position, and presented an aspect which was detrimental to doing business with business people.

The Electricity Act of 1922 had therefore provided for the establishment of Escom—a corporate body capable in law of suing and of being sued and having generally the rights and obligations of a private concern. It differed from a private concern mainly in that—

- ★ it had to operate as far as practicable at neither a profit nor a loss;
- ★ it had the privilege during the first seven years of its existence of being supplied with funds by the Government at cost (it then had to find its own money—this is the position today);
- ★ the Government appoints the auditors and all the members of the Commission regardless of where the money comes from;
- ★ the duties and powers of the auditors were wider than those in the case of companies registered under the Companies Act and the Commission was required by law to report to the Government annually on a basis considerably more extensive than that required of ordinary companies;

⁽²³⁾ Letter written by Dr H. J. van der Bijl, Chairman of the Electricity Supply Commission, dated 28 April 1932, in reply to a questionnaire from a Parliamentary Committee regarding the question of investigation into the accounts of government-supported establishments.

- ★ besides the usual provisions for safeguarding investors' money, the Commission's financial operations were definitely prescribed and limited and were subject to Government control and supervision.

Escom as reviewed by Dr Van der Bijl in 1932

Having sketched the history, Dr Van der Bijl went on to examine whether the Statute in terms of which Escom had been established and under which Escom operated provided sufficient and satisfactory means whereby the Government could ensure that its investment in this concern was adequately safeguarded; or whether greater Parliamentary control should be secured than that provided by the Statute. In particular, he dealt with a suggestion that Escom's accounts be examined by a Select Committee of the House of Assembly, or alternatively, be subject to audit by the Auditor-General. He gave detailed and extensive reasons why these suggestions were undesirable and would adversely affect Escom's activities. In doing so, he not only confirmed the correctness of the decisions that had originally applied in Escom's establishment, but also underlined their validity in the light of ten years experience.

In addition to the reasons already enumerated by him, as quoted previously, he added the following:

- ★ Parliamentary supervision would divide responsibility between the members of the Commission and Parliament acting through a Select Committee. Not only was a divided responsibility undesirable, but the one body (the Select Committee) would exercise a measure of control without executive responsibility.
- ★ Parliamentary supervision and control were certain to lead to political interference.
- ★ It was necessary that the policy of a large power supply concern should be based on business principles regardless of political considerations, and be followed consistently. Continuity of policy in such a business enterprise must be maintained regardless of change of Government.
- ★ The electricity supply industry was very specialised and intricate and any interference in its policy and method of management on the part of people who were not experts would undoubtedly have a serious hampering effect on its operations. Examination of the accounts of such a business by a Select Committee and consequent discussion in Parliament was certain to lead to such interference.
- ★ The Electricity Act of 1922 placed the Commission in an impartial and politically independent position having for its sole objective the interests, not of a particular group of persons, but of each and every one of its consumers.

Dr Van der Bijl illustrated the futility of attempting to carry on public business through Parliamentary control by a quotation from L. P. Jackson of Manchester College, Oxford, who said:

"It cannot be insisted on too often that democratic machinery, of the type that the modern world has become familiar with, was not originally created for the purpose of controlling industry, still less of working and managing what are known as the means of production.

"The method of popular representation, admirably adapted as it may be for securing the liberty of the subject, is ill-adapted for dealing with the infinite complexities and the constantly changing fortune of industry and commerce. To navigate a ship through dangerous seas by a committee of the passengers or to deal with an epidemic by consulting the patients, or to decide the strategy of a battle by a majority vote of the rank and file are feeble analogies to suggest the confusion that would result if our present democratic machinery were made to carry the whole weight of the nation's industrial fortunes. One or two things would inevitably happen; either the machinery would break down or industry would go bankrupt. More probably both things would happen together."

And he reinforced this quotation with a similar one from a Mr Hartly Withers in regard to Boards in general:

"The best thing for a Board to do is to give a free hand to a good manager if they are lucky enough to have got one."

Dr Van der Bijl used these quotations to substantiate his view that the surest safeguard the State can have for its investments if for the government to take the greatest pains in selecting the men they place in charge of these institutions. Once these Boards have been appointed, the members must be made to understand that they carry full responsibility, and the conduct of the business should from then on be left to them. Should it be established that they are not capable of successfully conducting the business, through causes not beyond their control, the Government should not hesitate to remedy the situation forthwith by making the necessary changes in the personnel of the Boards.

In rejecting the idea of an audit by the Auditor-General, Dr Van der Bijl emphasised the important principle of holding responsible the members who are entrusted with authority for the enterprise and the danger of this principle being attenuated if an administrative audit by the Auditor-General were introduced, as this could immediately relieve the men in the enterprise of a measure of responsibility.

Changes during the period 1932–1982 which affect Escom

Dr Van der Bijl was quite right when in 1932 he stated that Escom was not a monopoly but merely carried on a business in the same way as businesses were carried on by other concerns and institutions in South Africa.

In 1932 Escom supplied 30 % of South Africa's power requirements but this figure had reached 93,6 % by 1982.

The position at the end of 1982 was that Escom, to all intents and purposes, had virtually become a monopoly and *had emerged over the last decades as the supplier and forecaster of future demand as well as the planner providing for South Africa's future electricity requirements.*

In fact, Escom's responsibilities have undergone a major change. While the emphasis in 1932 was on how to achieve sound management to safeguard the Government's investment, Escom's main responsibilities today are—

- ☆ a macro-responsibility to act in the national interest, and
- ☆ an executive responsibility to manage Escom as an organisation on a sound basis and in the best interest of the country.

Since the last war the South African economy has also undergone certain significant structural changes.

Escom's large capital requirements for the industry's projected expansion and the need to control operating costs and to develop realistic pricing policies are obviously prominent national challenges. The size of the industry and its rapidly growing demand for capital raises the question of the allocation of resources.

Escom's investment programme is of major national significance in economic terms and represents a strongly competitive demand for capital. If not carefully managed, the demand for capital by Escom may squeeze out other demands and produce adverse economic effects.

The increasing borrowings for the expansion of Escom's capacity are having a substantial impact on capital markets. Escom has emerged as the major user of capital funds in the South African economy.

The magnitude of the capital requirements of the electricity supply industry emphasises the necessity for accurate demand forecasting to enable construction of generating plant to match demand closely.

Yet Escom alone carries the responsibility for forecasting and providing the capacity required for future demand. This system suffers from the disability that, should there be a shortage of electricity, Escom will be blamed while on the other hand, should it provide excessive capacity, it will also be blamed.

While Escom carries this responsibility alone the danger exists that in the attempt to do its duty it will make absolutely certain that a shortage of electricity will not occur in the future—even at a cost that possibly cannot be justified.

Finally, the oil crisis has created a completely new economic climate, the energy policy together with the traditional fiscal and monetary policy now inevitably form an integral part of total economic policy. Under these circumstances the inevitable question is whether the "arm's length" control system is still suitable for Escom and for that matter the other public corporations.

Is the "Arm's Length" control system still suitable?

It is interesting to note that the nationalised industries that originated in Britain under the 1945–1950 Labour Government when Herbert Morrison forced through the proposal that the boards of industries, although appointed by government, should be independent and should follow good commercial practice, were also based on the arm's length approach.

Yet in Britain no government has been able to resist the temptation to second-guess boards of management and at times to use pricing policy and investment programmes as part of an overall package of economic measures.

The fact that the arm's length approach has not worked in the nationalised industries in Britain is probably best expressed by Sir Peter Parker MVO, British Railways Board, when he wrote in 1982:

"The control and accountability of public enterprise is a theme that has foxed a generation."⁽²⁴⁾

One of the most thorough studies and reports on the relationship between public corporations and the Government was completed by a Study Team of the National Economic Development Office (NEDO) under the direction of Sir Richard McIntosh, K.B.E.⁽²⁵⁾

In the opinion of the Commission of Inquiry this study is of such exceptional value when these problems are studied that it is summarised below in some detail as it also applies to the South African scene.

A study of UK nationalised industries—their role in the economy and control in the future

In their report the Study Team drew attention to a number of facts applicable to the United Kingdom. These show a number of similarities to the South African position which should be mentioned:

- ★ Public corporations occupy the dominant position in energy, communication, steel and transport in Britain. The corresponding position in South Africa is occupied by Escom, Sasol the Post Office, SABC/TV, Iscor and SATS.
- ★ In certain sectors of the economy they occupy a monopoly or at least a dominant position.
- ★ Their influence on economic performance in Britain is "thus substantial and the way in which they use the resources they control is a matter of prime concern". This is also true of the public corporations in the Republic.
- ★ The Study Team's inquiry left them in no doubt that the existing framework of relationships in Britain, which developed under both main political parties, is unsatisfactory and in need of radical change.
- ★ There were certain aspects of the relationship between government and nationalised industries (in Britain) that came through so clearly in their inquiry that they believed that these could be stated without risk of contradiction:
 - "there was a lack of trust and mutual understanding between those who run the nationalised industries and those in government (politicians and civil servants) who are concerned with their affairs;
 - there was confusion about the respective roles of the boards of nationalised industries, Ministers and Parliament, with the result that accountability was seriously blurred;
 - there was no systematic framework for reaching agreement on long term objectives and strategy, and no assurance of continuity when decisions are reached;
 - there was no effective system for measuring the performance of nationalised industries and assessing managerial competence. (This is particularly apposite.)

Although the Commission of Inquiry cannot comment on the applicability of all these points, there are definite indications that most of them apply in Escom's case.

The main problems identified by the British Study Team were—

- ★ "a lack of understanding within the government machine of the problems of industrial management",
- ★ "the difficulty to reconcile the different time scales of politicians and industrialists", and
- ★ that "previous efforts to clarify the relationship between government and nationalised industries have ended in failure".

In particular, the 1967 British White Paper⁽²⁶⁾ represents a serious and carefully considered attempt to define their (the Government and industries) respective roles within the framework of an essentially "arm's length" relationship and yet it was unsuccessful for the following reasons:

- ★ In the complex environment in which these nationalised industries now operate and having regard to the degree of monopoly involved, the principles underlying the 1967 White Paper, namely the "arm's length" relationship and defined framework were too simplistic.
- ★ It concluded that no general system of guidelines for pricing policy, investment criteria and financial objectives could take adequate account of the circumstances of the individual industries and so provide the required stimulus to efficiency—for external guidelines to be effective they must be specifically tailored to the industry concerned—and based on a closer involvement of government in the *strategic planning process*.

⁽²⁴⁾ Controlling Public Industries by John Redwood and John Hatch.

⁽²⁵⁾ A study of UK Nationalised Industries—Their Role in the National Economy and Control in Future. Her Majesty's Stationery Office, London.

⁽²⁶⁾ White Paper of 1967—Nationalised Industries: A Review of economic and financial objectives. Cmd 3437.

- ☆ It seemed to the British Study Team that the thinking behind the entire arm's length approach was based on a false analogy with the private sector. The financial structures and disciplines in the public and private sectors are very different—not least because the ultimate sanction of liquidation is in practice absent in the major nationalised industries. Moreover their importance as employers, suppliers and customers, and the economic and social implications of their actions, make it *right as well as inevitable* that government should take a close look at their strategies. The issues of public policy are so large and politically sensitive that it is not realistic to suppose that they would for long be left to management alone to resolve, subject only to periodic checks on financial performance.
- ☆ The Study Team came to the conclusion that the nationalised industry's relationship should be based on three concepts—trust, continuity and accountability. Confusion over the respective roles of Ministers, civil servants and management means that no one can be properly held *accountable* for performance.
- ☆ The Study Team rejected the argument that all that was needed was to put more effort into making the existing system work. *They were convinced that a completely new system was needed.*
- ☆ This was based on the premise that the evolution of strategic plans for nationalised industries must be a combined operation. Experience here and abroad shows that interest groups which are closely concerned with the content and implementation of the industries' strategies—and which often have the power to frustrate them if they wish—should be involved in their formulation at an early stage.⁽²⁶⁾

The Study Team expressed themselves as follows:

- ☆ "Experience also shows that to involve bureaucracies in executive business decision-making usually leads to inefficiency and delay. While therefore we believe that in certain areas—mainly those which can loosely be called strategic—government and nationalised industries should work more closely together, we are equally clear that in other areas management should have much greater freedom than at present to take its own decisions and be held accountable for them."⁽²⁵⁾

The summary of the proposals of the Study Team is given in full below.

Summary of proposals

"We propose that for each major nationalised industry there should be a Policy Council and a separate Corporation Board.

The Policy Council's main functions would be to agree corporate objectives and the strategies to achieve them; to establish performance criteria appropriate to the individual industry; to endorse corporate plans; and to monitor performance.

The Corporation Board would manage the corporation within the framework of these objectives, strategies and criteria. It would put forward strategic policy options for consideration by the Council; undertake the necessary detailed planning; and be fully responsible for implementing policies and plans once they had been agreed by the Council.

The Policy Council would be chaired by a President who would be appointed by Government with considerable security of tenure. The chairman of the Corporation Board and some other Board members would sit on the Council, which would also include senior civil servants from the Treasury and sponsor department, representatives of trade unions concerned and members reflecting user and other independent viewpoints. The Council would have a small full time staff.

The Chairman and members of the Corporation Board would be appointed by and be accountable to the Policy Council. The Policy Council would account to Parliament through its annual reports, and the role of the Select Committee on Nationalised Industries would be strengthened by the provision of more relevant information about policies and performance.

Government would exercise its concern for the effective use of resources and for social and regional policy through the Policy Councils. It would not be able to intervene directly in the actions of the Corporation Board. It would, however, be given powers of specific direction which would enable it in extreme circumstances to override Policy Council decisions. All directions would be published at the time they were issued and Ministers would be accountable to Parliament for the use of their powers in the ordinary way.

⁽²⁵⁾ A study of UK Nationalised Industries—Their Role in the National Economy and Control in Future. Her Majesty's Stationery Office, London.

⁽²⁶⁾ White Paper of 1967—Nationalised Industries: A Review of economic and financial objectives. Cmd 3437.

We also propose that Government should devise more rational financing arrangements for nationalised industries which would take account of the specific environment in which individual corporations operate. The use of public dividend capital or its equivalent should be based on agreed principles rather than determined *ad hoc*. Firm ground rules for subsidy arrangements and, in exceptional cases, for capital write-offs should be agreed in advance with the Policy Council concerned.

Implications of these Proposals

Our proposals would involve a substantial departure from the traditional arrangements for directing and managing large public sector enterprises. We believe that this is necessary and justified because the existing system has fallen into such a state of disrepute. We are well aware that organisational change cannot of itself generate the trust and sense of commitment which are needed if the performance of nationalised industries is to improve. But a system which is securely founded on mutual understanding, openness, agreed objectives and clear lines of responsibility should make them a good deal easier to achieve.

The Policy Councils would bring together at regular intervals round one table all those whose support is essential to a successful strategy and whose opposition could frustrate it. At the risk of being thought naive we believe that the habit of working together on the problems of a particular industry should lead to a much greater convergence of views among the various interests concerned. In particular we think that the inclusion of senior civil servants on each Policy Council could over time do much to bring about a better understanding of industry in Whitehall. In this respect we believe that there is much we can usefully learn from French practice.

In the same way we believe, on the evidence we received, that the closer involvement of trade unions in the strategic policy making of most nationalised industries is overdue."

(There then follows a section dealing with industrial democracy which is not relevant and has therefore been omitted.)

"The creation of the office of President of the Policy Council is an important element in our proposals. The President would have a key role to play in securing the stable environment and continuity of policy on which increased efficiency in the nationalised industries manifestly depends. We also attach importance to the inclusion of consumers and an independent element in the Policy Councils.

As a result of our proposals the Treasury should gain a much better insight into the financial problems of nationalised industries and into the implications for them of macro-economic policy changes. There would be a considerable change in the role of sponsor departments. They would be able to concentrate on the strategic and sectoral aspects of nationalised industries' activities and since they would no longer be involved in detailed intervention, appraisal or monitoring there should be scope for savings in staff. At the same time we are satisfied that through their representatives on the Policy Councils and their increased powers of direction, Ministers would be able to ensure that full account was taken of the requirements of public policy, and accountability to Parliament would be strengthened.

Finally, we emphasise that our proposal for Policy Councils does not imply any down-grading of the status of Corporation Boards. It is true that it involves abandoning the pretence that Corporation Boards can be solely responsible for determining long term strategy. But they will retain responsibility for initiating all forms of strategic planning; they will be protected from interference in day-to-day management; and their performance will be measurable by objective and publicly known criteria. Their responsibility will still be among the heaviest in the country.

We appreciate that any major innovation must involve some flexibility and experiment."

The fate of the proposals

Unfortunately the proposals were not accepted in Britain, firstly because of a change in Government shortly after the publication of the study, and secondly because it represented a rather radical departure from the British (and for that matter South African) traditional approach in the private sector.

In a White Paper "The Nationalised Industries of March 1978", the Government, while agreeing that in dealing with nationalised industries its main concern should be with strategic and major issues rather than with day-to-day management, did not accept that the proposal for Policy Councils and Corporation Boards was the best way of achieving these objectives and of improving its relations with industries.

The White Paper also states: "The Government is the sole shareholder of the nationalised industries and their principal banker; and as the NEDO acknowledge, the industries' strategies and main policy decisions involve questions of major political importance with which the Government must be concerned".

The White Paper also makes a number of other interesting points:

- ★ "It agrees, therefore, with NEDO that the present powers should be extended to remedy this deficiency by enabling the Minister to give a board either general or specific directions on matters which appeared to him to affect the national interest".
- ★ "The Government will continue to appoint part-time non-executive members who are not representative of interest groups but who have the experience to make an important contribution to the running of the industries".
- ★ "In a statement of how well it is measuring up to these objectives, the industry would compare its financial performance against its target and also its progress against its published performance and service aims".
- ★ "The systematic and regular publication of this information . . . will be helpful to the Select Committee on Nationalised Industries and to the departments which deal with them".
- ★ "The Government also expects the industries to take the initiative in strengthening their own system of control and monitoring. It therefore welcomes the development of Audit Committees, which the National Coal Board, the British Steel Corporation and a number of private sector companies have recently been introducing, whereby a special group, usually including part-time executive directors, examine and report on annual financial statements, audit arrangements and internal financial controls. The Government believes that this is a useful and helpful innovation which other nationalised industries may wish to adopt. It hopes that they will develop further the role of these Audit Committees, or set up comparable arrangements to look more generally at questions of efficiency and performance within their industries".

It does seem that in rejecting the recommendations of the NEDO Study Committee, the British Government accepted the very approaches that Dr. Van der Bijl so lucidly warned against in 1932. His comments on Government departments operating a business, the utter futility of attempts to carry on public utility business through Parliamentary guidance and control and audits by the Auditor-General appear to be very apt; while L. P. Jackson's comments also come to mind.

The proposals made by the Study Team would have involved a substantial departure from the traditional arrangements for directing and managing public sector enterprises.

In view of this it may be instructive to see whether there have been any changes in the traditional arrangements for directing an enterprise in the private sector and, if so, whether these may be of use in the public sector.

The control of the private sector corporations

The South African system and concept of control in the private sector corporation are based on British example and practice.

A number of deficiencies and weaknesses of the traditional company structure have of late been of great concern in Britain and elsewhere.

In other countries the original British-type structures have been modified and new ones have been adopted.

The British system and structure

The British system of corporate direction, control and governance is based on the essentially 19th century concept of the limited liability joint stock company. The company is an artificial entity created under the law, able to sue and be sued in its own right.

Established and regulated under the successive Companies Acts the decision-making power essentially stems from the rights of the members who subscribe the capital to nominate and elect the board of directors.

Although this is the *de jure* position the *de facto* reality in the majority of British companies, both private and public, is significantly different. Only in exceptional circumstances do the members in fact exercise their rights to nominate and elect the board of directors.

Principally the board of directors becomes a *self-perpetuating oligarchy* with nominations for board replacements coming from existing board members and being approved automatically at the Annual General Meeting, not least because of the proxy votes available to the incumbent directors.

The proxy votes from institutions normally completely overshadow the individual shareholder's possible efforts to mobilise votes and has resulted in almost complete apathy on the part of shareholders.

The basic concept of board level direction in the British company is of a unitary board comprising the executive directors and, if any, the non-executive directors, meeting together and being jointly responsible for the enterprise.

In the majority of cases in Britain the practice is that the composition of the boards of public companies tends to be determined by the chief executive of the companies.

The extent to which *executives* dominate companies in Britain, is reflected by the following facts:

- ☆ Only 35 % of the top thousand companies in England had more than two non-executive directors while 25 % of these companies had none.
- ☆ The company's executives hierarchy is in most cases in practice accountable to nobody but themselves.⁽²⁷⁾

Under these circumstances it is difficult for executive directors to be objectively critical of their own performance, especially if the logic of an analysis of bad performance is that they themselves should be replaced. In the words of one chairman they are in fact marking their own examination paper.⁽²⁷⁾

There are however, other checks and balances on the British board, such as the effect of performance on stock market price and the investigations of analysts and others, that tend to keep board action in reasonable check, and then there is the *ultimate sanction of liquidation which in practice is the final discipline for the board of a private sector company.*

Sir Joseph Lockwood put one of the problems with this system this way:

"Much of our problems with bad management is that they are not removed. The boards of directors of companies are self-perpetuating. The shareholders should take action but do not."

The effective private section dictatorship is ultimately established when the chairman combines his position with those of Managing Director and Executive Chairman. In this case *he* runs the business and he himself has to judge whether that business is run properly. In this connection it is interesting that at least one British firm of stockbrokers used to advise its clients never to invest in a company which had the same man as Chairman and Managing Director.

Mr Charles Villiers summed up the British system of Board control as follows in a speech to the Financial Times Conference on 4 November 1971:

"I believe that Government cannot afford to see resources handled in a careless or inert way. The whole nature of business has become professional, rather ruthless, and quite different to the imperial and Commonwealth heritage. It will become tougher still as we lower our barriers against the Europeans. In this situation we have to ask if our system of Board members, executive or non-executive, if our arrangements for monitoring company results, if our practice of control by shareholders is adequate for the task of shifting unsuccessful management and of finding better replacement before catastrophe overtakes the concern. My own belief is that we need to bolster up the function of the non-executive director and provide an independent tribunal to which shareholders can complain about management performance. This would be in line with the practice of other successful industrialised countries and I doubt if we shall indefinitely get away with the utterly relaxed, even slack, system we have at the moment.

Against this background it is not surprising that there is great concern in the United Kingdom and elsewhere about the duties and functions of executive and non-executive directors.

There have been growing demands in the United Kingdom in recent years for the adoption of the two-tier system (which is discussed later) the essence of which is to recognise and cater for the distinction between the executive and the monitoring function. But the British, with their typical love for compromise, continue to retain the hybrid board of executive and non-executive directors and "to mix the players with the gentlemen".

The systems and structures that developed in other countries

The basic concept of a unitary board consisting essentially of *executive directors* and in the minority of cases a few non-executive directors, meeting together and being jointly responsible for the business, is the typical British system, while the typical main board of a *United States company has a majority of outside directors.*

Similarly in those European companies with two-tier boards the *supervisory* function has been physically separated from the *executive*.

⁽²⁷⁾ British Institute of Management.

In France and Sweden, only the chief executive sits on the company's main board and the rest of the directors are non-executive. In the Netherlands and France companies have the option of adopting a two-tier system with a 'supervisory board' consisting of non-executive directors and a 'management board' of executive directors. This may soon become compulsory in the Netherlands. The Belgians are also moving towards a two-tier system. In West Germany two-tier boards are already compulsory for companies of reasonable size.

In recent years in the United States and Canada a practice has developed of the boards of public companies appointing audit committees composed wholly or mainly of non-executive directors with the function of strengthening control, particularly internal financial control. This idea is being explored in Britain, to overcome some of their problems with their essentially executive boards.

The two-tier board system

In the private sector it is quite clear that shareholder influence needs to be greater than it is, but this influence needs to be brought to bear on management in a disciplined and restricted way rather than by introducing alternative communication routes between shareholders and some members of a unitary board or trying to appoint some of the members of a unitary board to a privileged auditing role.

Similar requirements and limitations apply to the public sector where there is the need for government to have a greater participation in the definition of policy in the public interest—in sharing the macro responsibility of the State associated corporation for which it assumes ultimate political accountability.

The Commission considers that both these private and public sector requirements can be met to a great extent by the adoption of the two-tier board system.

The fundamental concept behind the two-tier board system is the separation of the function of management and directors:

- ☆ The role of management (the executive) under this system is to run the business properly, while
- ☆ the role of directors (the board) is to see that the business is run properly.

The idea behind the separation of functions is an attempt to separate powers and introduce checks and balances to prevent abuse and domination of an enterprise with diverse interests by one person or a group of persons. The idea is rooted in constitutional thinking; the separation between the legislature and the judiciary.

The Supervisory Board or Council has a strategic and public responsibility to fulfil—to the shareholders and for the legal operation of the company. The Management Board is responsible for the success of the company.

The separation of functions inherent in the two-tier board system corresponds to the evolution of management thinking.

The evolution of management thinking

Management is a relatively new field of organised knowledge. It is within the twentieth century that this branch of human knowledge began to emerge and to take its place in the social heritage. The early pioneers made contributions in three main spheres:

- ☆ The science of work and the grouping and correlation of tasks,
- ☆ the adjustment of the individual to the different tasks, and
- ☆ directing and motivating the group.

The first stage of the evolution led to the concept that—

- ☆ managerial skill finds expression through *leadership* that represents higher authority, *interprets* policies and plans, *initiates, motivates, ratifies and manages* through the application of the aspects of management—investigating, forecasting, planning, organising, commanding, co-ordinating and controlling, and that—

- consistent managerial action with a common objective requires—
 - a strategy and policy framework with broad objectives,
 - an organisational framework,
 - a procedural framework, and
 - an adequate measuring and control framework.

This approach to management thinking to a great extent centres in the *enterprise itself*, in *operating variables* within the enterprise itself.

In the last two decades, but particularly in the last one, the idea emerged most forcefully that the total enterprise must be viewed as consisting of management operating an aggregation of resources within a competitive environment. It is against this background that the concept of strategic planning emerged as a broad ever-changing programme of intended future corporate emphasis and resources, the deployment of which responds to and influences the competitive environment in which the enterprise operates.

Strategic planning essentially centres in eight strategic variables, product, market, distribution and promotion policies, competitive emphases, price, finance, investment, and in key personnel placement policies and involves the analysis and rigorous evaluation of the following:

- ☆ The opportunities and threats as well as the crucial factors for success in the environment,
- ☆ the expectations and constraints as well as the strengths and weaknesses of the enterprise in order to identify,
- ☆ the cardinal emphasis in the allocation of resources and the action to be taken in order to exploit the competitive advantage optimally.

Within this context the role of the directors (the board) to see that the business is run properly involves ensuring that strategic planning, policy determination, five year planning and annual budgeting are done properly, agreeing with targets and objectives, exercising control measures so that these plans and objectives are in fact achieved by ensuring that there is adequate management to run the business properly within this framework.

Executive management is required to present the strategic and other plans, objectives, budgets and targets and to establish the control framework for reporting progress. This requirement in itself allows for an evaluation of the adequacy of executive management.

An analysis of the responsibility for various decision-making processes required for Escom

Against this background an analysis can be made of some of the decision-making processes required for the management and control of Escom as a major public utility, in order to establish a suitable management structure. This analysis is given in Table 79.

The decisions required for the management and control of Escom are listed vertically in Table 79, while the various authorities involved in the decision-making process are listed horizontally.

In this analysis it is accepted that, in the new world environment in which Escom has now to function—

- ☆ new approaches to the energy policy, and
- ☆ national priorities will have to be formulated by the Government, and their implementation will require close co-ordination between the Government and Escom, in the interests of South Africa as a whole and of its economy in particular.

TABLE 79

AN ANALYSIS OF THE RESPONSIBILITY FOR DECISION-MAKING PROCESSES REQUIRED FOR ESCOM

Item No. The particular activity and action are indicated by the following symbols: " Must be consulted = Must be informed x Must agree o Takes the decision p Prepares documentation			Outside parties involved																		
			Board of Control of Escor	Management Board of Escor	Cabinet or Cabinet Committee	Minister of Mineral and Energy Affairs	Department of Mineral and Energy Affairs	Department of Finance	Department of Industries and Commerce	Department of Water Affairs	S A Reserve Bank	Economic Adviser to the Prime Minister	Economic Advisory Council	Electricity Advisory Council	Large power users	Organised Trade	Organised Agriculture	Organised Industry	Organised Mining	Municipalities	Banks
1. Energy policy, including conservation of energy	"	"	o	x	p	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
2. Policy with regard to electricity supply	x	o																			
3. Corporate aims and objectives																					
4. Strategic planning of Escor particularly in respect of																					
Future load forecasts	o	"		"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
Capacity expansion plans	x	x																			
Capital programme	x	o		"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
Financing programme	"	o																			
Technology to be applied	"	o																			
Standardisation	"	o																			
Local manufacture	o	"																			
Energy saving	"	o		"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	"	
Load management	"	o																			
Tariff structures	x	o																			
5. Annual objectives for one, two, three, four, five or ten years regarding																					
Availability	x	o																			
Capital costs/MW	x	o																			
Labour productivity	x	o																			
Foreign currency	x	o																			
Fuel costs	x	o																			
Primary arithmetical information for performance measurement	x	o																			
Funding programme	x	o																			
6. Six-monthly monitory objectives	o	p																			

Although this analysis should not be regarded as final and must still be further refined, it does however provide a strong indication of the necessity for certain representatives of user organisations on the Escor Control Board.

The authorities which must contribute to Escom's strategy and policy and their implementation range from the Cabinet or Cabinet Committees through various Ministers and the S.A. Reserve Bank to large power users, to organised industry or mining.

A study of this analysis clearly illustrates why a two-tier system is best suited to the Escom situation and who should be involved in the system.

In order to bring about the required co-operation it is necessary to establish a two-tier control structure consisting of the Board of Control of the Electricity Supply Corporation and a Management Board. This system should, among other things, result in a new mechanism ensuring the involvement of Government and consumers of electricity in order to determine the growth rate of consumption and therefore the expansion programme and its effect on the tariff.

The application of the two-tier board system to Escom and change of name

The Commission accordingly recommends that the two-tier board system be applied to Escom in the form of a Board of Control and a Management Board. Furthermore the Commission of Inquiry is of the opinion that the name *Electricity Supply Commission* is not suitable and that the word Corporation should be substituted for Commission. The word Commission suggests a group of persons entrusted with a task. In the Escom case this group can be identified as the Commissioners acting as Directors or as the enterprise as a whole.

On the other hand the name Electricity Supply Corporation identifies an enterprise that accepts corporative responsibility and accountability for the generation and supply of electricity.

The Board of Control of the Electricity Supply Corporation (Escor)

A permanent Board of Control, chaired by an independent Chairman appointed by the State President, on the recommendation of the responsible Minister, should be set up for Escor to carry out the following functions:

- ☆ Approving corporate aims and objectives.
- ☆ Setting criteria for management performance.
- ☆ Reviewing and approving management's strategic plans, specifically those relating to—
 - future load forecasts,
 - capacity expansion plans,
 - technology to be applied,
 - standardisation,
 - local manufacture,
 - major investments,
 - energy saving programmes,
 - load management,
 - availability of plant and equipment,
 - tariff structure,
 - labour productivity,
 - salaries, wages and other emoluments, and
 - policies, specifically those on labour relations.
- ☆ Approval of corporate plans, including annual budgets, long and short term capital budgets, cost assumptions and budgets, pricing policies, short and long term financing arrangements and policy.
- ☆ Monitoring performance at appropriate intervals against predetermined policies and budget criteria. This implies adequate approved systems of management information and controls, performance reporting against budget and control based on the principle of exception.
- ☆ Top management succession planning in conjunction with the Chairman of the Management Board.

Composition of the Board of Control of the Electricity Supply Corporation

The requirements for and qualifications of the Chairman of the Escor Board of Control were set out very adequately by the British Study Team, as follows (using the terms *President, Policy Council* and *Corporation Board* for the terms *Chairman, Escor Board of Control* and *Management Board* respectively applied in the South African context):

"A President of the Council should be appointed, independent of the interest groups represented and with the personal standing and experience to concert their differing viewpoints. In order to ensure a sufficient degree of independence, the *position of the President should preferably be part time* and have a security of tenure which could only be terminated in pre-defined circumstances, such as loss of confidence of the Policy Council members.

The President's job would be primarily to ensure that the Council concentrated on the long-term horizon and that clear corporate aims, policies and performance criteria were drawn up which were understood and accepted by the Chairman and members of the Corporation Board. He would also have a vital role in seeing that the Corporation Board was protected from intervention in carrying out its responsibilities, that its performance was monitored and that it was held accountable for performance deficiencies.

The role and functions of President of the Council would be distinct from those of Chairman of the Corporation Board. It is hard to envisage these very different functions being performed by the same man, except as a short-term expedient. There would be many disadvantages in combining these two roles. For example it would be more difficult to ensure that the views of the groups represented on the Policy Council were concerted openly, and that the separation of Council and Corporation Board responsibilities were achieved. It would be easier for government and others to bring direct pressures to bear on executive management. Moreover, the fortunes of these vast national enterprises would rest too much on the personality and capability of a single individual."

As far as membership of the Policy Council is concerned the British Study Team suggested the following:

"Each Policy Council should be representative of the main interest groups whose joint participation in policy making is needed in order to achieve effective concertation. Its powers and functions should be explicitly and formally distinguished from those of executive management."

The Commission suggests that the Escor Board of Control be constituted as follows:

- ☆ Chairman.
- ☆ The Chairman of the Management Board (The General Manager).
- ☆ The Director-General of the Department of Mineral and Energy Affairs.
- ☆ The Director-General of the Department of Finance.
- ☆ Representatives nominated by the following user organisations for periods of five years:
 - One nominated jointly by the Afrikaanse Handelsinstituut and the Association of Chambers of Commerce of South Africa,
 - one nominated jointly by the South African Federated Chamber of Industries and the Steel and Engineering Industries Federation of South Africa,
 - one nominated by the Chamber of Mines,
 - one nominated by the South African Agricultural Union and
 - one nominated by the municipalities supplied by Escom.
- ☆ Three independent members.

It is important that there should be members of the Escor Board of Control who are independent of executive management and representative interests. Their role would be to assist the Chairman in maintaining continuity of policy in securing clear and timely decisions and in ensuring that difficult subjects are not ignored or delayed indefinitely.

The Escor Board of Control should be provided with a small supporting staff, drawn mainly from experienced civil servants, managers and other staff seconded on a full-time basis by the sponsor department, corporation and trade unions.

The following is also taken from the Study Teams's report as it so adequately defines the requirements:

"The President of the Policy Council should be appointed by the sponsor Minister. The representative members . . . should be nominated by the parties concerned subject to the approval of the sponsor Minister. The independent members should be nominated by the President if they are to play the role expected of them, but they too would be subject to Ministerial approval.

The responsibility for selecting and appointing the Chairman and other members of the Corporation Board should rest with the Policy Council."

The independent members should in the South African context be appointed with the approval of the State President.

"The remuneration and related conditions of service of members of the Policy Council should be determined by the sponsor Minister.

The Policy Council should determine the terms and conditions of service of the Chairman and members of the Corporation Board.

Government should not be able to intervene directly in the decisions of the Corporation Board. Since the Chairman and members of the Board would be appointed by the Policy Council and would be directly accountable to the Council for performance, the Board could not alter its strategic policies, corporate plans and performance objectives without the prior agreement of the Policy Council.

In circumstances where the requirements of government policy change—and such change is likely to have an effect upon the corporation's strategic policies—government representatives on the Policy Council should explain the issues to the Council and seek to achieve changes by co-operation and agreement. In extreme circumstances where it is not possible to persuade the Council generally to adopt a policy which the government feels to be imperative, the sponsor Minister should be able to issue a formal direction to the Policy Council. Accordingly the sponsor Minister should be given more powers of specific direction and possibly less restrictive powers of general direction. The exercise of such powers should always be publicly announced and thus be subject to public scrutiny at the time that a direction is issued."

The Management Board

A Management Board should be established to act as the executive authority while the Chairmanship of the Management Board would be quite separate from that of the Board of Control and its members would be drawn from those working within the corporation. It would be represented on the Board of Control by its Chairman.

The Board's prime function would be to manage the corporation within a framework of jointly agreed policies, plans and performance criteria. It would initiate corporate aims, strategic policy options and proposals, carry out detailed planning and be responsible for implementation of policies and plans once they had been agreed by the Board of Control.

Thus the role of the Management Board (the executive) will be to run Escor properly. Its functions will include—

- ☆ the formulation of strategies,
- ☆ the creation of plans, policies and budgets,
- ☆ the organisation, planning and control and co-ordination of the business operations and
- ☆ the achievement of results,

(in one word—TO MANAGE)

Some implications of the control structure proposed for Escor

The evaluation of the potential effectiveness of the present strategy for the future indicates that—

- ☆ Escor's load growth must in future be limited by—
 - energy saving, and
 - electricity saving,
- ☆ in order to limit the growth rate of electricity sales and the generating capacity required,
- ☆ the required generating capacity must be provided at the lowest effective capital cost per MW in order to limit the total capital cost of electricity supply, and
- ☆ limit the price of electricity, by keeping capital-related costs in check,
- ☆ furthermore, operating costs must be limited by reducing fuel and other costs.

Under the proposed control structure representatives of large power users will not only participate in, but will also together with the representatives of government and management be jointly responsible for, among other things, the approval of strategic plans, load forecasts, expansion of generating capacity, major investment, energy and electricity saving programmes, load management, adjustment of tariff structures and price increases, and for monitoring their implementation.

Energy and electricity saving

The past decade has been characterised by the effect of energy on the world economy. The growing awareness, following the two oil price shocks, of the fundamental relationship between energy and the economy, brought the energy-related policy to the centre of economic policy-making.

A common objective of the policy of most countries is now to separate energy and particularly oil consumption from economic growth in the long-term.

A number of principles of the energy policy, adopted by the industrial countries in establishing their energy policies, are interesting:

- ☆ The objective, which is defined as specifically as possible, is in absolute terms to reduce or limit oil imports by saving energy, expanding local energy sources and finding substitutes for oil.
- ☆ Allowing the prices of local energy to reach levels that encourage energy saving or allowing the development of alternative energy sources.
- ☆ Strong encouragement of energy saving on a high priority level and with additional resources, in order to reduce energy consumption in relation to economic growth. Energy saving in this context consists in two completely different kinds of activity. The first kind consists in restrictions in the quality or extent of economic activity or services, such as reduced production, lower temperatures in heated buildings, lower speed limits and the use of smaller motor cars. The second kind consists in improvements in the efficiency of energy consumption which do not lead to a lowering of the extent or quality of activities and may result even in their improvement.

Effective energy saving measures normally include the following:

- ☆ Price policy (including fiscal measures) that encourages energy saving,
- ☆ minimum energy consumption efficiency standards,
- ☆ encouragement of and increased investment in energy saving equipment and techniques.

The "World Energy Outlook (1982)" states that the most important positive conclusion of their investigation into energy is that the *recent large price increases, while extremely detrimental to economic growth, did launch exceptional economy measures which have already resulted in important improvements in efficiency and will probably continue to do so in future.*

The most effective mechanism for restructuring the energy economy is to ensure that market indications, particularly changes in price, are continually passed on to the end consumer. In this connection price control, which prevents energy prices from reflecting the escalation of the cost of supply, should be abandoned.

As the market is sometimes inadequate and in conflict with other social objectives against which it has to be balanced, most of the governments of the OECD countries accept that they have a justifiable role to play and a responsibility to improve and supplement market forces in order to achieve energy policy objectives.

Most of the programmes for saving energy emphasise the following aspects:

- ☆ Information, education and counselling to ensure that energy users, particularly private users and small and medium-sized companies, have an accurate basis on which to make valid decisions.
- ☆ The establishment of minimum thermal efficiency standards for buildings, equipment and motor vehicles.
- ☆ The requirement that all large items of consumer equipment (e.g. water heaters, refrigerators, deep-freezers, etc.) bear an mark of energy consumption efficiency.

In the OECD countries considerable progress has been made with energy saving, as indicated by the following figures:

- ☆ Firstly, to use the most common criterion for the total energy efficiency of an economy, namely total energy consumption to economic growth, this ratio decreased by 12.1 % in the OECD countries between 1973 and 1980 and improvements of the same order or greater are expected during the next decade.
- ☆ In the industrial sector, the ratio of energy consumption per unit of industrial expansion was reduced by an average of 27.1 % in the U.S.A., Japan, Germany, France, the United Kingdom, Italy and Canada during the period 1973–1980.
- ☆ Based on the projections of a number of governments, a further decrease of between 15 % and 20 % in the present ratio is forecast for the period 1980 and 1991.

- ☆ With regard to savings, the following statement appeared in the Financial Times of London, on 5 December 1983:

"It is now reckoned that for every percentage point of economic growth, energy demand will grow only by *half* a percentage point—another dramatic change from 1973 when the ratio was 1:1".

Against this background a number of important strategy and policy guidelines can be established.

Energy saving policy

South Africa's future opportunities and challenges in economic growth, competitive position in the export market, utilisation of capital and the inflation rate will clearly, under the present world economic conditions, depend on the success it achieves with an energy saving policy which, in accordance with the broad OECD guidelines, must be tackled with vision and drive.

Electricity saving policy

Although Eskom was in the past mainly geared for the provision of an abundant supply of cheap electricity, and cheap electricity encouraged excessive consumption, Eskom will in future have to play almost the opposite role as *its policy for the saving of electricity by consumers must be designed to serve the national interest.*

Eskom can encourage more efficient utilisation of electricity by—

- ☆ applying an appropriate tariff policy,
- ☆ encouraging consumers to use electrical equipment with a high efficiency, utilise electricity in a more efficient way and improve productivity and utilisation standards, and
- ☆ making a wide range of information available to consumers by means of an advisory function in order to help them to get the best from the utilisation of electricity.

Eskom's tariff policy must be directed towards the maximum reasonable electricity saving.

Tariff policy

With regard to tariff policy the Commission is content to accept the conclusions reached in AN EVALUATION OF THE CURRENT ELECTRICITY TARIFFS OF ESCOM and recommends that the aspects which are of importance in the tariff policy, as set out below, be accepted:

- ☆ Eskom should annually in January publish the electricity price increase foreseen by it for each of the following five years, together with the previous forecast and actual figures, so that all consumers will be aware of what they can expect and include this in their own calculations and decisions.
- ☆ The price of electricity should be increased only once a year, in January, should include the coal price adjustment for the following year and should apply for the whole year.
- ☆ Eskom should make every effort to persuade consumers to save electricity and in this connection abandon its "abundant electricity" policy in order to discourage waste.
- ☆ The present seven distribution undertaking should be reduced to not more than three in order to reduce administration costs and eliminate differences between undertakings.
- ☆ Owing to changed circumstances—
 - all references in the Electricity Act to individual undertakings should be removed,
 - unit costs should be determined for a small group of users of different kinds and sizes in order to distinguish between maximum demand and actual consumption where applicable,
 - unit cost of transmission to a reference point and unit cost of distribution from the reference point to the consumer, calculated on the bases of cost per kilometre for different voltages and loads, should be pooled so that tariffs for individual groups of consumers can be deduced from average pooled costs, and administration costs as well as loan charges associated with rural supply divided into groups according to consumption density.

Although tariff structures were in the past established and applied by Eskom within the constraints posed by the Electricity Act, it is now proposed that Eskom should in future be allowed more flexibility to be able to establish structures that fulfil the requirements of load management and economic demands.

Electricity price policy

In order to ensure reasonable electricity prices—

- ★ Escom should, as far as generation is concerned, supply electricity as cheaply as possible by striving for the most economical combination of fuel costs and thermal efficiency within the constraints indicated in this investigation, improving power station availability and thermal efficiency, minimising system losses, obtaining optimum utilisation of capital goods and by enforcing the strictest control of costs.
- ★ The electricity generation and distribution systems should be developed to cope with the foreseen future load with the lowest possible capital expenditure by limiting the expenditure per MW, improving load management, applying suitable tariff structures and utilising existing capacity at the highest occupation and availability.

STEP 2: THE ANALYSIS OF THE RESOURCES OF THE UNDERTAKING FOR FUTURE APPLICATION

As a second step in the planning of future strategy it is now necessary to identify the undertaking's most important strong points as well as how these may be utilised. At the same time the most important weak points should be identified as well as how these may be overcome or improved to be able to make the best use of opportunities, minimise the effect of threats and deal with those factors that are critical for success in the industry and its environment in a way that would ensure optimum results.

Escom's strong points centre in—

- ★ its monopolistic market position which guarantees its market share but also places certain responsibilities on it as already indicated,
- ★ its strong technical ability which should in future be applied particularly to—
 - limiting increases in the average price per kW.h,
 - energy and electricity saving in close co-operation with consumers, as well as
 - applying load management in order to
 - bring about a lower growth rate of electricity consumption and maximum load in future,
 - limit costs by achieving higher productivity and higher operational standards, and
 - exercise control over large coal-fields in order to utilise these resources in the best way possible.

Escom's weak points centre in—

- ★ its approach to the financing of its capital requirements *as interpreted by outsiders, particularly as a result of Escom's accounting and reporting system,*
- ★ its approach in acting and continuing to act strictly in accordance with the constraints imposed by the Electricity Act, notwithstanding the marked changes in environmental conditions, and
- ★ the constraints imposed on Escom by the Act.

STEP 3: IDENTIFICATION OF THE FUTURE COMPETITIVE ADVANTAGE

Escom's future competitive advantage should be seen in a broader perspective: the most important contribution Escom can make to the competitive position of South Africa's exports on the world market is to supply electricity at reasonable prices that result in the minimum escalation annually.

STEP 4: DEVELOPING STRATEGIC GUIDELINES FOR THE FUTURE

The strategic guidelines for the future are clear:

- ★ Escom should in future play a leading role in saving energy and electricity while preventing the price from rising too fast, and the generation of electricity from making very high capital demands on the economy.
- ★ The objective of supplying abundant electricity at cost price in South Africa, wherever there is a demand, should therefore be abandoned. On its own, it can no longer be an objective.
The objective should be the maximum utilisation of resources and capital in the economy by making optimum use of energy and electricity. The elimination of wastage, the maximum saving and efficiency of consumption of electricity will also contribute to more modest expansion programmes in respect of the growth rate of generating capacity in future.

- ☆ Limiting risks through accurate load forecasts and therefore determining the growth rate of generating capacity by—

- close co-operation with consumers,
- shortening lead and construction times, and
- flexibility of building programmes,

should in future enjoy a high priority.

- ☆ The obvious way of limiting electricity price increases, which are partly a consequence of the rising costs per MW of generating capacity, is to—

- achieve maximum availability of power stations as quickly as possible and then to maintain it.
- explore the possibilities of standardisation and local manufacture of generating equipment in order to shorten lead times, save currency used for imports and promote job creation in South Africa.

Regarding the latter a *comparative investigation* of the lowest tender prices for the last three or four power stations, and the implications of actual inflation and currency changes in comparison with those originally estimated, is necessary.

- ☆ In order to ensure that Escom's tariff increases will in future be adequate to provide healthy asset and income structures for lenders—

- Future tariff increases should be tested in order to make provision for a revenue cover of at least 1,05, and for
- the expected average future increase in operating costs so that the necessary tariff increase, actuarially calculated, makes it possible to maintain a 3:2 asset/liability ratio, and
- The extent of internal financing so achieved is accepted, subject to a minimum of 25 % and a maximum of 35 % of the annual requirements.

Escom's accounting system should be such that profits from equity capital are easily identified in the accounts and that items subtracted later, for instance depreciation and future capital expenditure, are shown as applications of this return and motivated separately.

- ☆ Owing to changed circumstances the concept of different undertakings in Escom should be abandoned and tariff structures should be changed to—

- apply unit costs differentiating between maximum demand and actual consumption where applicable,
 - determine unit costs of transmission up to the reference point and, in respect of distribution, from the reference point to the consumer, on the basis of the cost per km for different voltages and loads,
 - bring about the pooling of costs so that tariffs for individual groups of consumers can be determined from average pooled costs.
- Although tariff structures were in the past established and applied by Escom within the constraints of the Electricity Act, it is now recommended that Escom should in future be allowed more flexibility to establish structures that fulfil the requirements of load management and economic demands.

- ☆ The Electricity Act, No. 40 of 1958, should be amended to give effect to the foregoing recommendations (and as set out in greater detail in the Report).

STEP 5: IDENTIFICATION OF POSSIBLE FUTURE PROJECTS

In this connection two possible projects should receive attention:

- ☆ The future use of nuclear power, and
- ☆ the possible privatisation of Escom.

With regard to the future use of nuclear power, a confidential report is being prepared. An in-depth investigation of the potential of power generation from coal is however also necessary. Although we are reasonably familiar with the Republic's potential coal-fields and their extent, two factors are of vital importance in determining the future potential available for power generation:

- ☆ *Percentage recovery* of available reserves which is compatible with the appropriate economical mining methods, and
- ☆ *how many blocks of reserves* which fulfil the requirements for power generation are still available, their suitability in terms of pollution, availability of water, quality of the reserve and so forth.

An investigation to evaluate these is a necessary part of establishing a policy for future energy and electricity generation.

Privatising

The Commission regards the following arguments against proposals for privatising Escom as a whole as decisive:

- ☆ A private monopoly is not preferable to a public monopoly.
- ☆ The Commission's view of the tariff policy as part of the national economic policy is much better suited to a public sector industry.
- ☆ The equity amassed by Escom in the past originally came from consumers and should therefore be used (within safe financial limits) to their advantage.
- ☆ The calculations of Escom's "profitability", which form the basis of the argument for privatising, are exaggerated and are in certain cases based on an erroneous interpretation of its accounts.
- ☆ In the absence of competition there is an inherent conflict between the interests of consumers and investors. In the case of privatisation it will be possible to keep the extent of profit-taking, and therefore tariffs, in check only by means of price control. Should Escom be private property, this means of regulation would certainly require at least the number of resources (probably more) needed by Government to ensure that Escom operates efficiently.

With regard to total privatisation, Sasol was mentioned as an example. In the case of Sasol there is an alternative supplier in the form of overseas oil and a market mechanism for price testing which is lacking in the case of Escom.

Partial shareholding in *private hands* will lack appeal owing to the pressures the public partner would exert to limit prices. The possibility of privatising parts of the electricity supply industry was also examined.

Of the three vertical steps in the industry, namely generation in power stations, transmission over high-voltage power lines and distribution over low-voltage networks, only generation offers possibilities for private participation.

Distribution in South Africa is mainly in the hands of municipalities and other local authorities and networks seldom overlap. Such bodies are at present free to transfer this function to the private sector but in most cases the present owner would be loath to give up control over this aspect of community life and the surplus income it provides. The national implications of this situation as far as the policy with regard to tariffs and saving is concerned are discussed elsewhere by the Commission; the Commission does not feel that privatising this function will as such be beneficial. It is common knowledge that Escom is involved in this function only to a very limited extent and would like to be free of it; the Commission is in agreement with this.

In South Africa transmission takes the form of a national network and the Commission found no basis to do otherwise than keep it under public control.

Generation offers possibilities for private participation in the following ways:

- ☆ At present anyone is free to generate power in order to supply his own needs. It seldom happens, as the "privileged" tariffs for consumers are considerably lower than those at which anyone (including Escom) can generate power from new facilities. The much smaller scale of such possible private facilities also militates against viability.
- ☆ In the United Kingdom legal provision was recently made for the possibility of private capital constructing a power station(s) and connecting it to the national network. The CEBG, which manages the network, objected on the grounds of the problems involved in the incorporation of such power, and the price basis has still to be negotiated.

- ☆ Where an industrial process requires large amounts of heat in the form of steam, it is possible to use the steam for generating purposes before it is subsequently condensed for heating (the so-called "co-generation"). If there is a market for such power, it can make the process much more economical and may even make the difference between a profit and a loss, or determine whether the project is viable or not.
- ☆ In order to ensure that the country benefits from this, the U.S.A. in 1978 adopted legislation which compels electrical utilities to receive suitable power of this kind into their networks, and at a price that reflects the expenses *they will save* (the so-called "avoided costs")
- ☆ There are examples in some countries of large power users who wanted to peg the capital-related cost of their power for an extended period of time and who therefore paid for a specific generating set in a utility.

The Commission is in favour of a legal framework which allows arrangements for all four types mentioned above, as well as a procedure that will ensure Escom's whole-hearted co-operation in actualising such possibilities on the principle of "avoided costs" if any interest should be shown by the private sector. This does not imply, however, that Escom should make any concessions in the quality and reliability of supply.

STEP 6: ESTABLISH FUTURE PERFORMANCE SPECIFICATIONS

At this stage objectives can be determined in order to obtain the involvement of the staff. These new objectives will obviously reflect the results of the total strategic planning process. Only a limited number of objectives can however be set at this stage: the other objectives are closely bound up with the load forecast accepted for the future.

The objectives which can be set at this stage refer to—

- ☆ power station availability: 77–80 %,
- ☆ increase in productivity: 3 % per annum,

and are based on what has been achieved in other countries.

Further objectives to be set refer to—

- ☆ capital costs per MW,
- ☆ coal costs per ton and per kW.h,
- ☆ operating costs per kW.h,
- ☆ costs per kW.h,
- ☆ capital-related costs per kW.h,
- ☆ saving on electricity consumption as measured by the difference between the growth rate of electricity consumption and that of the economy.

Performance can then be measured against these objectives.

STEP 7: DEFINING THE SCOPE OF THE FUTURE STRATEGY

In short, the future strategy will differ from the present strategy in that the emphasis will in future be on electricity saving rather than on making electricity readily available.

STEP 8: PROCURING AND ALLOCATING RESOURCES

In the case of Escom the allocation of resources begins with the load forecast, is followed by the calculation of the required generating capacity, determination of the most capital-effective methods to create capacity and includes the mobilisation of the required capital.

MATTERS OUTSIDE THE SCOPE OF THE STRATEGY STUDY OF ESCOM

In the light of its terms of reference, the Commission of Inquiry considered various matters which are outside the scope of the strategy study of Escom. In the light of Escom's large market share in the electricity supply industry in South Africa, it follows that the activities of the other suppliers of electricity, having a market share of a little more than 6 %, do not have a great impact on the industry as a whole.

Supply/distribution of electricity by local authorities

The Commission of Inquiry is satisfied that Escom's role should be predominantly that of a bulk supplier and therefore feels that the role of the local authorities in the industry should in general be left unchanged. It is however necessary that local authorities should supply electricity in accordance with the principle of efficient load management, and uniformity of tariff structures of local authorities throughout the country is furthermore desirable.

Electricity Control Board

The Commission of Inquiry feels that the role of the Electricity Control Board as laid down by the Electricity Act was a necessary one. Should the Commission's recommendations with regard to a new control structure for Escom be accepted, however, it would mean that some of the Electricity Control Board's functions would fall away. The Commission of Inquiry is of the opinion that the remaining functions of the Electricity Control Board can be efficiently carried out by the Department of Mineral and Energy Affairs and where applicable by the Minister of Mineral and Energy Affairs.

Other sources of energy

The Commission of Inquiry gathered information about the possibility of generating electricity hydro from sources other than the conventional thermal, hydro and nuclear power sources. The renewable sources are mostly linked to solar and tidal energy, as for instance "solar thermal, photovoltaic, wind, wave, ocean thermal and biomass". Tidal and geothermal energy have no connection with solar energy sources. The information on the economic justification and operating costs of the other sources indicate that although there is a need for the development of technology, electricity obtained from conventional sources is considerably cheaper. It follows, however, that an eye should be kept on developments in this field.

Nuclear power as a source of electricity

Since its appointment and the publication of its terms of reference in the *Government Gazette*, the Commission has been requested to devote its attention to the nuclear power generation programme for the Republic of South Africa as well. This matter is receiving the Commission's attention and a separate confidential report will be submitted to the State President as soon as possible. It is expected that these findings may be published as a whole or in part, at the discretion of the State President.

ANNEXURE A

AN ANALYSIS OF CONSUMER PATTERNS IN THE DIFFERENT DISTRIBUTION UNDERTAKINGS

Tables 7A to 7H, attached at the end of this Annexure, contain the following information for the period 1967-1982:

- ☆ Data relating to the consumption of electricity in the bulk supply; industrial, mining, traction and domestic sectors,
- ☆ data relating to the extent of the distribution undertakings.

It follows that the results of the analysis contained in this Annexure have been incorporated in the report.

Trends in different consumer sectors

Information as summarised from the figures in Tables 7A to 7H with regard to the *total* GW.h consumed each year from 1967 to 1982 in the traction, bulk supply, mining, industrial and domestic sectors supplied by Escom, and the percentage growth in consumption per sector over the previous year, is given in Table 8 for each of these sectors.

In Table 9 the percentage of the *total* GW.h supplied by Escom and consumed by the traction, bulk supply, mining, industrial and domestic sectors is set out for the years 1967, 1974 and 1982. In addition the average annual growth rate of consumption in each sector for the periods 1967-1974, 1974-1982 and 1967-1982, as well as the years when the growth rate for all undertakings as a whole was high in specific sectors, is set out in the table.

From the information in Tables 8 and 9 the following is evident:

- ☆ **Bulk supply**, as a percentage of total Escom sales, increased from 22,4 % in 1967 to 29,5 % in 1974 and to 33,5 % in 1982. The average annual growth rate of sales in this sector was 11,93 % for the period 1967-1982. The average annual growth rate of 14,64 % for the period 1967-1974 was considerably higher than the growth rate of 9,61 % for the period 1974-1982. In this sector high growth rates were achieved particularly in the years 1971, 1972, 1973, 1974 and 1975, when they were 14,2 %, 15,6 %, 18,9 %, 21,7 % and 16,3 % respectively.

TABLE 8

THE TOTAL CONSUMPTION AND ANNUAL GROWTH OF CONSUMPTION IN THE TRACTION, BULK SUPPLY, MINING, INDUSTRIAL AND DOMESTIC SECTORS

Year	Total for all undertakings					Total for all undertakings				
	Total GW.h consumed during year					Percentage growth over that of previous year				
	Traction	Bulk supply	Mining	Industrial	Domestic	Traction	Bulk supply	Mining	Industrial	Domestic
1967.....	1 958,1	5 964,5	11 441,5	6 729,5	562,8	4,0	—	—	—	—
1968.....	2 180,6	6 628,2	11 995,5	7 439,0	641,9	11,4	11,1	4,8	10,5	14,1
1969.....	2 307,0	7 263,7	12 641,8	8 573,8	719,5	5,8	9,6	5,4	15,2	12,1
1970.....	2 409,6	8 108,2	13 947,9	9 607,8	818,1	4,4	11,6	10,3	12,1	13,7
1971.....	2 616,0	9 264,4	14 227,0	11 013,8	918,8	8,6	14,2	2,0	14,6	12,3
1972.....	2 782,3	10 716,1	14 508,6	12 641,5	1 000,7	6,4	15,6	2,0	14,8	8,9
1973.....	2 895,6	12 751,8	15 799,9	14 026,2	1 105,6	4,1	18,9	9,0	10,9	10,5
1974.....	3 107,9	15 521,9	16 960,3	16 105,7	909,5	7,3	21,7	7,4	14,8	-17,7
1975.....	3 307,1	18 055,1	17 444,3	18 049,2	1 013,2	6,4	16,3	3,9	12,1	11,4
1976.....	3 474,6	20 035,7	18 746,2	19 945,9	1 093,7	5,1	10,9	7,5	10,5	7,9
1977.....	3 507,6	20 862,3	20 138,8	21 523,1	1 038,4	1,0	4,1	7,4	8,0	-5,1
1978.....	3 586,0	21 833,6	23 330,2	24 182,4	959,6	2,2	6,7	15,8	12,4	-7,6
1979.....	4 035,0	24 133,7	23 999,7	27 474,9	939,7	12,5	10,5	2,9	13,6	-2,1
1980.....	4 465,6	26 922,9	25 881,6	29 373,5	907,8	10,7	11,5	7,8	7,0	-3,4
1981.....	4 659,6	30 017,1	27 131,3	31 091,4	1 003,2	4,3	11,5	4,8	6,0	10,5
1982.....	4 436,0	32 348,0	27 372,1	30 932,3	984,8	-4,8	7,8	0,9	-0,5	-1,8

Source: ESCOM.

TABLE 9

PERCENTAGE OF THE TOTAL GW.h SUPPLIED BY ESCOM AND USED BY SECTORS, AVERAGE ANNUAL GROWTH RATE OF CONSUMPTION FOR CERTAIN PERIODS AND YEARS OF HIGH GROWTH

	Percentage of total consumption			Average annual growth rate of consumption			Years of high growth rate of consumption in particular sector, for all undertakings as a whole
	1967	1974	1982	1967-74	1974-82	1967-82	
Traction.....	7,3	5,9	4,6	7,62	4,54	5,60	1968 @ 11,4% 1979 @ 12,5% 1980 @ 10,7%
Bulk supply.....	22,4	29,5	33,6	14,64	9,61	11,93	1971 @ 14,2% 1972 @ 15,6% 1973 @ 18,9% 1974 @ 21,7% 1975 @ 16,3%
Mining	42,9	32,2	28,5	5,76	6,55	5,98	1970 @ 10,3% 1978 @ 15,8%
Industrial.....	25,2	30,6	32,2	13,27	9,37	10,70	1969 @ 15,2% 1970 @ 12,1% 1971 @ 14,6% 1972 @ 14,8% 1974 @ 14,8% 1975 @ 12,1% 1978 @ 12,4% 1979 @ 13,6%
Domestic	2,1	1,7	1,0	7,09	1,47	4,05	1968 @ 14,1% 1969 @ 12,1% 1970 @ 13,7% 1971 @ 12,3%

Source: ESCOM.

☆ **Sales in the industrial sector**, as a percentage of total Escom sales, increased from 25,2 % in 1967 to 30,6 % in 1974 and to 32,2 % in 1982. The average annual growth rate of sales in this sector was 10,70 % for the period 1967-1982. The average annual growth rate of 13,27 % for the period 1967-1974 was considerably higher than the growth rate of 9,37 % for the period 1974-1982. In this sector high growth rates were achieved particularly in the years 1969, 1970, 1971, 1972, 1974, 1975, 1978 and 1979, when they were 15,2 %, 12,1 %, 14,6 %, 14,8 %, 14,8 %, 12,1 %, 12,4 % and 13,6 % respectively.

☆ **Sales in the mining sector**, as a percentage of total Escom sales, declined from 42,9 % in 1967 to 32,2 % in 1974 and to 28,5 % in 1982. The average annual growth rate of the sales in this sector was 5,98 % for the period 1967-1982. The average annual growth rate of 5,76 % for the period 1967-1974 was lower than the growth rate of 6,55 % for the period 1974-1982. In this sector high growth rates were achieved in the years 1970 and 1978, when they were 10,3 % and 15,8 % respectively.

☆ **Electricity sales for use by traction**, as a percentage of total Escom sales, declined from 7,3 % in 1967 to 6,0 % in 1972 and to 4,6 % in 1982. The average annual growth rate of sales in this sector was 5,60 % for the period 1967-1982. The average annual growth rate of 7,62 % for the period 1967-1974 was higher than the growth rate of 4,54 % for the period 1974-1982. In this sector high growth rates were achieved in the years 1968, 1969 and 1980, when they were 11,4 %, 12,5 % and 10,7 % respectively.

☆ **Electricity sales for domestic consumption**, as a percentage of total Escom sales, declined from 2,1 % in 1967, to 1,7 % in 1974 and to 1,0 % in 1982. This low percentage does not reflect the true position as bulk buyers of electricity from Escom also sell to domestic consumers.

Changes in the market share of the distribution undertakings

In Table 10 the most important features of the different distribution undertakings, i.e. GW.h sold, area of supply in square kilometres, number of consumers, network kilometres, working capital, operating costs, total cost to consumers in cents per KW.h, and the system load factor for the different undertakings are compared for the years 1974 and 1982. The percentage increase with regard to these factors, for the period 1974-1982, is also indicated in this table.

An analysis of the figures in this table shows that the total *market share* of all the Escom undertakings is subdivided as follows:

TABLE 10

A COMPARISON OF THE MOST IMPORTANT FEATURES OF THE DISTRIBUTION UNDERTAKINGS AND THE CHANGES WHICH TOOK PLACE BETWEEN 1974 AND 1982

	Year	Rand and OFS Under- taking	% of total	Natal Under- taking	% of total	Eastern Transvaal Under- taking	% of total	Cape Western Under- taking	% of total	Cape Northern Under- taking	% of total	Orange River Under- taking	% of total	Border Under- taking	% of total	Total of all Under- takings
GW.h sold.....	1974 1982	31 147 54 011	59,2 56,2	8 500,0 15 973	16,2 16,6	6 527,4 14 053	12,4 14,6	3 851,6 7 014,9	7,3 7,3	1 210,5 2 667,4	2,3 2,8	786,2 1 381,7	1,5 1,4	551,5 1 035	1,0 1,1	52 574,2 96 136,0
% Increase.....	1974- 1982	73,4	—	87,9	—	115,3	—	82,1	—	120,3	—	75,7	—	87,7	—	82,9
Area of supply in km ²	1974 1982	261 900 264 400		106 700 106 700		97 600 93 500		105 900 116 800		144 800 244 100		139 600 146 800		55 400 55 400		911 900 1 027 700
% Increase.....	1974- 1982	0,1		—		-4,2		10,3		68,6		5,2		—		12,7
Number of consumers	1974 1982	35 766 41 362		26 345 34 475		8 216 13 320		69 873 99 153		3 731 6 122		225 2 112		4 194 7 046		148 350 203 590
% Increase.....	1974- 1982	15,6		30,8		62,1		41,9		64,1		838,7		68,0		37,2
Number of consumers per GW.h sold	1974 1982	1,15 0,77		3,10 2,16		1,26 0,95		18,14 14,13		3,08 2,30		0,29 1,53		7,60 6,81		
% Decline	1974- 1982	33,1		30,4		24,6		22,2		25,5		—		10,4		
Network kilometres	1974 1982	30 274 43 117	36,4 34,1	14 569 21 589	17,5 17,1	12 516 22 158	15,1 17,5	14 617 20 308	17,6 16,1	6 092 10 469	7,3 8,3	2 384 4 292	2,9 3,4	2 682 4 565	3,2 3,6	83 134 126 498
% Increase.....	1974- 1982	42,4	—	48,1	—	77,0	—	38,9	—	71,8	—	80,0	—	70,2	—	52,2
Working capital in R,000	1974 1982	309 845 832 126	47,5 44,3	109 810 228 932	16,9 12,1	95 002 297 744	14,6 15,2	77 084 258 533	11,8 13,8	34 536 165 217	5,3 8,8	14 279 49 294	2,2 2,6	10 969 45 175	1,7 2,4	651 525 1 877 021
% Increase.....	1974- 1982	168,6	—	108,5	—	213,4	—	235,4	—	378,4	—	245,2	—	311,8	—	188,1
Operating costs in R,000	1974 1982	12 094 82 676	37,0 37,6	5 926 37 120	18,1 16,9	4 802 31 436	14,7 14,3	6 271 39 516	19,2 18,0	1 884 13 016	5,8 5,9	333 7 686	1,00 3,5	1 388 8 425	4,2 3,8	32 698 219 875
% Increase.....	1974- 1982	583,6	—	526,4	—	554,6	—	530,1	—	590,9	—	2 208,1	—	507,0	—	572,4
Total cost to consumers in c/kW.h	1974 1982	0,5726 2,634		0,7941 2,274		0,6528 2,763		1,1536 3,614		0,9869 3,860		— —		1,4642 4,323		— —
% Increase.....	1974- 1982	360,0	—	186,4	—	323,3	—	213,3	—	291,1	—	—	—	195,2	—	—
System load factor	1974 1982	0,742 0,712		0,721 0,731		0,825 0,718		0,685 0,719		0,665 0,693		— —		0,595 0,588		— —
% Increase/% Decline	1974- 1982	-4,05	—	+1,4	—	-13,0	—	+4,9	—	+4,2	—	—	—	-1,2	—	—

Source: ESCOM.

- ☆ **The Rand and Orange Free State Undertaking**, with 59,2 % of the total Escom sales in 1974 and 56,2 % in 1982, was the major seller although the *increase* of 73,4 % in its sales during that period was less than the increase of 82,9 % in Escom's total sales.
- ☆ **The Natal Undertaking's market share** of 16,2 % in 1974 and 16,6 % in 1982 was the second largest market share of all the undertakings, and indeed remained almost constant during the period under review.
- ☆ **The Eastern Transvaal Undertaking's market share** increased from 12,4 % in 1974 to 14,6 % of the Escom total in 1982. The increase in the undertaking's sales during this period was 115,3 %.

During the period 1974–1982 sales increased by 7 525,6 GW.h in the Eastern Transvaal and 7 473,0 GW.h in the Natal Undertaking, as against 23 864 GW.h in the Rand and Orange Free State Undertaking.

The three undertakings mentioned above, namely the Rand and Orange Free State, Natal and Eastern Transvaal Undertakings, supplied 87,8 % of the total electricity sold by all undertakings in 1974 and 87,4 % in 1982.

The Cape Western Undertaking's *market share* of Escom's total sales remained constant at 7,3 % of total sales in 1974 and 1982, while its sales increased by 82,1 %, i.e. almost the same percentage increase as that of the total Escom sales.

The Cape Northern Undertaking's *market share* increased from 2,3 % in 1974 to 2,8 % in 1982 while its sales increased by 120,3 %.

The Orange River and Cape Eastern Undertakings together had only 1,4 % of the total market in both 1974 and 1982, while the *market share* of the Border Undertaking was 1,0 % in 1974 and 1,1 % in 1982.

Essential differences between certain features of the distribution undertakings

The information in Table 10 also illustrates the essential differences between certain features of the distribution undertakings.

Escom's *total area of supply* increased by 12,7 % to more than a million km² during the period 1974–1982. The *greatest increase in area of supply* during that period was that of 68,6 % in the Cape Northern and 10,3 % in the Cape Western Undertakings. The Rand and Orange Free State and Cape Northern Undertakings, with 264 000 and 244 100 km² respectively, were the largest in terms of area in 1982, the Orange River Undertaking, with 146 800 km², was in the second class in terms of area in that year, while the Cape Western, the Natal and the Eastern Transvaal Undertakings, with 116 800, 106 700 and 93 500 km² respectively, could be grouped together and the Border Undertaking was the smallest with an area of 55 400 km².

The total number of consumers of Escom power in the distribution undertakings

During the period 1974–1982 the total number of Escom consumers increased by 37,2 % to 203 590.

That there are essential differences between the types and mix of consumers in the different undertakings is evident from the figures for the number of consumers per GW.h sold in 1982, which varied from 14,13 for the Cape Western to 0,77 for the Rand and Orange Free State Undertakings, while the number of consumers in these two undertakings during that year was 99 153 and 41 362 respectively. These differences exist because Escom, except in the Cape Western Undertaking, supplies electricity mainly to bulk consumers, be they municipalities, mines or industries and, to a limited extent, apart from the exception mentioned, directly to private dwellings, as in the Cape Western Undertaking.

The length of transmission lines in the distribution undertakings

The network kilometres of transmission lines per distribution undertaking, the length of the network in kilometres per GW.h sold, and the change which took place in the two parameters during the period 1974–1982, give a good indication of the differences in the *regional* demand for electricity in the distribution areas covered by the undertakings.

During the period 1974–1982 the total length of the supply network in the distribution undertakings increased from 83 134 km to 126 498 km, or by 52,2 %. The greatest increases in network lengths were those in the Eastern Transvaal, Cape Northern, and Border Undertakings and the Orange River plus the Cape Eastern Undertakings, where lengths *increased by more than 70 %*, while the lengths of the networks of the Rand and Orange Free State, Natal and Cape Western Undertakings increased by 42,4 %, 48,1 % and 38,9 % respectively during the period 1974–1982.

On 31 December 1982 the length of the network in the Rand and Orange Free State Undertaking was 43 117 km, which was approximately twice as long as those of the Natal, Eastern Transvaal and Cape Western Undertakings. The 10 469 km of the Cape Northern network, on the other hand, equalled approximately *one quarter* of the length of that of the Rand and Orange Free State Undertaking at the end of 1982, while the network of the Border and Orange River Undertakings plus the Cape Eastern Undertaking was approximately *one tenth* of the length of that of the Rand and Orange Free State Undertaking during that year.

The total working capital in the distribution undertakings

The total working capital in the distribution undertakings increased from R651 525 000 in 1974 to R1 877 021 000 in 1982, or by 188,1 %.

The total capital in the distribution undertakings increased from R12,39 per GW.h sold in 1974 to R34,75 per GW.h sold in 1982, or by 180,5 %.

In 1982 there were reasonably large differences in the working capital per GW.h sold in the different distribution undertakings, as is evident from the figures in Table 11.

TABLE 11

WORKING CAPITAL IN R000 IN THE DIFFERENT DISTRIBUTION UNDERTAKINGS PER GW.h SOLD IN 1974 AND 1982

Undertaking	Working capital in R000 per GW.h sold		
	1974	1982	% Increase
Rand and Orange Free State	9,95	15,41	54,9
Natal	12,92	14,33	10,9
Eastern Transvaal	14,55	21,19	45,6
Cape Western	20,01	36,85	84,2
Cape Northern	28,83	61,94	114,8
Orange River	18,16	35,68	96,5
Cape Eastern, Border	19,89	43,65	119,5

Source: ESCOM.

In 1982 the Cape Northern Undertaking had the highest amount of working capital per GW.h sold, but it must be pointed out that both the area of supply and the network in kilometres of this undertaking increased by approximately 70 % in the period 1974–1982.

Operating costs—excluding electricity purchases—of the distribution undertakings

The figures in Table 10 also indicate that the total operating costs—excluding electricity purchased—of all the distribution undertakings together increased from R32 698 000 in 1974 to R219 875 000 in 1982. This 572,4 % increase in total operating costs during the period 1974 to 1982 is one of the contributory factors to the increase in the price of electricity and must be examined in depth. It is particularly significant that operating costs, excluding electricity purchased, increased substantially in *all* the distribution undertakings during the period 1974–1982, as indicated below:

Undertaking	Increase in operating costs (electricity purchases ex- cluded)
	1974–1982
Rand and Orange Free State	583,5%
Natal	526,4%
Eastern Transvaal	554,6%
Cape Western	530,1%
Cape Northern	590,9%
Border	507,0%

Source: ESCOM.

Operating costs—excluding electricity purchased—per GW.h sold and per kilometre of network length of the distribution undertakings

The operating costs—excluding electricity purchased—per GW.h sold and per kilometre of network length for the different distribution undertakings are reflected in Tables 7A to 7H and summarised in Table 12.

The total operating costs, excluding electricity purchased, per GW.h sold for all the distribution undertakings as a whole, increased from R624 in 1974 to R2 287 in 1982, or by 267 %.

The percentage increase in total operating costs per GW.h sold, excluding electricity purchased, was between 213 % and 292 % for the *different* distribution undertakings for the period 1974–1982.

The operating costs—excluding electricity purchased—per kilometre of network length, for the distribution undertakings as a whole, increased from R394 in 1974 to R1 738 in 1982, or by 341 % during that period. The percentage increase in total operating costs, excluding electricity purchased, per kilometre network length, was between 256 % and 368 % for the different distribution undertakings during the period 1974–1982.

Total cost to consumers in cents per kW.h sold

Table 13 shows the total cost to consumers in cents per kW.h sold in the different distribution undertakings for the years 1974 and 1982 as well as the percentage increase in the total costs.

TABLE 12

THE TOTAL OPERATING COSTS, EXCLUDING ELECTRICITY PURCHASED, PER GW.h SOLD AND PER KILOMETRE OF NETWORK LENGTH, FOR THE DIFFERENT DISTRIBUTION UNDERTAKINGS IN 1974 AND 1982

	Total operating costs excluding electricity purchased					
	Per GW.h sold			Per Kilometre of network length		
	1974	1982	% Increase	1974	1982	% Increase
	R	R		R	R	
Rand and Orange Free State Undertaking.....	390	1 530	292	410	1 920	368
Natal Undertaking.....	700	2 320	231	410	1 720	320
Eastern Transvaal Undertaking.....	740	2 240	202	380	1 420	274
Cape Western Undertaking.....	1 630	5 630	245	430	1 950	353
Cape Northern Undertaking.....	1 560	4 880	213	310	1 240	300
Orange River and Cape Eastern Undertaking.....						
Border Undertaking.....	2 520	8 140	223	520	1 850	256

Source: ESCOM.

TABLE 13

TOTAL COSTS TO CONSUMERS IN CENTS PER kW.h SOLD BY THE DIFFERENT UNDERTAKINGS IN 1974 AND 1982

Undertaking	Total cost to consumers in cents per kW.h		
	1974	1982	% Increase
Rand and Orange Free State	0,5726	2,634	360
Natal.....	0,7941	2,724	243
Eastern Transvaal	0,6528	2,763	323
Cape Western.....	1,1536	3,614	213
Cape Northern.....	0,9869	3,860	291
Orange River and Cape Eastern		3,477	
Border	1,4642	4,323	195

Source: ESCOM.

Although the total costs to consumers in cents per kW.h sold in the distribution undertakings have increased by percentages varying between 195 and 360 from 1974 to 1982, *three average tariff structures* emerged for the different undertakings in 1982.

In the Rand and Orange Free State, Natal and Eastern Transvaal Undertakings the cost to consumers in cents per kW.h sold in 1982 varied between 2,634 and 2,763 cents, in the Cape Western, Cape Northern and Orange River Undertakings between 3,477 and 3,860 cents and in the Border Undertaking it was 4,323 cents.

Trends of growth of electricity sales during the period 1967–1982

The period 1967–1982 was characterised by a number of years in which the percentage growth of GW.h sales, in comparison with those of the previous year, was particularly high.

These years of extremely high growth rate of electricity consumption in the different undertakings are set out in Table 14.

Information on the percentage increase in electricity sales in certain sectors in the various distribution undertakings during certain periods has been summarised in Table 15.

TABLE 14

YEARS OF EXCEPTIONALLY HIGH GROWTH RATE OF ELECTRICITY CONSUMPTION IN CERTAIN UNDERTAKINGS

Year	Rand and Orange Free State Undertaking		Natal Undertaking		Eastern Transvaal Undertaking		Cape Western Undertaking		Cape Northern Undertaking		Orange River Undertaking		Border Undertaking		Cape Eastern Undertaking		Escom growth for year as a percentage	Million kW.h sold by Escom	Increase in GW.h sold by Escom over previous year
	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year	Percentage growth over previous year	Increase in GW.h sold in year			
1967.....	7,57	—	6,35	—	17,5	—	12,15	—	17,52	—	—	—	8,00	—	28,0	—	8,6	26 657,1	—
1968.....	6,77	—	10,78	500,9	12,79	361,8	8,68	—	17,25	89,7	—	—	5,54	—	28,13	0,9	8,4	28 885,0	2 227,9
1969.....	6,53	—	12,50	515,2	19,83	633,0	9,49	158,1	7,92	—	333,3	5,6	6,44	—	39,02	1,6	9,1	31 505,6	2 620,6
1970.....	10,26	2 075	9,42	436,8	12,28	469,7	15,17	276,7	8,66	—	428,8	34,3	9,5	29,9	7,02	—	10,7	34 890,6	3 394,0
1971.....	5,95	—	19,69	998,8	6,23	—	18,73	393,5	10,46	74,8	124,8	52,8	10,96	39,5	16,39	1,0	9,0	38 040,0	3 149,4
1972.....	6,72	—	14,26	865,7	14,76	673,2	11,10	276,8	13,44	106,1	52,0	49,5	12,05	48,2	18,31	1,3	9,5	41 648,9	3 608,9
1973.....	10,83	2 730	9,27	643,3	16,48	826,8	13,62	377,7	18,34	164,3	65,3	94,3	12,61	56,5	15,48	1,3	11,8	46 578,4	4 929,5
1974.....	11,49	3 209	12,12	918,7	7,05	—	22,32	703,0	14,19	150,4	229,2	547,4	9,29	46,9	18,56	1,8	12,9	52 585,1	6 002,7
1975.....	8,88	—	7,83	—	11,33	739,4	20,87	804,0	10,73	129,9	16,4	129,2	8,38	—	17,39	2,0	10,0	57 869,2	5 284,1
1976.....	9,79	3 321	8,35	—	10,48	761,5	5,90	—	12,41	166,3	13,0	119,4	12,90	77,1	4,44	—	9,5	63 355,7	5 486,5
1977.....	4,29	—	8,22	—	12,88	933,9	1,98	—	10,71	161,3	0,3	—	7,78	—	57,45	0,6	5,9	67 125,4	3 769,7
1978.....	8,00	—	9,20	989,0	11,20	1 014,8	3,74	—	16,21	268,8	0,9	—	7,08	—	32,74	8,1	8,4	72 780,4	5 655,0
1979.....	9,37	3 933	10,67	1 752,0	16,09	1 621,0	7,23	—	22,26	431,1	12,0	125,9	6,11	—	0,68	—	10,7	80 582,8	7 802,4
1980.....	8,24	—	7,71	—	10,16	1 189,0	10,28	577,2	8,81	—	10,1	118,7	9,04	74,7	13,76	7,4	8,6	87 539,3	6 945,5
1981.....	5,91	—	6,41	—	13,17	1 697,0	8,26	—	5,94	—	5,9	—	7,79	—	—	—	7,2	93 844,0	6 304,7
1982.....	2,63	—	7,31	—	-3,64	—	5,05	—	-2,28	—	1,0	—	6,56	—	—	—	2,4	96 135,0	2 291,0

Source: ESCOM.

TABLE 15

PERCENTAGE INCREASE OF ELECTRICITY SALES IN CERTAIN SECTORS FOR CERTAIN PERIODS IN DISTRIBUTION UNDERTAKINGS

	Year	Rand & OFS Undertaking	% of total	Natal Undertaking	% of total	Eastern Tvl. Undertaking	% of total	Cape Western Undertaking	% of total	Cape Northern Undertaking	% of total	Orange River plus Cape East Undertaking	% of total	Border Undertaking	% of total	Total of all Undertakings	% of total
Traction G.W.h.....	1967	724.1	37.0	509.6	26.0	251.3	12.8	368.5	18.8	104.6	5.3	—	—	—	—	1 958.1	7.3
Traction G.W.h.....	1974	1 020.3	32.8	981.6	31.6	353.6	11.4	491.2	15.8	261.2	8.4	—	—	—	—	3 107.9	6.1
% annual growth.....	1967-1974	5.02	—	9.8	—	4.9	—	4.19	—	13.9	—	—	—	—	—	7.62	—
Traction C.W.h.....	1982	1 572.9	35.5	1 354.9	30.5	560.6	12.6	603.9	13.6	343.6	7.7	—	—	—	—	4 435.9	4.6
% annual growth.....	1974-1982	5.6	—	4.1	—	5.92	—	2.61	—	3.48	—	—	—	—	—	4.54	—
% annual growth.....	1967-1982	5.3	—	6.7	—	5.5	—	3.34	—	8.25	—	—	—	—	—	5.6	—
Bulk supply G.W.h.....	1967	2 656.7	44.5	2 445.7	41.0	150.3	2.5	334.3	5.6	122.0	2.0	—	0.02	254.4	4.3	5 964.5	22.4
Bulk supply G.W.h.....	1974	6 947.3	44.8	4 696.6	30.3	704.1	4.5	1 736.2	11.2	265.0	1.7	689.1	4.4	483.3	3.1	15 521.6	29.5
% annual growth.....	1967-1974	14.7	—	9.76	—	24.68	—	26.53	—	11.71	—	150.93	—	9.60	—	14.64	—
Bulk supply G.W.h.....	1982	15 502.0	47.9	8 470.3	26.2	1 715.5	5.3	3 899.2	12.1	531.4	1.6	1 325.7	4.1	904.3	2.8	32 348.4	33.6
% annual growth.....	1974-1982	10.55	—	7.65	—	11.77	—	10.64	—	9.08	—	6.52	—	8.14	—	9.61	—
% annual growth.....	1967-1982	12.47	—	8.63	—	17.62	—	17.79	—	10.30	—	60.47	—	8.82	—	11.93	—
Mining G.W.h.....	1967	10 078.5	88.1	120.5	1.1	1 026.8	9.0	—	—	215.7	1.9	—	—	—	—	11 441.5	42.9
Mining G.W.h.....	1974	14 562.5	86.0	1 652.9	1.0	1 652.9	9.8	—	—	549.3	3.2	—	—	—	—	16 940.6	32.2
% annual growth.....	1967-1974	5.39	—	7.03	—	7.03	—	—	—	14.28	—	—	—	—	—	5.76	—
Mining C.W.h.....	1982	22 557.3	82.4	334.1	1.2	2 942.0	10.7	—	—	1 538.7	5.6	—	—	—	—	27 372.1	28.5
% annual growth.....	1974-1982	6.08	—	7.42	—	7.08	—	—	—	15.33	—	—	—	—	—	6.55	—
% annual growth.....	1967-1982	5.51	—	7.03	—	7.26	—	—	—	13.99	—	—	—	—	—	5.98	—
Industrial G.W.h.....	1967	4 094.4	60.8	575.9	8.6	1 370.5	20.4	602.5	9.0	65.2	1.0	1.1	0.02	19.6	0.3	6 729.2	25.2
Industrial G.W.h.....	1974	8 354.1	51.9	2 490.8	15.5	3 792.1	23.5	1 215.2	7.5	108.3	0.7	104.8	0.7	40.4	0.3	16 105.7	30.6
% annual growth.....	1967-1974	10.72	—	23.26	—	15.64	—	10.54	—	7.51	—	91.73	—	10.88	—	13.27	—
Industrial C.W.h.....	1982	14 150.2	45.7	5 665.2	18.3	8 804.3	28.4	1 941.9	6.3	246.8	0.8	53.6	0.2	97.3	0.3	30 959.3	32.2
% annual growth.....	1974-1982	8.01	—	11.91	—	11.26	—	6.42	—	9.29	—	-4.15	—	13.71	—	9.37	—
% annual growth.....	1967-1982	8.61	—	16.46	—	13.20	—	8.11	—	9.27	—	29.57	—	11.27	—	10.7	—
Domestic/Street G.W.h.....	1967	201.8	35.9	68.9	12.2	30.7	5.5	227.8	40.5	12.4	2.2	1.0	0.2	20.2	3.6	562.8	2.1
Domestic/Street G.W.h.....	1974	262.3	28.9	155.0	17.0	24.7	2.7	409.0	45.0	26.4	2.9	3.9	0.4	27.8	3.1	909.1	1.7
% annual growth.....	1967-1974	3.81	—	12.27	—	-3.05	—	8.72	—	11.39	—	21.46	—	4.66	—	7.09	—
Domestic/Street C.W.h.....	1982	228.6	22.4	148.6	14.5	30.9	3.0	569.9	55.8	6.8	0.7	4.0	0.4	32.9	3.2	1 021.7	1.0
% annual growth.....	1974-1982	-1.7	—	-0.52	—	2.83	—	4.23	—	-15.6	—	0.31	—	2.12	—	1.41	—
% annual growth.....	1967-1982	0.83	—	5.25	—	0.94	—	6.30	—	3.92	—	9.68	—	3.30	—	4.05	—

Source: ESCOM.

Table 16 highlights years of particularly high growth rates of electricity consumption in certain sectors in the various distribution undertakings, while Table 17 provides information on GW.h sales and average prices for the years 1967, 1974 and 1982 for the various undertakings as well as the average annual growth percentage of GW.h sales and c/kW.h prices for the same undertakings for the periods 1967–1974, 1974–1982 and 1967–1982.

As regards the high growth rate years of electricity consumption in the various undertakings, the figures in Table 14 reflect the following:

Electricity sales in GW.h per annum by the *Rand and Orange Free State Undertaking* increased by 2 075 GW.h or 10,26 % in 1970 as compared with sales in the previous year, by 2 730 GW.h or 10,83 % in 1973, by 3 209 GW.h or 11,49 % in 1974, by 3 321 GW.h or 9,79 % in 1976 and by 3 933 GW.h or 9,37 % in 1979.

In the *Natal Undertaking* the annual growth rate of electricity sales exceeded the 9 % notch in 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1978 and 1979.

In the *Eastern Transvaal Undertaking* the annual growth rate of electricity sales failed to exceed the 9 % notch only in 1971, 1974 and 1982.

In the *Cape Western Undertaking* the annual growth rate of electricity sales exceeded the 9 % notch in 1967, 1969, 1970, 1971, 1972, 1973, 1974, 1975 and 1980.

In the *Cape Northern Undertaking* electricity sales increased from 519,9 GW.h in 1972 to 2 667,4 GW.h in 1982. In this undertaking the annual growth rate of electricity sales failed to exceed the 9 % notch only in 1969, 1970, 1980, 1981 and 1982.

In the *Orange River Undertaking* exceptionally high annual growth rates marked the period 1968 to 1982, when GW.h sales increased from 2,4 in 1968 to 1 381,7 in 1982. This undertaking merged with the Cape Eastern Undertaking in 1980. In the *Orange River Undertaking* the annual growth rate of electricity sales failed to exceed the 9 % notch only in 1977, 1978, 1981 and 1982.

In the *Border Undertaking* the annual growth rate of electricity sales exceeded the 9 % notch in 1970, 1971, 1972, 1973, 1974, 1976 and 1980.

Growth rates of bulk supply in the various distribution undertakings and years of exceptionally high growth rates in this sector

The figures in Tables 15 and 16 give the information included in the following sections regarding growth rates and years of exceptionally high growth.

The average annual growth rate of 14,64 % for bulk supply, for the period 1967–1974, which was considerably higher than the growth rate of 9,61 % for the period 1974–1982, was the result of the following exceptionally high average annual growth rates in certain undertakings, namely:

TABLE 16

YEARS OF EXCEPTIONALLY HIGH GROWTH RATES OF ELECTRICITY CONSUMPTION IN CERTAIN SECTORS, IN DISTRIBUTION UNDERTAKINGS

Year	Rand and Orange Free State Undertaking					Natal Undertaking					Eastern Transvaal Undertaking					Cape Western Undertaking					Cape Northern Undertaking					Orange River Undertaking					Cape Eastern Undertaking			Border Undertaking		
	Percentage growth over previous year					Percentage growth over previous year					Percentage growth over previous year					Percentage growth over previous year					Percentage growth over previous year					Percentage growth over previous year					Percentage growth over previous year			Percentage growth over previous year		
	Traction	Bulk supply	Mining	Industrial	Domestic	Traction	Bulk supply	Mining	Industrial	Domestic	Traction	Bulk supply	Mining	Industrial	Domestic	Traction	Bulk supply	Mining	Industrial	Domestic	Traction	Bulk supply	Mining	Industrial	Domestic	Traction	Bulk supply	Mining	Industrial	Domestic	Bulk supply	Industrial	Domestic	Bulk supply	Industrial	Domestic
1967	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1968	7.4	13.0	3.9	9.3	22.7	13.8	9.5	8.4	13.8	9.6	7.4	22.0	13.3	12.3	14.3	6.1	6.6	—	11.6	8.0	54.6	9.5	5.8	9.6	16.9	—	—	—	—	—	—	—	—	—	—	
1969	1.9	8.6	5.2	8.5	6.2	15.1	11.0	2.0	18.0	13.8	0.1	14.2	7.3	33.9	6.3	1.5	8.0	—	15.4	8.2	10.9	6.6	6.1	8.8	11.0	—	257.0	—	—	—	—	—	—	—	—	
1970	0.6	11.3	10.3	10.6	9.1	12.5	7.5	15.5	12.8	10.6	0.03	18.3	10.7	14.3	7.5	4.0	36.5	—	12.4	9.1	-0.7	12.1	9.2	20.4	17.4	—	420.0	—	—	—	—	—	—	—	—	
1971	9.6	12.0	1.6	10.4	19.2	9.1	10.3	5.0	66.0	17.8	10.7	18.6	4.0	6.0	-3.5	1.8	50.0	—	11.2	8.9	14.2	7.2	10.6	7.2	15.3	—	25.6	—	—	—	—	—	—	—	—	
1972	6.9	17.6	1.3	10.2	12.5	9.0	11.8	1.05	24.9	11.6	9.3	24.2	3.3	21.4	-18.0	0.9	22.8	—	7.5	6.4	-0.3	11.1	26.2	8.4	11.0	—	27.7	—	—	—	—	—	—	—	—	
1973	3.4	20.5	9.0	8.3	10.0	0.28	11.8	2.9	8.5	13.2	7.4	56.3	5.0	18.3	9.8	6.2	23.2	—	8.9	9.6	14.1	21.0	23.7	5.0	11.5	—	119.0	—	—	-60.0	11.1	10.3	26.0	10.3	45.2	13.9
1974	5.6	20.6	6.9	17.8	-48.0	9.5	6.3	4.8	27.2	9.6	0.7	23.6	6.1	5.8	-29.0	8.9	46.6	—	7.0	10.9	12.7	15.2	20.2	-5.2	-2.6	—	400.0	—	-2.3	150.0	15.0	34.9	0.0	9.6	3.1	13.5
1975	9.7	18.5	2.4	12.1	12.6	5.4	6.1	5.7	11.9	11.9	5.6	9.1	4.6	15.1	20.6	3.0	37.2	—	8.1	10.6	4.8	12.6	13.3	10.1	-8.0	—	25.7	—	-48.0	80.0	0.0	25.9	14.7	8.4	5.4	12.2
1976	12.0	13.5	6.9	10.1	15.2	2.5	7.9	15.6	11.3	-0.9	1.4	9.6	8.1	12.2	22.1	-3.7	6.5	—	8.2	6.6	7.6	12.6	16.5	3.6	1.9	—	15.5	—	-29.0	11.1	13.0	6.8	-5.1	14.0	9.6	-0.9
1977	0.1	1.7	6.0	4.6	20.0	3.3	7.2	14.2	13.2	-28.0	11.2	7.4	13.7	13.8	-20.0	-5.1	4.6	—	5.0	-13.8	-7.9	8.4	21.2	-2.4	7.5	—	1.3	—	-29.0	0.0	226.9	24.4	8.1	7.9	13.5	-3.2
1978	12.5	5.9	9.9	8.7	-19.3	1.5	5.6	8.0	18.0	-4.1	4.7	-5.5	7.4	15.8	-29.2	-0.6	1.5	—	8.8	4.7	-4.5	6.1	152.8	15.7	4.2	—	1.7	—	-25.0	-98.0	69.4	40.2	-60.0	7.1	19.8	-15.0
1979	9.3	12.0	7.3	11.1	-16.4	8.12	7.1	9.7	16.6	8.9	9.1	24.6	7.1	18.8	25.7	10.5	9.3	—	3.8	3.4	57.3	7.6	-39.0	10.3	9.7	—	12.1	—	6.7	400.0	0.7	1.5	-6.2	5.8	10.2	3.5
1980	9.1	14.2	7.5	4.9	-27.5	10.8	8.8	7.4	5.7	-2.5	19.2	3.8	9.0	10.9	8.5	13.6	12.7	—	5.4	8.7	-0.3	7.0	11.0	18.5	8.2	—	9.2	—	60.7	0.0	12.4	16.0	66.0	8.8	14.3	3.0
1981	5.1	12.1	4.6	2.0	18.2	4.17	10.1	8.8	1.6	12.3	1.3	29.7	5.4	14.3	5.3	10.4	8.4	—	6.5	10.7	0.1	10.5	5.8	17.0	-34.6	—	40.2	2 000.0	—	—	—	—	7.6	7.6	12.5	
1982	-4.4	7.5	7.4	1.6	-3.1	-2.5	8.1	-1.8	9.2	5.6	-4.0	19.6	4.8	-9.5	4.4	-5.0	8.1	—	2.5	5.4	-15.6	7.9	-3.4	15.7	-70.7	—	0.5	—	15.5	14.3	—	—	—	5.9	13.0	7.9

Source: ESCOM.

TABLE 17

GW.h SALES, AVERAGE PRICES AND AVERAGE ANNUAL PERCENTAGE GROWTH OF SALES AND PRICES FOR BULK, RETAIL AND DOMESTIC SALES IN THE VARIOUS DISTRIBUTION UNDERTAKINGS

Undertaking	GW.h Sales and average prices									Average annual percentage growth of GW.h sales and c/kW.h price								
	Year	Bulk sales		Retail sales		Domestic sales		Total sales		Period	Bulk sales		Retail sales		Domestic sales		Total sales	
		GW.h sold	Price c/kW.h	GW.h sold	Price c/kW.h	GW.h sold	Price c/kW.h	GW.h sold	Price c/kW.h		GW.h sold	Price c/kW.h	GW.h sold	Price c/kW.h	GW.h sold	Price c/kW.h	GW.h sold	Price c/kW.h
Rand and Orange Free State Undertaking	1967	17 538,3	0,4355	15,4	1,3952	201,7	0,8114	17 755,4	0,4430	1967-1974	8,3	3,5	41,7	3,3	3,8	4,7	8,4	3,7
	1974	30 708,5	0,5548	175,7	1,7533	262,3	1,1169	31 146,5	0,5726	1974-1982	7,1	21,3	19,0	14,4	-1,7	19,2	7,1	21,0
	1982	53 076,6	2,5926	705,8	5,1419	228,6	4,5641	54 011,0	2,6342	1967-1982	7,7	12,6	29,1	9,1	0,8	12,2	7,7	12,6
Natal Undertaking.....	1967	3 621,7	0,6985	31,9	1,7549	67,0	1,6237	3 720,6	0,7248	1967-1974	12,5	1,3	15,5	2,2	12,3	0,4	12,5	1,3
	1974	8 284,0	0,7647	84,6	2,0394	152,5	1,6672	8 500,0	0,7941	1974-1982	8,2	16,8	18,8	12,0	-0,01	14,0	8,2	16,7
	1982	15 498,7	2,6562	325,7	5,0420	148,6	4,7428	15 973,0	2,7243	1967-1982	10,2	9,3	17,2	7,3	5,3	7,4	10,2	9,2
Eastern Transvaal Undertaking	1967	2 785,9	0,5264	13,6	2,2197	30,1	1,5948	2 829,6	0,5437	1967-1974	12,8	2,6	19,5	0,2	-3,1	2,2	12,7	2,6
	1974	6 457,4	0,6294	45,3	2,2531	24,7	1,8516	6 527,4	0,6528	1974-1982	9,9	20,1	23,9	10,8	2,8	12,8	10,1	19,8
	1982	13 771,0	2,7154	251,4	5,1006	30,9	4,8395	14 053,3	2,7627	1967-1982	11,2	11,6	21,8	5,7	0	7,7	11,3	11,4
Cape Western Undertaking	1967	1 233,2	0,9791	178,6	1,6885	221,3	1,4680	1 533,1	1,0914	1967-1974	15,1	0,8	10,1	4,5	8,7	1,6	14,1	0,8
	1974	3 301,4	1,0388	141,2	2,2904	409,0	1,6456	3 851,6	1,1536	1974-1982	7,9	15,4	13,1	12,1	4,2	17,2	7,8	15,3
	1982	6 066,6	3,2729	378,4	5,7205	569,9	5,8459	7 014,9	3,6139	1967-1982	11,2	8,4	11,7	8,5	6,3	9,6	10,7	8,3
Cape Northern Undertaking	1967	—	0,8434	—	2,0413	12,4	1,6891	519,9	0,8758	1967-1974	—	1,7	—	5,9	11,4	-0,4	12,8	1,7
	1974	—	0,9507	—	3,0505	26,4	1,6393	1 210,5	0,9869	1974-1982	—	18,8	—	10,7	-15,6	17,3	10,4	18,6
	1982	2 581,9	3,7625	—	6,8915	6,8	5,8868	2 667,4	3,8603	1967-1982	—	10,5	—	8,4	-3,9	8,7	11,5	10,4
Orange River Undertaking	1967	—	1,0583	—	2,3092	20,2	1,6760	294,2	1,304	1967-1974	—	—	—	—	—	—	—	—
	1974	—	1,3914	—	3,3093	27,8	2,2140	551,5	1,4642	1974-1982	—	2,9	—	8,9	21,7	11,0	7,3	22,3
	1982	—	4,0930	—	7,7002	32,9	7,1514	1 034,5	4,3234	1967-1982	—	—	—	—	—	—	—	—
Cape Eastern Undertaking	1967	—	2,6066	—	3,0292	1,0	3,6938	3,2	3,0532	1967-1974	—	3,5	—	1,4	19,1	-0,4	20,0	1,4
	1974	—	3,3086	—	3,3430	3,4	3,5941	11,5	3,4087	1974-1982	—	—	—	—	—	—	—	—
	1982	—	—	—	—	—	—	—	—	1967-1982	—	—	—	—	—	—	—	—
Border Undertaking	1967	—	1,0583	—	2,3092	20,2	1,6760	294,2	1,304	1967-1974	—	4,0	—	5,3	4,7	4,1	9,4	3,8
	1974	—	1,3914	—	3,3093	27,8	2,2140	551,5	1,4642	1974-1982	—	14,4	—	11,1	2,1	15,8	8,2	14,5
	1982	—	4,0930	—	7,7002	32,9	7,1514	1 034,5	4,3234	1967-1982	—	9,4	—	8,4	3,3	10,2	8,7	9,4

Source: ESCOM.

Undertaking	Average annual percentage growth rate for the periods	
	1967-1974	1974-1982
Rand and Orange Free State	14,70	10,55
Natal	9,76	7,65
Eastern Transvaal	24,68	11,77
Cape Western	26,53	10,64
Cape Northern	11,71	9,08
Orange River and Cape Eastern	150,93	8,52
Border	9,60	8,14

Growth rates in the different distribution undertakings in respect of sales in the industrial sector, and years of exceptionally high growth rates in this sector

The average annual growth rate of 13,27 % for electricity sales in the industrial sector during the period 1967-1974, which was considerably higher than the growth rate of 9,37 % during the period 1974-1982, was due to the following average annual growth rates being exceptionally high, namely:

Undertaking	Average annual percentage growth rate for the periods	
	1967-1974	1974-1982
Rand and Orange Free State	10,72	8,01
Natal	23,26	11,91
Eastern Transvaal	15,64	11,26
Cape Western	10,54	6,42
Cape Northern	7,51	9,29
Orange River	91,73	-4,15
Border	10,88	13,71

Growth rates in the different distribution undertakings in respect of sales in the mining sector, and years of exceptionally high growth rates in this sector

The average annual growth rate of 6,55 % for electricity sales in the mining sector during the period 1974-1982, which was higher than the growth rate of 5,76 % during the period 1967-1974, was due to the high average annual growth rates in certain undertakings, namely:

Undertaking	Average annual percentage growth rate for the periods	
	1967-1974	1974-1982
Rand and Orange Free State	5,39	6,08
Natal	5,50	7,42
Eastern Transvaal	7,03	7,08
Cape Northern	14,28	15,33

Growth rates in the different distribution undertakings in respect of sales in the traction sector, and years of exceptionally high growth rates in this sector

The average annual growth rate of 7,62 % in sales of electricity for traction during the period 1967-1974, which was higher than the growth rate of 4,54 % during the period 1974-1982, was due to the high average annual growth rates in certain undertakings, namely:

Undertaking	Average annual percentage growth rate for the periods	
	1967-1974	1974-1982
Rand and Orange Free State	5,02	5,60
Natal	9,80	4,10
Eastern Transvaal	4,90	5,92
Cape Western	4,19	2,61
Cape Northern	13,90	3,48

In 1982 sales of electricity for domestic use constituted only 1 % of Escom's total sales and consequently requires no further analysis in this connection at present.

Apart from the above division of consumption into sectors, Escom also differentiates between bulk, retail and domestic sales. In this instance bulk sales include not only sales to municipalities, as in the previous instance, but also those to industries and other bulk consumers.

Growth rate in bulk, retail and domestic sales in the different distribution undertakings, in terms of GW.h sales and prices in c/kW.h

The information in Annexure A on bulk, retail and domestic sales in all distribution undertakings during the years 1967–1982, expressed as GW.h sales and c/kW.h price for each year, is summarised in Table 17 which, among other things, indicates the average annual growth percentage of sales and prices for the years 1967–1974, 1974–1982 and 1967–1982.

From the information in these tables it is clear that—

- ★ **Bulk sales** in the different distribution undertakings increased as follows in GW.h sold and price in c/kW.h during the following periods:

Period	Undertaking	Percentage increase per annum in	
		Sales	Price
1967–1974.....	Rand and OFS	8,3	3,5
	Natal.....	12,5	1,3
	Eastern Transvaal	12,8	2,6
	Cape Western.....	15,1	0,8
	Cape Northern.....	7,1	21,3
1974–1982.....	Rand and OFS	8,2	16,8
	Natal.....	9,9	20,1
	Eastern Transvaal	7,9	15,4
	Cape Western.....	7,7	12,6
	Cape Northern.....	10,2	9,3
1967–1982.....	Rand and OFS	11,2	11,6
	Natal.....	11,2	11,7
	Eastern Transvaal	11,2	11,7
	Cape Western.....	11,2	11,7
	Cape Northern.....	11,2	11,7

Although these figures are not available for bulk sales in other distribution undertakings, it is clear that in the four major undertakings, which were responsible for more than 80 % of sales, the annual growth rate of—

- GW.h sales were exceptionally high during the period 1967–1974, while the percentage annual growth in c/kW.h was exceptionally low; the second period was characterised by exactly the opposite trends, namely
- the average annual growth percentage of GW.h sales during the period 1974–1982 was relatively low while it was very high in c/kW.h.

As bulk sales in these four undertakings are of predominant importance for the determination of growth trends of sales, the facts stated above are of vital importance in determining long-term trends and will be examined in greater detail at a later stage.

- ★ **Retail sales** in different distribution undertakings increased as follows in respect of GW.h sold and price in c/kW.h during the following periods:

Period	Undertaking	Percentage increase per annum in	
		Sales	Price
1967–1974.....	Rand and OFS	41,7	3,3
	Natal.....	15,5	2,2
	Eastern Transvaal	19,5	0,2
	Cape Western.....	10,1	4,5
	Cape Northern.....	5,9	5,9
1974–1982.....	Rand and OFS	19,0	14,4
	Natal.....	18,8	12,0
	Eastern Transvaal	23,9	10,8
	Cape Western.....	13,1	12,1
	Cape Northern.....	10,7	10,7
1967–1982.....	Rand and OFS	29,1	9,1
	Natal.....	17,2	7,3
	Eastern Transvaal	21,8	5,7
	Cape Western.....	8,4	8,4
	Cape Northern.....	8,4	8,4

During both periods, 1967–1974 and 1974–1982, GW.h sales in the four major undertakings increased by an exceptionally high average annual growth rate, while the percentage growth rate in c/kW.h was low during the first period and high during the second period.

- ★ **Domestic sales** constituted a relatively small part of total sales in all undertakings except the Cape Western Undertaking.

It is clear that the exceptionally high growth rate during the period 1967–1974 was due particularly to the high growth rate of bulk sales in the Rand and Orange Free State, Natal, Eastern Transvaal and Cape Western Undertakings during that period.

PAGE 1 OF TABLE 7A

DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982

RAND AND ORANGE FREE STATE UNDERTAKING

Calendar year	GW.h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Undertakings operating costs per km of network length in R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per kW.h sold -	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967.....	17 775	189 600	19 436	18 187	447 799	3 799	10,67	1,09	1,02	25,19	0,21	0,764	0,21	7,57	0,4430	6,2
1968.....	18 979	189 600	22 352	20 292	485 689	4 353	9,99	1,18	1,07	25,59	0,23	0,750	0,21	6,77	0,4527	2,2
1969.....	20 218	189 600	25 513	22 343	596 520	4 657	9,38	1,26	1,11	29,50	0,23	0,759	0,21	6,53	0,4568	0,9
1970.....	22 293	189 600	27 906	23 599	677 024	4 818	8,50	1,25	1,06	30,37	0,22	0,757	0,20	10,26	0,4542	-0,6
1971.....	23 620	189 600	30 667	25 601	841 067	4 811	8,03	1,30	1,08	35,61	0,20	0,751	0,19	5,95	0,4821	6,1
1972.....	25 208	261 900	30 221	25 444	247 019	8 812	10,39	1,20	1,01	9,80	0,35	0,757	0,35	6,72	0,5222	8,3
1973.....	27 938	261 900	32 698	28 518	272 520	10 556	9,37	1,17	1,02	9,75	0,38	0,767	0,37	10,83	0,5496	5,2
1974.....	31 147	261 900	35 766	30 274	309 845	12 094	8,41	1,15	0,97	9,95	0,39	0,742	0,41	11,49	0,5726	4,2
1975.....	33 914	261 900	38 545	32 026	343 155	17 453	7,72	1,14	0,94	10,12	0,52	0,760	0,55	8,88	0,6847	19,6
1976.....	37 235	261 900	42 191	34 275	392 758	22 287	7,03	1,13	0,92	10,55	0,60	0,748	0,65	9,79	0,9056	32,3
1977.....	38 833	261 900	43 829	36 329	459 922	24 991	6,74	1,13	0,94	11,84	0,64	0,740	0,69	4,29	1,3395	47,9
1978.....	41 874	264 400	45 423	38 055	515 606	29 762	6,30	1,08	0,91	12,28	0,71	0,765	0,78	8,09	1,6333	21,9
1979.....	45 907	264 400	33 943	39 090	574 453	34 939	5,76	0,74	0,85	12,51	0,76	0,746	0,89	9,37	1,7569	7,6
1980.....	49 691	264 400	36 252	40 233	660 124	43 233	5,32	0,73	0,81	13,28	0,87	0,754	1,07	8,24	1,9012	8,2
1981.....	52 629	264 400	38 371	42 188	721 231	60 840	5,02	0,73	0,80	13,70	1,16	0,752	1,44	5,91	2,156	13,4
1982.....	54 011	264 400	41 362	43 117	832 126	82 676	4,90	0,77	0,80	15,41	1,53	0,712	1,92	2,63	2,634	22,2

N.B.—With the establishment of the Central Generating Undertaking on 1 January 1972, some of the assets of the Rand and Orange Free State Undertaking which were in commercial use were transferred to the Central Generating Undertaking.

PAGE 2 OF TABLE 7A

DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982

RAND AND ORANGE FREE STATE UNDERTAKING

Year	Traction				Bulk supply				Mining				Industrial				Domestic and Street Lighting				Total				% of Escom Total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967	724,1	4,1	2	362,1	2 656,7	15,0	117	22,7	10 078,5	56,8	103	97,8	4 094,4	23,0	1 621	2,5	201,8	1,1	17 593	0,01	17 755,4	100	19 436	0,9	66,6	20,4
1968	777,5	4,1	2	388,7	3 002,5	15,8	125	24,0	10 473,8	55,2	101	103,7	4 477,8	23,6	1 863	2,4	247,7	1,3	20 261	0,01	18 979,3	100	22 352	0,9	65,7	22,5
1969	792,4	3,9	2	396,2	3 258,3	16,1	132	24,7	11 019,2	54,5	102	108,0	4 860,4	24,0	2 086	2,3	287,8	1,5	23 191	0,01	20 218,1	100	25 513	0,8	64,2	23,7
1970	796,9	3,6	2	398,5	3 261,1	16,3	139	26,1	12 148,7	54,5	101	120,3	5 379,0	24,1	2 236	2,4	342,7	1,5	27 657	0,01	22 293,4	100	27 906	0,8	63,9	24,2
1971	873,7	3,7	2	436,9	4 063,5	17,2	143	28,4	12 337,3	52,3	105	117,5	5 937,0	25,1	2 243	2,6	408,4	1,7	28 174	0,01	23 620,0	100	30 667	0,8	62,1	24,7
1972	934,4	3,7	2	467,2	4 778,7	19,0	152	31,4	12 492,5	49,5	102	122,5	6 543,1	26,0	2 060	3,2	459,5	1,8	27 905	0,02	25 208,2	100	30 221	0,8	60,5	23,7
1973	965,8	3,5	2	482,9	5 760,7	20,6	156	36,9	13 617,7	48,7	102	133,5	7 088,6	25,4	2 155	3,3	505,0	1,8	30 283	0,02	27 937,7	100	32 698	0,9	60,0	23,7
1974	1 020,3	3,3	2	510,2	6 947,3	22,3	142	48,9	14 562,5	46,8	99	147,1	8 354,1	26,8	19 745	0,4	262,3	0,8	15 778	0,02	31 146,5	100	35 766	0,9	59,2	24,0
1975	1 119,1	3,3	2	559,6	8 230,7	24,2	150	54,9	14 907,5	44,0	103	144,7	9 361,2	27,6	21 329	0,4	295,5	0,9	16 961	0,02	33 814,1	100	38 545	0,9	58,6	25,1
1976	1 253,4	3,4	2	626,7	9 399,0	25,2	154	61,0	15 936,5	42,8	102	156,2	10 359,9	27,7	23 430	0,4	340,5	0,9	18 503	0,02	37 235,4	100	42 191	0,9	58,8	25,2
1977	1 254,7	3,2	2	627,3	9 500,6	24,5	157	60,5	16 884,8	43,5	102	165,5	10 784,8	27,8	24 240	0,5	408,5	1,0	19 328	0,02	38 833,4	100	43 829	0,9	57,9	25,8
1978	1 311,4	3,1	2	655,7	10 064,7	24,0	170	59,2	18 549,3	44,2	106	175,0	11 719,8	27,9	25 225	0,5	329,4	0,8	19 920	0,02	41 974,5	100	45 423	0,9	57,7	25,8
1979	1 432,9	3,1	2	716,5	11 273,1	24,5	178	63,3	19 905,6	43,4	110	181,0	13 019,5	28,4	24 202	0,5	275,4	0,6	9 451	0,03	45 906,5	100	33 943	1,4	57,0	20,2
1980	1 562,6	3,1	2	781,3	12 868,3	25,9	184	69,9	21 398,7	43,1	116	184,5	13 662,2	27,5	25 293	0,5	199,6	0,4	10 657	0,02	49 691,2	100	36 252	1,4	56,8	20,2
1981	1 642,8	3,1	2	821,4	14 425,7	27,4	188	76,7	22 390,5	42,5	124	190,6	13 933,7	26,5	27 195	0,5	236,0	0,5	10 862	0,02	52 628,7	100	38 371	1,4	56,1	20,0
1982	1 572,9	2,9	2	786,4	15 502,0	26,7	191	81,2	22 557,3	41,8	128	176,2	14 150,2	26,2	29 268	0,5	228,6	0,4	11 773	0,02	54 011,0	100	41 362	1,3	56,2	20,3

N.B.:

- Escom from time to time sells sections of networks in this undertaking as well as in other undertakings to local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of a total.
- In 1974 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; the consumption by such consumers is reflected in the "Industrial" column.

PAGE 3 OF TABLE 7A

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR PERIOD 1967 TO 1982

RAND AND ORANGE FREE STATE UNDERTAKING

Cal- endar year	Bulk				Retail				Domestic and street lighting				Undertaking system			
	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h
1967....	17 538,3			0,4355	15,3			1,3952	201,8			0,8114	17 755,4	66,6		0,4430
1968....	18 711,9		6,7	0,4441	19,7		28,6	1,4032	247,7		22,8	0,8160	18 979,3	65,7	6,9	0,4527
1969....	19 905,5		6,4	0,4470	24,8		26,3	1,4600	287,8		16,2	0,8295	20 218,1	64,2	6,5	0,4568
1970....				0,4439				1,3917	342,7		19,1	0,8294	22 293,4	63,9	10,3	0,4542
1971....	23 178,6			0,4703	33,0			1,4602	408,4		19,2	0,8549	23 620,0	62,1	6,0	0,4821
1972....	24 720,4		6,7	0,5092	28,3		-14,2	1,4785	459,5	46,5	12,5	0,9273	25 208,2	60,5	6,7	0,5222
1973....	27 406,6		10,9	0,5363	26,1		-7,7	1,5351	505,0	46,2	9,9	0,9578	27 937,7	60,0	10,8	0,5496
1974....	30 708,5		12,0	0,5548	175,7		570,6	1,7533	262,3	28,9	-48,0	1,1169	31 146,5	59,2	11,5	0,5726
1975....	33 248,2		8,3	0,6634	370,4		110,8	2,0680	295,5	29,3	12,7	1,3498	33 914,1	58,6	8,9	0,6847
1976....	36 474,0		9,7	0,8809	420,9		13,6	2,4720	340,5	31,2	15,3	1,6054	37 235,4	58,8	9,8	0,9056
1977....	37 879,9	58,3	3,9	1,3110	545,0	47,6	29,5	2,8461	408,5	39,3	19,9	2,0233	38 833,4	57,9	4,3	1,3395
1978....	41 178,8	58,2	8,7	1,5973	466,3	41,4	-14,4	3,9175	329,4	34,3	-19,4	2,9106	41 974,5	57,7	8,1	1,6333
1979....	45 112,5	57,6	9,6	1,7216	518,6	41,1	11,2	4,1280	275,4	29,3	-16,4	3,0619	45 906,5	57,0	9,4	1,7569
1980....	48 954,6	57,4	8,5	1,8675	537,0	39,2	3,5	4,4541	199,6	22,0	-27,5	3,2929	49 691,2	56,8	8,2	1,9012
1981....	51 804,1	56,7	5,8	2,1165	588,6	39,0	9,6	4,9779	236,0	23,6	18,2	3,7049	52 628,7	56,1	5,9	2,1537
1982....	53 076,6	56,9	2,5	2,5926	705,8	39,1	19,9	5,1419	228,6	22,4	-3,1	4,5641	54 011,0	56,2	2,6	2,6342

AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT

67-74	8,3			3,5	41,7			3,3	3,8			4,7	8,4			3,7
74-82	7,1			21,3	19,0			14,4	-1,7			19,2	7,1			21,0
67-82	7,7			12,6	29,1			9,1	0,8			12,2	7,7			12,6

N.B.:

1. Data omitted are not available.
2. Escom from time to time sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of growth.
3. In 1974 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; the consumption by such consumers is reflected in the "retail" column. The full effect of this is evident only in the 1975 data.

PAGE 1 OF TABLE 7B

DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982

NATAL UNDERTAKING

Calendar year	GW.h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Undertaking's operating costs per km of network length R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per kW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967	3 720,6	87 000	16 256	8 877	132 764	2 743	23,38	4,37	2,39	35,68	0,74	0,675	0,31	6,35	0,7248	-1,0
1968	4 121,5	87 000	15 788	9 555	148 629	3 151	21,11	3,83	2,32	36,06	0,76	0,689	0,33	10,78	0,7051	-2,7
1969	4 636,7	87 000	17 188	10 504	166 771	3 630	18,76	3,71	2,27	35,97	0,78	0,697	0,35	12,50	0,6991	-0,9
1970	5 073,5	104 100	18 651	11 276	170 707	4 098	20,52	3,68	2,22	33,65	0,81	0,703	0,36	9,42	0,7044	0,8
1971	6 072,3	104 100	20 444	12 343	193 057	4 368	17,14	3,37	2,03	31,79	0,72	0,690	0,35	19,69	0,6907	-1,9
1972	6 938,0	106 700	22 816	13 327	88 294	3 881	15,38	3,29	1,92	12,73	0,56	0,713	0,29	14,26	0,7014	1,5
1973	7 581,3	106 700	24 654	13 873	95 858	4 949	14,07	3,37	1,83	12,64	0,65	0,727	0,36	9,27	0,7556	7,7
1974	8 500,0	106 700	26 345	14 569	109 810	5 926	12,55	3,10	1,71	12,92	0,70	0,721	0,41	12,12	0,7941	5,1
1975	9 165,8	106 700	28 309	15 276	121 475	8 575	11,64	3,09	1,67	13,25	0,94	0,737	0,56	7,83	0,9133	15,0
1976	9 931,1	106 700	29 540	16 093	129 492	11 220	10,74	2,97	1,62	13,04	1,13	0,737	0,70	8,35	1,2234	34,0
1977	10 747	106 700	29 618	16 956	144 390	12 440	9,93	2,76	1,58	13,44	1,16	0,734	0,73	8,22	1,8624	52,2
1978	11 736	106 700	30 153	17 570	164 547	15 297	9,09	2,57	1,50	14,02	1,30	0,725	0,87	9,20	1,8790	0,9
1979	12 988	106 700	28 553	17 930	174 461	17 654	8,22	2,20	1,38	13,43	1,36	0,732	0,98	10,67	1,8594	-1,0
1980	13 989	106 700	30 225	18 859	184 784	23 064	7,63	2,16	1,35	13,21	1,65	0,763	1,22	7,71	1,9492	4,8
1981	14 885	106 700	32 246	19 877	204 636	29 950	7,17	2,17	1,34	13,75	2,01	0,747	1,51	6,41	2,188	12,3
1982	15 973	106 700	34 475	21 589	228 932	37 120	6,68	2,16	1,35	14,33	2,32	0,731	1,72	7,31	2,724	24,5

N.B.: With the establishment of the Central Generating Undertaking on 1 January 1972 some of the assets of Natal Undertaking were transferred to the Central Generating Undertaking.

PAGE 2 OF TABLE 7B

DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982

NATAL UNDERTAKING

Year	Traction				Bulk supply				Mining				Industrial				Domestic and street lighting				Total				% of Econ total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967	509.6	13.7	9	56.6	2 445.7	65.7	24	101.9	120.5	3.2	27	4.5	575.9	15.5	2 469	0.2	68.9	1.9	13 727	0.005	3 720.6	100	16 256	0.2	14.0	17.1
1968	580.1	14.1	12	48.3	2 680.2	65.0	25	107.2	130.6	3.2	29	4.5	655.1	15.9	2 939	0.2	75.5	1.8	12 783	0.006	4 121.5	100	15 788	0.3	14.3	15.9
1969	667.9	14.4	12	55.7	2 976.5	64.2	26	114.5	133.2	2.9	33	4.0	773.2	16.7	3 350	0.2	85.9	1.8	13 767	0.006	4 636.7	100	17 188	0.3	14.7	16.0
1970	751.5	14.8	13	57.8	3 201.1	63.1	28	114.3	153.9	3.0	32	4.8	872.0	17.2	3 688	0.2	95.0	1.9	14 890	0.006	5 073.5	100	18 651	0.3	14.5	16.2
1971	819.7	13.5	13	63.1	3 532.5	58.2	29	121.8	161.5	2.7	32	5.0	1 446.7	23.8	4 032	0.4	111.9	1.8	16 338	0.007	6 072.3	100	20 444	0.3	16.0	16.5
1972	893.5	12.9	14	63.8	3 950.3	56.9	30	131.7	163.2	2.4	31	5.3	1 805.9	26.0	4 529	0.4	124.9	1.8	18 212	0.007	6 938.0	100	22 816	0.3	16.7	17.9
1973	896.0	11.8	14	64.0	4 417.3	58.3	32	138.0	167.9	2.2	32	5.2	1 958.7	25.8	5 087	0.4	141.4	1.9	19 489	0.007	7 581.3	100	24 654	0.3	16.3	17.9
1974	981.6	11.5	14	70.1	4 696.6	55.3	35	134.2	175.9	2.1	33	5.3	2 490.8	29.3	5 485	0.5	155.0	1.8	20 778	0.007	8 500.0	100	26 345	0.3	16.2	17.7
1975	1 034.9	11.3	14	73.9	4 984.7	54.4	35	142.4	185.9	2.0	36	5.2	2 786.9	30.4	5 937	0.5	173.4	1.9	22 287	0.008	9 165.8	100	28 309	0.3	15.8	18.5
1976	1 060.8	10.7	14	75.8	5 381.5	54.2	37	145.4	215.0	2.2	35	6.1	3 101.9	31.2	12 948	0.2	171.9	1.7	16 506	0.01	9 931.1	100	29 540	0.3	15.7	17.7
1977	1 096.4	10.2	15	73.1	5 771.2	53.7	35	164.9	245.6	2.3	34	7.2	3 510.3	32.7	12 403	0.3	123.1	1.1	17 131	0.007	10 746.5	100	29 618	0.4	16.0	17.4
1978	1 113.5	9.5	12	92.8	6 097.0	51.9	34	179.3	265.3	2.3	34	7.8	4 142.6	35.3	12 905	0.3	118.0	1.0	17 168	0.007	11 736.4	100	30 153	0.4	16.1	17.1
1979	1 204.0	9.3	10	120.4	6 532.2	50.3	35	186.6	291.0	2.2	33	8.8	4 832.1	37.2	12 890	0.4	128.5	1.0	15 585	0.008	12 987.8	100	28 553	0.5	16.1	17.0
1980	1 334.2	9.6	10	133.4	7 109.3	50.8	35	203.1	312.5	2.2	39	8.0	5 107.7	36.5	13 768	0.4	125.3	0.9	16 373	0.008	13 989.0	100	30 225	0.5	16.0	16.8
1981	1 389.9	9.3	10	139.0	7 828.4	52.6	36	217.5	340.2	2.3	48	7.1	5 187.9	34.9	14 712	0.4	140.7	0.9	17 440	0.008	14 885.0	100	32 246	0.5	15.9	16.8
1982	1 354.9	8.5	10	135.5	8 470.3	53.0	36	235.3	334.1	2.1	50	6.7	5 665.2	35.5	15 850	0.4	148.6	0.9	18 529	0.008	15 973.0	100	34 475	0.5	16.6	16.9

N.B.:

1. Econ from time to time sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of a total.
2. In 1976 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; consumption by such consumers has been included in the "industrial" column.

PAGE 3 OF TABLE 7B

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1967 TO 1982

NATAL UNDERTAKING

Cal- endar year	Bulk				Retail				Domestic and street lighting				Undertaking total			
	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h
1967	3 621,7			0,6985	30,0			1,7549	68,9			1,6237	3 720,6	14,0	6,3	0,7248
1968	4 014,8		10,9	0,6796	31,2		3,1	1,7675	75,5		10,1	1,5913	4 121,5	14,3	10,8	0,7051
1969	4 512,0		12,4	0,6727	38,8		23,7	1,1870	85,9		13,8	1,5659	4 636,7	14,7	12,5	0,6991
1970				0,6781				1,7535	95,0		10,8	1,5178	5 073,5	14,5	9,4	0,7044
1971	5 906,1			0,6654	54,3			1,7537	111,9		17,9	1,4812	6 072,3	16,0	19,7	0,6907
1972	6 750,4		14,3	0,6752	62,7		14,9	1,8051	124,9	12,4	11,8	1,4716	6 938,0	16,7	14,3	0,7014
1973	7 365,8		9,1	0,7261	74,1		17,7	1,9650	141,4	12,7	13,4	1,6237	7 581,3	16,3	9,3	0,7556
1974	8 262,9		11,9	0,7647	82,1		10,9	2,0394	155,0	16,8	9,6	1,6672	8 500,0	16,2	12,1	0,7941
1975	8 900,7		8,0	0,8821	91,7		12,2	2,1965	173,4	16,9	11,6	1,8024	9 165,8	15,8	7,8	0,9133
1976	9 640,7		8,3	1,1868	118,5		24,9	2,7882	171,9	15,7	1,0	2,1876	9 931,1	15,7	8,3	1,2234
1977	10 434,3	16,1	8,2	1,8025	189,1	16,5	59,7	3,7285	123,1	11,8	-28,4	4,0723	10 746,5	16,0	8,2	1,8624
1978	11 441,0	16,2	9,6	1,8161	177,4	15,7	-6,2	4,4832	118,0	12,3	-4,1	4,0658	11 736,4	16,1	9,2	1,8790
1979	12 361,9	16,1	10,4	1,7997	227,4	18,0	28,2	4,0566	128,5	13,7	-8,9	3,8399	12 987,8	16,1	10,7	1,8594
1980	13 607,0	16,0	7,7	1,8903	256,7	18,7	12,9	4,1220	125,3	13,8	-2,5	3,8896	13 989,0	16,0	7,7	1,9492
1981	14 469,0	15,8	6,3	2,1181	275,3	18,3	7,8	4,7298	140,7	13,9	11,3	4,3529	14 885,0	15,9	6,4	2,1875
1982	15 498,7	16,6	7,1	2,6562	325,7	18,0	17,8	5,0420	148,6	14,6	6,6	4,7428	15 973,0	16,6	7,3	2,7243

AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT

67-74	12,5			1,3	15,5			2,2	12,3			0,4	12,5			1,3
74-82	8,2			16,8	18,8			12,0	-0,01			14,0	8,2			16,7
67-82	10,2			9,3	17,2			7,3	5,3			7,4	10,2			9,2

N.B.:

1. Data omitted are not available.
2. Escom from time to time sells sections of networks in this Undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of growth.
3. As from 1 September 1976 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; consumption by such consumers is reflected in the "retail" column. The full effect of this is evident only in the 1977 data.

PAGE 1 OF TABLE 7C

DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982

EASTERN TRANSVAAL UNDERTAKING

Calendar year	GW.h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Undertaking's operating costs per km of network length in R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per kW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967.....	2 829,6	92 500	6 211	7 182	134 662	972	32,69	2,20	2,54	47,59	0,34	0,772	0,14	17,50	0,5437	2,6
1968.....	3 191,4	92 500	6 687	8 049	139 154	1 097	28,98	2,10	2,52	43,60	0,34	0,764	0,14	12,79	0,5540	1,9
1969.....	3 824,4	92 500	6 976	8 555	142 105	1 286	24,19	1,82	2,24	37,16	0,34	0,777	0,15	19,83	0,5366	-3,1
1970.....	4 294,1	92 500	7 609	9 287	140 695	1 773	21,54	1,77	2,16	32,76	0,41	0,818	0,19	12,28	0,5192	-3,2
1971.....	4 561,5	92 500	6 412	9 972	146 378	1 841	20,28	1,41	2,19	32,09	0,40	0,786	0,18	6,23	0,5196	0,1
1972.....	5 234,7	97 600	7 138	10 927	75 162	2 370	18,64	1,36	2,09	14,36	0,45	0,788	0,22	14,76	0,5367	3,3
1973.....	6 097,5	97 600	7 605	11 748	88 186	3 396	16,01	1,25	1,93	14,46	0,56	0,816	0,29	16,48	0,5612	4,6
1974.....	6 527,4	97 600	8 216	12 516	95 002	4 802	14,95	1,26	1,92	14,55	0,74	0,825	0,38	7,05	0,6528	16,3
1975.....	7 266,8	97 600	8 918	13 195	99 478	5 854	13,43	1,23	1,82	13,69	0,81	0,818	0,44	11,33	0,7621	16,7
1976.....	8 028,3	97 600	9 453	14 010	117 879	7 269	12,16	1,18	1,75	14,68	0,91	0,772	0,52	10,48	0,9758	28,0
1977.....	9 062,2	97 600	9 888	15 210	154 773	9 201	10,77	1,09	1,68	17,08	1,02	0,816	0,60	12,88	1,4001	43,5
1978.....	10 077	97 600	10 254	18 013	184 400	10 847	9,69	1,02	1,79	18,30	1,08	0,807	0,60	11,20	1,7187	22,8
1979.....	11 698	93 500	10 727	19 187	220 050	14 163	7,99	0,92	1,64	18,81	1,21	0,801	0,74	16,09	1,8758	9,0
1980.....	12 887	93 500	11 302	20 254	239 660	19 116	7,26	0,88	1,57	18,60	1,48	0,734	0,94	10,16	1,9607	4,5
1981.....	14 584	93 500	12 189	20 763	251 777	22 699	6,41	0,84	1,42	17,26	1,56	0,766	1,09	13,17	2,173	10,8
1982.....	14 053	93 500	13 320	22 158	297 744	31 436	6,65	0,95	1,58	21,19	2,24	0,718	1,42	-3,64	2,763	27,2

N.B.—With the establishment of the Central Generating Undertaking on 1 January 1972, some of the assets of the Eastern Transvaal Undertaking were transferred to the Central Generating Undertaking.

PAGE 2 OF TABLE C

DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982

EASTERN TRANSVAAL UNDERTAKING

Year	Traction				Bulk Supply				Mining				Industrial				Domestic and Street Lighting				Total				% of Excom Total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967	251.3	8.9	7	35.9	150.3	5.3	18	8.4	1 026.8	36.3	75	13.7	1 370.5	48.4	1 585	0.9	30.7	1.1	4 526	0.007	2 829.6	100	6 211	0.5	10.6	6.5
1968	269.9	8.5	7	38.6	184.0	5.8	20	9.2	1 162.9	36.4	79	14.7	1 539.4	48.2	1 804	0.9	35.1	1.1	4 777	0.007	3 191.4	100	6 687	0.5	11.0	6.7
1969	270.2	7.1	7	38.6	209.0	5.4	21	10.0	1 247.3	32.6	82	15.2	2 060.6	53.9	2 070	1.0	37.3	1.0	4 796	0.008	3 824.4	100	6 976	0.5	12.1	6.5
1970	270.3	6.3	7	38.6	247.3	5.7	23	10.8	1 380.9	32.2	84	16.4	2 355.4	54.9	2 405	1.0	40.1	0.9	5 090	0.008	4 294.1	100	7 609	0.6	12.3	6.6
1971	299.3	6.6	7	42.7	293.3	6.4	24	12.2	1 435.6	31.5	82	17.5	2 494.7	54.7	2 591	1.0	38.7	0.8	3 708	0.010	4 561.5	100	6 412	0.7	12.0	5.2
1972	327.1	6.2	7	46.7	364.3	7.0	27	13.5	1 483.5	28.3	89	16.7	3 028.8	57.9	2 945	1.0	31.1	0.6	4 070	0.008	5 234.7	100	7 138	0.7	12.6	5.6
1973	351.3	5.8	7	50.2	569.5	9.3	30	19.0	1 557.5	25.5	94	16.6	3 584.5	58.8	3 254	1.1	34.8	0.6	4 220	0.008	6 097.5	100	7 605	0.8	13.1	5.5
1974	353.6	5.4	7	50.3	704.1	10.8	32	22.0	1 652.9	25.3	105	15.7	3 792.1	58.1	5 296	0.7	24.7	0.4	2 776	0.009	6 527.4	100	8 216	0.8	12.4	5.5
1975	373.3	5.1	7	53.3	768.1	10.6	31	24.8	1 728.5	23.8	110	15.7	4 367.2	60.1	5 848	0.7	29.8	0.4	2 922	0.01	7 266.8	100	8 918	0.8	12.6	5.8
1976	378.6	4.7	8	47.3	842.5	10.5	32	26.3	1 869.4	23.3	119	15.7	4 901.4	61.0	6 319	0.8	36.4	0.5	2 975	0.01	8 028.3	100	9 453	0.8	12.0	5.6
1977	423.1	4.7	12	35.3	904.9	10.0	32	28.3	2 125.7	23.4	127	16.7	5 579.5	61.6	7 297	0.8	29.1	0.3	2 420	0.01	9 062.2	100	9 888	0.9	13.5	5.8
1978	443.0	4.4	13	34.1	870.6	8.5	30	29.0	2 283.3	22.7	128	17.8	6 459.7	64.2	7 604	0.8	20.6	0.2	2 479	0.008	10 077.1	100	10 254	1.0	13.8	5.8
1979	483.2	4.1	5	96.6	1 064.5	9.1	30	35.5	2 445.9	20.9	128	19.1	7 678.7	65.7	7 997	1.0	25.9	0.2	2 567	0.01	11 698.2	100	10 727	1.1	14.5	6.4
1980	576.2	4.4	5	115.2	1 105.2	8.6	31	35.7	2 663.6	20.7	138	19.3	8 514.0	66.1	8 472	1.0	28.1	0.2	2 656	0.01	12 887.2	100	11 302	1.1	14.7	6.3
1981	583.6	4.0	5	116.7	1 433.8	9.8	31	46.3	2 807.0	19.3	135	20.8	9 730.3	66.7	9 193	1.1	29.6	0.2	2 825	0.01	14 584.3	100	12 189	1.2	15.5	6.3
1982	560.6	4.0	5	112.1	1 715.5	12.2	31	55.3	2 942.0	20.9	149	19.7	8 804.3	62.7	10 181	0.9	30.9	0.2	2 354	0.01	14 053.3	100	13 320	1.1	14.6	6.5

N.B.

- Excom from time to time sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of a total.
- In 1974 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; the consumption by such consumers is reflected in the "industrial" column.
- In 1975 there were 7 consolidated traction sections. Between 1976 and 1978 additional stations were added to the traction system. From 1979 the entire traction system in this undertaking was reconsolidated and at present comprises 5 sections.

PAGE 3 OF TABLE 7C

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1967 TO 1982

EASTERN TRANSVAAL UNDERTAKING

Calendar Year	Bulk				Retail				Domestic and street lighting				Undertaking Total			
	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h
1967	2 785,9			0,5264	13,0			2,2197	30,7			1,5948	2 829,6	10,6		0,5437
1968	3 141,3		12,8	0,5367	15,0		14,7	2,2463	35,1		14,6	1,5573	3 191,4	11,0	12,8	0,5540
1969	3 768,2		20,0	0,5184	18,8		25,6	2,1587	37,3		6,1	1,4817	3 824,4	12,1	19,8	0,5366
1970				0,5003				1,9520	40,1		7,7	1,4765	4 294,1	12,3	12,3	0,5192
1971	4 473,4			0,5012	49,4			1,5942	38,7		-3,3	1,8053	4 561,5	12,0	6,2	0,5196
1972	5 165,1		15,5	0,5168	38,5		-21,8	1,9387	31,1	3,1	-19,9	1,7439	5 234,7	12,6	14,8	0,5367
1973	6 014,8		16,5	0,5417	47,9		24,0	1,9751	34,8	3,1	12,1	1,8350	6 097,5	13,1	16,5	0,5612
1974	6 457,4		7,4	0,6294	45,3		-6,6	2,2531	24,7	2,7	-27,8	1,8516	6 527,4	12,4	7,1	0,6528
1975	7 159,2		10,9	0,7366	77,8		72,0	2,5732	29,8	2,9	20,2	1,7765	7 266,8	12,6	11,3	0,7621
1976	7 897,4		10,3	0,9468	94,5		21,3	2,8513	36,4	3,3	22,6	1,9929	8 028,3	12,7	10,5	0,9758
1977	8 912,5	13,7	12,9	1,3659	120,6	10,5	27,6	3,5093	29,1	2,8	-20,1	2,4681	9 062,2	13,5	12,9	1,4001
1978	9 905,0	14,0	11,1	1,6867	151,5	13,4	25,6	3,6294	20,6	2,1	-29,1	4,3793	10 077,1	13,8	11,2	1,7214
1979	11 510,2	14,7	16,2	1,8401	161,9	12,8	7,0	4,1517	25,9	2,7	24,8	3,4984	11 698,0	14,5	16,1	1,8920
1980	12 677,2	14,9	10,1	1,9238	181,9	13,3	12,2	4,2746	28,1	3,1	9,3	3,6183	12 887,2	14,7	10,2	1,9607
1981	14 346,7	15,7	13,2	2,1340	208,0	13,8	14,3	4,6021	29,6	3,0	5,3	3,9868	14 584,3	15,5	13,2	2,1730
1982	13 771,0	14,8	-4,0	2,7154	251,4	13,9	20,9	5,1006	30,9	3,0	4,4	4,8395	14 053,3	14,6	-3,6	2,7627

AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT

67-74	12,8			2,6	19,5			0,2	-3,1			2,2	12,7			2,6
74-82	9,9			20,1	23,9			10,8	2,8			12,8	10,1			19,8
67-82	11,2			11,6	21,8			5,7	0			7,7	11,3			11,4

N.B.:

1. Data omitted are not available.
2. Escom from time to time sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of growth.
3. As from 1 April 1974 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; the consumption by such consumers is included in the "retail" column. The full effect of this is evident only in the 1975 data.

PAGE 1 OF TABLE 7D

DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982

CAPE WESTERN UNDERTAKING

Calendar year	GW.h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Under-taking's operating costs per km of network length R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per kW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967	1 533,1	62 700	46 279	9 727	91 166	2 683	40,90	30,19	6,34	59,47	1,75	0,681	0,28	12,15	1,0914	2,7
1968	1 666,2	62 700	47 091	10 572	95 437	3 069	37,63	28,26	6,34	57,28	1,84	0,685	0,29	8,68	1,1052	1,3
1969	1 824,3	65 800	49 785	11 278	102 565	3 314	36,07	27,29	6,18	56,22	1,82	0,692	0,29	9,49	1,1032	-0,2
1970	2 101,0	88 300	52 254	12 258	120 403	3 725	42,03	24,87	5,83	57,31	1,77	0,680	0,30	15,17	1,0832	-1,8
1971	2 494,5	88 300	59 336	12 819	130 427	4 130	35,40	23,79	5,14	52,29	1,66	0,710	0,32	18,73	1,0813	-0,2
1972	2 771,3	105 900	59 434	12 852	63 581	4 047	38,21	21,45	4,64	22,94	1,46	0,713	0,31	11,10	1,0948	1,2
1973	3 148,8	105 900	66 024	13 729	72 867	4 823	33,63	20,97	4,36	23,14	1,53	0,720	0,35	13,62	1,1798	7,8
1974	3 851,6	105 900	69 873	14 617	77 084	6 271	27,50	18,14	3,80	20,01	1,63	0,685	0,43	22,32	1,1536	-2,2
1975	4 655,6	105 900	68 133	15 397	82 190	9 487	22,75	14,63	3,31	17,65	2,04	0,721	0,62	20,87	1,1999	4,0
1976	4 930,4	105 900	76 078	16 157	111 035	11 285	21,48	15,43	3,28	22,52	2,29	0,697	0,70	5,90	1,4846	23,7
1977	5 028,2	105 900	76 204	16 681	131 995	13 294	21,06	15,16	3,32	26,25	2,64	0,713	0,80	1,98	2,2271	50,0
1978	5 216,2	116 800	79 039	17 398	156 332	16 100	22,39	15,15	3,34	29,97	3,09	0,704	0,93	3,74	2,3841	7,0
1979	5 593,1	116 800	83 546	17 996	177 165	18 572	20,88	14,94	3,22	31,68	3,32	0,760	1,03	7,23	2,4844	4,2
1980	6 168,3	116 800	89 011	18 886	209 091	23 471	18,94	14,43	3,06	33,90	3,81	0,771	1,24	10,28	2,5935	4,4
1981	6 677,5	116 800	95 596	19 627	230 430	30 727	17,49	14,32	2,94	34,51	4,60	0,752	1,57	8,26	2,950	13,7
1982	7 014,9	116 800	99 153	20 308	258 533	39 516	16,65	14,13	2,89	36,85	5,63	0,719	1,95	5,05	3,614	22,5

N.B.—With the establishment of the Central Generating Undertaking on 1 January 1972 some of the assets of the Cape Western Undertaking were transferred to the Central General Undertaking.

PAGE 2 OF TABLE 7D

DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982

CAPE WESTERN UNDERTAKING

Year	Traction				Bulk Supply				Industrial				Domestic and street lighting				Total				% of Escom total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967.....	368,5	24,0	7	52,6	334,3	21,8	33	10,1	602,5	39,3	4 992	0,1	227,8	14,9	41 247	0,006	1 533,1	100	46 279	0,03	5,8	48,6
1968.....	391,3	23,5	7	55,9	356,5	21,4	34	10,5	672,3	40,3	6 104	0,1	246,1	14,8	40 946	0,006	1 666,2	100	47 091	0,04	5,8	47,4
1969.....	397,0	21,8	6	66,2	385,1	21,1	34	11,3	776,0	42,5	6 542	0,1	266,3	14,6	43 203	0,006	1 824,3	100	49 785	0,04	5,8	46,3
1970.....	412,6	19,7	6	68,8	525,7	25,0	35	15,0	872,0	41,5	6 960	0,1	290,7	13,8	45 253	0,006	2 101,0	100	52 254	0,04	6,0	45,4
1971.....	420,2	16,8	6	70,0	788,1	31,6	40	19,7	969,7	38,9	7 015	0,1	316,4	12,7	52 275	0,006	2 494,5	100	59 336	0,04	6,6	47,8
1972.....	424,3	15,3	6	70,7	968,4	34,9	42	23,1	1 042,1	37,6	7 818	0,1	336,6	12,2	51 568	0,007	2 771,3	100	59 434	0,05	6,7	46,6
1973.....	450,8	14,3	6	75,1	1 193,8	37,9	45	26,5	1 135,3	36,1	9 223	0,1	368,9	11,7	56 750	0,007	3 148,8	100	66 024	0,05	6,8	47,9
1974.....	491,2	12,7	6	81,9	1 736,2	45,1	54	32,2	1 215,2	31,6	9 636	0,1	409,0	10,6	60 177	0,007	3 851,6	100	69 873	0,06	7,3	46,8
1975.....	505,9	10,9	6	84,3	2 383,3	51,2	56	42,6	1 314,1	28,2	8 780	0,1	452,2	9,7	59 291	0,008	4 655,6	100	68 133	0,07	8,0	44,4
1976.....	486,9	9,9	6	81,2	2 538,9	51,5	56	45,3	1 422,5	28,8	16 542	0,09	482,0	9,8	59 474	0,008	4 930,4	100	76 078	0,06	7,8	45,5
1977.....	461,9	9,2	6	77,0	2 637,5	52,8	57	46,6	1 493,6	29,7	16 151	0,09	415,1	8,3	59 990	0,007	5 028,2	100	76 204	0,07	7,5	44,8
1978.....	458,9	8,8	7	65,6	2 698,2	51,7	58	46,5	1 624,5	31,1	16 400	0,1	434,6	8,4	62 547	0,007	5 216,2	100	79 039	0,07	7,2	44,9
1979.....	507,1	9,1	9	56,3	2 950,3	52,7	64	46,1	1 686,5	30,2	16 769	0,1	449,2	8,0	66 704	0,007	5 593,1	100	83 546	0,07	6,9	49,7
1980.....	576,1	9,4	9	64,0	3 325,5	53,9	64	52,0	1 778,3	28,8	17 554	0,1	488,5	7,9	71 384	0,007	6 168,3	100	89 011	0,07	7,0	48,5
1981.....	636,2	9,5	9	70,7	3 606,8	54,0	68	53,0	1 893,7	28,4	18 515	0,1	540,8	8,1	77 004	0,007	6 677,5	100	95 596	0,07	7,1	49,8
1982.....	603,9	8,6	9	67,1	3 899,2	55,6	76	51,3	1 941,9	27,7	18 583	0,1	569,9	8,1	80 485	0,007	7 014,9	100	99 153	0,07	7,3	48,7

N.B.: 1. Escom from time to time sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of a total.

2. As from 1 September 1976 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; the consumption by such consumers is reflected in the "Industrial" column.

PAGE 3 OF TABLE 7D

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1967 TO 1982

CAPE WESTERN UNDERTAKING

Cal- end- year	Bulk				Retail				Domestic and Street Lighting				Undertaking total			
	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h
1967....	1 233,2			0,9791	72,1			1,6885	227,8			1,4680	1 533,1	5,8		1,0914
1968....	1 343,3		8,9	0,9862	76,8		6,6	1,7852	246,1		8,0	1,4966	1 666,2	5,8	8,7	1,1052
1969....	1 465,2		9,1	0,9822	92,8		19,6	1,9010	266,3		8,3	1,4391	1 824,3	5,8	9,5	1,1032
1970....				0,9648				1,8687	290,7		9,2	1,4353	2 101,0	6,0	15,2	1,0832
1971....	2 062,2			0,9642	115,9			1,9558	316,4		8,8	1,4697	2 494,5	6,6	18,7	1,0813
1972....	2 305,9		11,8	0,9776	128,8		10,8	1,9734	336,6	33,1	6,4	1,5034	2 771,3	6,7	11,1	1,0948
1973....	2 644,1		14,7	1,0592	135,8		5,7	2,1581	368,9	32,9	9,6	1,6203	3 148,8	6,8	13,6	1,1798
1974....	3 301,4		24,9	1,0388	141,2		-3,2	2,2904	409,0	45,1	14,0	1,6456	3 851,6	7,3	22,3	1,1536
1975....	4 048,6		22,6	1,0881	154,7		9,6	2,3750	452,2	44,8	10,6	1,7503	4 655,5	8,0	20,9	1,1999
1976....	4 279,1		5,7	1,3351	169,3		9,4	2,8475	482,0	44,1	6,6	2,2130	4 930,4	7,8	5,9	1,4846
1977....	4 373,6	6,7	2,2	1,9528	239,5	20,9	41,5	4,2026	415,1	39,9	-13,9	3,9103	5 028,2	7,5	2,0	2,2271
1978....	4 511,9	6,4	3,2	2,0844	269,7	23,9	12,6	4,3656	434,6	45,3	4,7	4,2666	5 216,2	7,2	3,7	2,3841
1979....	4 854,4	6,2	7,6	2,1731	289,5	22,9	7,3	4,5408	449,2	47,8	3,4	4,5219	5 593,1	6,9	7,2	2,4843
1980....	5 359,8	6,3	10,4	2,2755	320,0	23,3	10,5	4,6873	488,5	53,9	8,7	4,7119	6 168,3	7,0	10,3	2,5935
1981....	5 803,8	6,4	8,3	2,5962	332,9	22,1	4,0	5,4522	540,8	54,0	10,7	5,2096	6 677,5	7,1	8,3	2,9503
1982....	6 066,6	6,5	4,5	3,2729	378,4	20,9	13,7	5,7205	569,9	55,9	5,4	5,8459	7 014,9	7,3	5,1	3,6139
AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT																
67-74	15,1			0,8	10,1			4,5	8,7			1,6	14,1			0,8
74-82	7,9			15,4	13,1			12,1	4,2			17,2	7,8			15,3
67-82	11,2			8,4	11,7			8,5	6,3			9,6	10,7			8,3

N.B.

1. Data omitted are not available.
2. Escom from time to time sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, especially those reflecting a percentage of growth.
3. As from 1 September 1976 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; consumption by such consumers has been included in the "retail" column. The full effects of this were evident only in the 1977 data.

PAGE 1 OF TABLE 7E
DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982
CAPE NORTHERN UNDERTAKING

Calendar year	GW,h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW,h sold					System load factor	Undertakings operating costs per km of network in R000	Percentage growth of GW,h sold over previous year's sales	Total costs to consumers in cents per kW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967.....	519,9	60 100	2 502	3 277	17 276	440	115,60	4,81	6,30	33,23	0,85	0,621	0,13	17,52	0,8758	0,1
1968.....	609,6	60 100	2 633	3 607	18 032	519	98,59	4,32	5,92	29,58	0,85	0,635	0,14	17,25	0,8775	0,2
1969.....	657,9	60 100	2 971	4 112	19 871	579	91,35	4,52	6,25	30,20	0,88	0,643	0,14	7,92	0,8677	-1,1
1970.....	714,9	60 100	3 206	4 091	22 359	735	84,07	4,48	5,72	31,28	1,03	0,651	0,18	8,66	0,8941	3,0
1971.....	789,7	60 100	3 596	4 322	23 977	819	76,10	4,55	5,47	30,36	1,04	0,639	0,19	10,46	0,8993	0,6
1972.....	895,8	144 800	3 897	5 147	25 007	1 223	161,64	4,35	5,75	27,92	1,37	0,634	0,24	13,44	0,9059	0,7
1973.....	1 060,1	144 800	4 083	5 691	29 814	1 507	136,59	3,85	5,37	28,12	1,42	0,669	0,26	18,34	0,9539	5,3
1974.....	1 210,5	144 800	3 731	6 092	34 536	1 884	119,62	3,08	5,03	28,83	1,56	0,665	0,31	14,19	0,9869	3,5
1975.....	1 340,4	147 400	3 849	6 456	37 736	2 969	109,97	2,87	4,82	28,15	2,22	0,684	0,46	10,73	1,1548	17,0
1976.....	1 506,7	147 400	4 147	6 806	45 976	3 528	97,83	2,77	4,52	30,51	2,34	0,698	0,52	12,41	1,4440	25,0
1977.....	1 668,0	147 400	4 334	7 418	72 654	4 356	88,37	2,60	4,45	43,56	2,61	0,699	0,59	10,71	2,0937	45,0
1978.....	1 936,8	244 100	4 646	8 328	122 642	4 979	126,03	2,40	4,30	63,32	2,57	0,683	0,60	16,12	2,8498	36,1
1979.....	2 367,9	244 100	4 701	8 602	129 106	6 627	103,09	1,99	3,63	54,52	2,80	0,699	0,77	22,26	3,0399	6,7
1980.....	2 576,6	244 100	5 787	9 030	139 708	8 296	94,74	2,25	3,50	54,22	3,22	0,706	0,92	8,81	3,1450	3,5
1981.....	2 729,6	244 100	5 760	9 565	152 717	10 991	89,43	2,11	3,50	55,95	4,03	0,683	1,15	5,94	3,394	7,9
1982.....	2 667,4	244 100	6 122	10 469	165 217	13 016	91,51	2,30	3,92	61,94	4,88	0,693	1,24	-2,28	3,860	13,7

N.B.—Data omitted are not available.

PAGE 2 OF TABLE 7E
DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982
CAPE NORTHERN UNDERTAKING

Year	Traction				Bulk supply				Mining				Industrial				Domestic and street lighting				Total				% of Escom total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967	104,6	20,1	3	34,9	122,0	23,5	10	12,2	215,7	41,5	62	3,5	65,2	12,5	290	0,225	12,4	2,4	2 137	0,006	519,9	100	2 502	0,2	2,0	2,6
1968	161,8	26,6	3	53,9	133,6	21,9	11	12,1	228,2	37,4	67	3,4	71,5	11,7	319	0,224	14,5	2,4	2 233	0,006	609,6	100	2 633	0,2	2,1	2,7
1969	179,5	27,3	3	59,8	142,4	21,6	12	11,9	242,1	36,8	72	3,4	77,8	11,8	393	0,198	16,1	2,5	2 491	0,006	657,9	100	2 971	0,2	2,1	2,8
1970	178,3	24,9	3	59,4	159,6	22,3	15	10,6	264,4	37,0	77	3,4	93,7	13,1	472	0,199	16,9	2,7	2 439	0,007	714,9	100	3 206	0,2	2,0	2,8
1971	203,6	25,8	3	67,9	171,2	21,7	15	11,4	292,6	37,0	78	3,8	100,5	12,7	563	0,179	21,8	2,8	2 937	0,007	789,7	100	3 596	0,2	2,1	2,9
1972	203,0	22,7	3	67,7	190,2	21,2	17	11,2	369,4	41,2	77	4,8	108,9	12,2	628	0,173	24,2	2,7	3 172	0,008	895,8	100	3 897	0,2	2,2	3,1
1973	231,7	21,8	3	77,2	230,2	21,7	18	12,8	456,8	43,1	74	6,2	114,3	10,8	716	0,160	27,1	2,6	3 272	0,008	1 060,1	100	4 083	0,3	2,3	3,0
1974	261,2	21,6	3	87,1	265,3	21,9	21	12,6	549,3	45,4	77	7,1	108,3	8,9	746	0,145	26,4	2,2	2 884	0,009	1 210,5	100	3 731	0,3	2,3	2,5
1975	273,9	20,4	3	91,3	298,7	22,3	30	10,0	622,4	46,4	76	8,2	119,2	8,9	873	0,137	26,2	2,0	2 867	0,009	1 340,4	100	3 849	0,4	2,3	2,5
1976	294,9	19,6	3	98,3	336,3	22,3	29	11,6	725,3	48,1	77	9,4	123,5	8,2	966	0,128	26,7	1,8	3 099	0,009	1 506,7	100	4 174	0,4	2,4	2,5
1977	271,5	16,3	3	90,5	364,6	21,9	30	12,2	862,7	52,9	77	11,5	120,5	7,3	981	0,123	28,7	1,7	3 243	0,009	1 668,0	100	4 334	0,4	2,5	2,5
1978	259,2	13,4	5	51,8	387,2	20,0	32	12,1	121,2	57,9	86	13,0	139,4	7,2	1 033	0,135	29,9	1,5	3 490	0,009	1 936,8	100	4 646	0,4	2,7	2,6
1979	407,8	17,2	5	81,6	416,5	17,6	33	12,6	357,2	57,3	86	15,8	153,7	6,5	1 048	0,147	32,8	1,4	3 529	0,009	2 367,9	100	4 701	0,5	2,9	2,8
1980	406,5	15,8	5	81,3	445,7	17,3	35	12,7	506,8	58,5	93	16,2	182,2	7,2	1 397	0,130	35,5	1,3	4 257	0,008	2 576,6	100	5 787	0,5	2,9	3,2
1981	407,1	14,9	5	81,4	492,4	18,0	38	13,0	593,6	58,4	96	16,6	213,3	7,8	4 873	0,044	23,2	0,9	748	0,031	2 729,6	100	5 760	0,5	2,9	3,0
1982	343,7	12,9	3	114,6	531,4	19,9	42	12,7	538,7	57,7	91	16,9	246,8	9,3	5 185	0,48	6,8	0,2	801	0,008	2 667,4	100	6 122	0,4	2,8	3,0

N.B. 1. Escom from time to time sell sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, specially those reflecting a percentage of a total.

2. As from 1 July 1981 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. This resulted in the transfer of some consumers to Tariff B; consumption by such consumers has been included in the "Industrial" column. The full effects of this were evident only in the 1982 data.

PAGE 3 OF TABLE 7E

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1967 TO 1982

CAPE NORTHERN UNDERTAKING

Calendar year	Bulk				Retail				Domestic and street lighting				Undertaking total			
	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h
1967....				0,8434				2,0413	12,4				519,9	2,0		0,8758
1968....				0,8465				1,8311	14,5				609,6	2,1	17,3	0,8775
1969....				0,8329				1,9701	16,1		16,9	1,6135	657,9	2,1	7,9	0,8677
1970....				0,8858				1,9571	18,9		17,4	1,5587	714,9	2,0	8,7	0,8941
1971....				0,8575				2,1020	21,8		15,3	1,5058	789,7	2,1	10,5	0,8993
1972....				0,8654				2,1177	24,2	2,4	11,0	1,5373	895,8	2,2	13,4	0,9059
1973....				0,9138				2,3339	27,1	2,5	12,0	1,6041	1 060,1	2,3	18,3	0,9539
1974....				0,9507				3,0505	26,4	2,9	-2,6	1,6393	1 210,5	2,3	14,2	0,9869
1975....				1,1166				3,0102	26,2	2,6	-0,8	1,8923	1 340,4	2,3	10,7	1,1548
1976....	1 466,3			1,4015	13,6			4,1839	26,7	2,4	1,9	2,3744	1 506,7	2,4	12,4	1,4440
1977....	1 619,6	2,5	10,5	2,0422	19,7	1,7	44,9	4,6288	28,7	2,8	7,5	3,2465	1 668,0	2,5	10,7	2,0937
1978....	1 885,3	2,7	16,4	2,8035	21,6	1,9	9,6	5,2948	29,9	3,1	4,2	3,9980	1 936,8	2,7	16,1	2,8498
1979....	2 312,8	3,0	22,7	2,9988	22,3	1,8	3,2	5,5691	32,8	3,5	9,7	4,2191	2 367,9	2,9	22,3	3,0399
1980....	2 525,7	3,0	8,8	3,0956	25,4	1,9	13,9	6,0430	35,5	3,9	8,2	4,5746	2 576,6	2,9	8,8	3,1450
1981....	2 658,7	2,9	5,7	3,3222	47,7	3,2	87,8	6,4881	23,2	2,3	-34,6	5,2279	2 729,6	2,9	5,9	3,3937
1982....	2 581,9	2,8	-2,9	3,7625	78,7	4,4	65,0	6,8915	6,8	0,7	-70,7	5,8868	2 667,4	2,8	-2,3	3,8603

AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT

67-74			1,7			5,9	11,4		-0,4	12,8		1,7
74-82			18,8			10,7	-15,6		17,3	10,4		18,6
67-82			10,5			8,4	-3,9		8,7	11,5		10,4

N.B. 1. Data omitted are not available.

- From time to time Escom sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, particularly those reflecting a percentage of growth.
- As from 1 July 1981 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "retail" column. The full effect of this is evident only in the 1982 data.
- The high growth rate of sales during the years 1978 and 1979 is due mainly to new mining developments and an increase in traffic on the Sishen-Saldanha railway line.

PAGE 1 OF TABLE 7F

DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982

ORANGE RIVER UNDERTAKING

Calendar year	GW.h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Under-taking's operating costs per km of net-work length in R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per KW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
1968.....	2,4	139 300	4	123	177	10	58 042	1,67	51,25	73,75	4,17	0,364	0,08	—	2,1422	—
1969.....	8,0	139 300	12	845	3 395	41	17 413	1,50	105,63	4,38	5,13	0,180	0,05	333,3	1,2219	-43,0
1970.....	47,3	139 300	14	873	5 503	95	2 949	0,30	18,46	116,34	2,01	0,471	0,11	591,3	1,1013	-9,9
1971.....	95,1	139 300	35	1 546	26 448	171	1 465	0,37	16,26	278	1,80	0,550	0,11	124,8	0,9864	-10,4
1972.....	144,5	139 300	69	1 509	7 772	250	964	0,48	10,44	53,79	1,73	0,577	0,17	52,0	1,1030	11,8
1973.....	238,8	139 300	130	2 132	10 350	255	583	0,54	8,93	43,34	1,07	0,339	0,12	65,3	0,9649	-12,5
1974.....	786,2	139 600	225	2 384	14 279	333	178	0,29	3,03	18,16	0,42	0,700	0,14	329,2	0,6965	-27,8
1975.....	915,4	137 000	252	2 435	17 211	661	150	0,28	2,66	18,80	0,72	0,812	0,27	16,4	0,7647	9,8
1976.....	1 034,8	137 000	296	2 784	24 139	1 504	132	0,29	2,69	23,33	1,45	0,685	0,54	13,0	0,9421	23,2
1977.....	1 037,5	137 000	318	2 821	27 911	2 218	132	0,31	2,72	26,90	2,14	0,786	0,79	0,3	1,3652	44,9
1978.....	1 047,3	137 000	338	2 914	30 137	2 186	131	0,32	2,78	28,78	2,09	0,798	0,75	0,95	1,7850	30,8
1979.....	1 173,2	137 000	369	2 815	31 570	2 487	117	0,31	2,40	26,91	2,12	0,767	0,88	12,0	2,0565	15,2
1980.....	1 291,9	137 000	486	3 061	35 456	3 117	106	0,38	2,37	27,44	2,41	0,774	1,02	10,1	2,3168	12,7
1981.....	1 367,6	146 800	1 638	3 923	45 555	5 484	107	1,20	2,87	33,31	4,01	0,794	1,40	5,9	2,833	22,3
1982.....	1 381,7	146 800	2 112	4 292	49 294	7 686	106	1,53	3,11	35,68	5,56	0,719	1,79	1,0	3,477	22,7

N.B.

1. The original licence for the Orange River Undertaking was granted on 3 June 1968.
2. As from 1 January 1981 the Cape Eastern Undertaking was amalgamated with the Orange River Undertaking.
3. Data omitted are not available.

PAGE 2 OF TABLE 7F

DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982

ORANGE RIVER UNDERTAKING

Year	Traction				Bulk Supply				Mining				Industrial				Domestic and Street Lighting				Total				% of Escm Total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967					—	—	—	—					—	—	—	—	—	—	—	—	—	—	—	—	—	—
1968					2.1	87.5	3	0.7					0.3	12.5	1	0.3					2.4	100	4	0.6	0.01	0.004
1969					7.5	93.8	9	0.8					0.5	6.2	3	0.2					8.0	100	12	0.8	0.03	0.01
1970					39.0	82.5	10	3.9					8.3	17.6	4	2.1					47.3	100	14	3.4	0.2	0.01
1971					49.0	51.5	20	2.5					46.0	48.4	15	3.1					95.1	100	35	2.7	0.3	0.03
1972					62.6	43.3	26	2.4					81.9	56.7	21	3.9	0.05	0.03	22	0.002	144.5	100	69	2.1	0.4	0.05
1973					137.3	57.5	28	4.9					101.3	42.5	57	1.8	0.2	0.08	45	0.004	238.8	100	130	1.8	0.5	0.1
1974					686.8	87.4	31	22.2					99.0	12.6	91	1.1	0.5	0.06	103	0.005	786.2	100	225	3.5	1.5	0.2
1975					863.4	94.3	32	27.0					51.2	5.6	111	0.5	0.9	0.1	109	0.008	915.4	100	252	3.6	1.6	0.2
1976					997.6	96.4	37	27.0					36.2	3.5	138	0.3	1.0	0.1	121	0.008	1 034.8	100	296	3.5	1.6	0.2
1977					1 010.7	97.4	39	25.9					25.7	2.5	166	0.2	1.0	0.1	113	0.009	1 037.5	100	318	3.3	1.5	0.2
1978					1 028.0	98.2	40	25.7					19.3	1.8	290	0.07	0.02	—	8	0.003	1 047.3	100	338	3.1	1.4	0.2
1979					1 152.5	98.2	40	28.8					20.6	1.8	299	0.07	0.1	0.01	30	0.003	1 173.2	100	369	3.2	1.5	0.2
1980					1 258.6	97.4	44	28.6					33.1	2.6	408	0.08	0.1	0.01	34	0.003	1 291.9	100	486	2.7	1.5	0.3
1981					1 319.1	96.5	50	26.4					46.4	3.4	1 226	0.04	2.1	0.2	362	0.006	1 367.6	100	1 638	0.6	1.5	0.9
1982					1 325.7	96.0	51	26.0					53.6	3.9	1 493	0.04	2.4	0.2	568	0.004	1 381.7	100	2 112	0.7	1.4	1.0

N.B.:

1. From time to time Escm sells sections of networks in this undertaking as well as in other undertakings to other local authorities . This affects the analogy of the figures above, particularly those reflecting a percentage of a total.
2. The original licence for the Orange River Undertaking was granted on 3 June 1968.
3. Data omitted is not available.
4. The increase and decrease in consumption in the Industrial section during the years 1970 to 1977 reflect the activities of the tunnelling contractors for the Orange River Project.
5. The Municipality of Port Elizabeth was provided with a partial bulk supply in 1973.
6. In 1978 Tariff C (domestic) in this Undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "Industrial" column.
7. As from 1 January 1981 the Cape Eastern Undertaking was amalgamated with the Orange River Undertaking.

PAGE 3 OF TABLE 7F

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1968 TO 1982

ORANGE RIVER UNDERTAKING

Calendar year	Bulk				Retail				Domestic and street lighting				Undertaking Total			
	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of previous year %	Average selling price c/kW.h
1968....													2,4	0,008		2,1422
1969....				1,2219									8,0	0,03	233,3	1,2219
1970....				1,1013									47,3	0,1	491,3	1,1013
1971....				0,9864									95,1	0,3	101,1	0,9864
1972....				1,1011				2,1720	0,05	0,005		4,5944	144,5	0,3	51,9	1,1030
1973....				0,9587				2,4492	0,2	0,02	300,0	3,8367	238,8	0,5	65,3	0,9649
1974....				0,6899				4,1243	0,5	0,1	150,0	4,0208	786,2	1,5	229,2	0,6965
1975....				0,7540				3,9236	0,9	0,1	80,0	3,8350	915,4	1,6	16,4	0,7647
1976....				0,9295				5,4864	1,0	0,1	11,1	4,7943	1 034,8	1,6	13,0	0,9421
1977....	1 026,7	1,6		1,3451	9,8	0,9		5,4730	1,0	0,1	0	7,4068	1 037,5	1,5	0,3	1,3652
1978....	1 040,0	1,5	1,3	1,7934	7,3	0,6	-25,5	6,1221	0,02	0,002	-98,0	8,8801	1 047,3	1,4	0,9	1,8706
1979....	1 166,7	1,5	12,2	2,0184	6,4	0,5	-13,7	8,1172	0,1	0,02	0,2	9,1394	1 173,2	1,5	12,0	2,1078
1980....	1 282,1	1,5	9,9	2,2983	9,7	0,7	52,4	7,6396	0,1	0,02	0	9,6178	1 291,9	1,5	10,1	2,3908
1981....	1 342,4	1,5	4,7	2,7160	23,1	1,5	23,1	8,9400	2,1	0,2	950,0	10,462	1 367,6	1,5	5,9	2,8328
1982....	1 350,6	1,4	0,6	3,3676	28,7	1,6	24,2	8,1352	2,4	0,2	14,3	9,2478	1 381,7	1,4	1,0	3,4768

AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT

68-74				21,9				8,9	21,7			11,0	7,3			22,3
74-82																
68-82																

N.B.

1. From time to time Escom sells sections of networks in this undertaking as well as in other Undertakings to other local authorities. This affects the analogy of the figures above, particularly those reflecting a percentage of growth.
2. The original licence for the Orange River Undertaking was granted on 3 June 1968.
3. Data omitted are not available.
4. In 1978 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "retail" column.
5. As from 1 January 1981 the Cape Eastern Undertaking was amalgamated with the Orange River Undertaking.

PAGE 1 OF TABLE 7G

DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1982

BORDER UNDERTAKING

Calendar year	GW,h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Under-taking's operating costs per km of net-work length R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per kW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967	294,2	55 700	4 096	1 863	16 605	452	189,33	13,92	6,33	56,44	1,54	0,569	0,24	8,0	1,1304	0,9
1968	310,5	55 700	4 316	1 944	17 689	502	179,39	13,90	6,26	56,97	1,62	0,550	0,26	5,54	1,1839	4,7
1969	330,5	55 700	4 577	2 005	18 681	557	168,53	13,85	6,07	56,52	1,69	0,563	0,28	6,44	1,1950	0,9
1970	360,4	55 700	4 898	2 100	21 464	637	154,55	13,59	5,83	59,56	1,82	0,591	0,31	9,05	1,2002	0,4
1971	399,9	55 700	3 153	2 095	21 485	692	139,28	7,88	5,24	59,73	1,73	0,580	0,33	10,96	1,2117	1,0
1972	448,1	55 700	3 405	2 186	22 556	888	124,30	7,60	4,88	50,34	1,98	0,596	0,41	12,05	1,2724	5,0
1973	504,6	55 700	3 789	2 521	23 438	1 129	110,38	7,51	5,00	46,45	2,24	0,589	0,45	12,61	1,4040	10,3
1974	551,5	55 400	4 194	2 682	10 969	1 388	100,45	7,60	4,86	19,89	2,52	0,595	0,52	9,29	1,4642	4,3
1975	597,7	55 400	4 454	2 935	14 959	2 064	92,69	7,45	4,91	24,42	3,45	0,583	0,70	8,38	1,6658	13,8
1976	674,8	55 400	4 672	3 257	20 009	2 656	82,10	6,92	4,83	29,65	3,94	0,576	0,82	12,90	2,0798	24,9
1977	727,3	55 400	4 893	3 558	27 243	3 440	76,17	6,73	4,89	37,46	4,73	0,609	0,97	7,78	2,9146	40,1
1978	778,8	55 400	5 109	3 632	33 602	3 969	71,14	6,56	4,66	43,15	5,10	0,574	1,09	7,08	2,9302	0,5
1979	826,4	55 400	5 447	3 881	39 319	4 388	67,04	6,59	4,70	47,58	5,31	0,583	1,13	6,11	3,1152	6,3
1980	901,1	55 400	5 814	4 075	39 253	5 373	61,48	6,45	4,52	43,56	5,96	0,624	1,32	9,04	3,2410	4,0
1981	971,3	55 400	6 342	4 206	42 788	6 191	57,04	6,53	4,33	44,05	6,37	0,564	1,47	7,79	3,632	12,1
1982	1 035	55 400	7 046	4 565	45 175	8 425	53,53	6,81	4,41	43,65	8,14	0,588	1,85	6,56	4,323	19,0

PAGE 2 OF TABLE 7C
DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1982
BORDER UNDERTAKING

Year	Traction				Bulk Supply				Mining				Industrial				Domestic and Street Lighting				Total				% of ESCOM Total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967					254,4	86,5	14	18,2					19,6	6,7	415	0,05	20,2	6,9	3 667	0,006	294,2	100	4 096	0,07	1,1	4,3
1968					268,2	86,4	14	19,2					20,8	6,7	429	0,05	21,6	6,9	3 873	0,006	310,5	100	4 316	0,07	1,1	4,3
1969					283,5	85,8	14	20,3					22,7	6,9	437	0,05	24,4	7,3	4 126	0,006	330,5	100	4 577	0,07	1,0	4,3
1970					308,1	85,5	14	22,0					24,6	6,8	462	0,05	27,7	7,7	4 422	0,006	360,4	100	4 898	0,07	1,0	4,3
1971					365,3	91,3	16	22,8					15,8	4,0	358	0,04	18,8	4,7	2 779	0,007	399,9	100	3 153	0,1	1,1	2,5
1972					399,8	89,2	15	26,7					26,9	6,0	383	0,07	21,5	4,8	3 007	0,007	448,2	100	3 405	0,1	1,1	2,7
1973					441,0	87,4	16	27,6					39,2	7,8	416	0,09	24,5	4,8	3 357	0,007	504,7	100	3 789	0,1	1,1	2,8
1974					483,3	87,6	16	30,2					40,4	7,3	432	0,09	27,8	5,1	3 746	0,007	551,5	100	4 194	0,1	1,0	2,8
1975					523,9	87,7	18	29,1					42,6	7,1	472	0,09	31,2	5,2	3 964	0,008	597,7	100	4 454	0,1	1,0	2,9
1976					597,3	88,5	19	31,4					46,7	6,9	507	0,09	30,9	4,6	4 146	0,007	674,8	100	4 672	0,1	1,1	2,8
1977					644,3	88,6	19	33,9					53,0	7,3	976	0,05	29,9	4,1	3 898	0,008	727,3	100	4 893	0,1	1,1	2,9
1978					689,8	88,6	20	34,5					63,5	8,2	1 694	0,04	25,4	3,3	3 395	0,007	778,8	100	5 109	0,2	1,1	2,9
1979					730,1	88,4	22	33,2					70,0	8,5	1 786	0,04	26,3	3,2	3 639	0,007	826,4	100	5 447	0,2	1,0	3,2
1980					794,0	88,1	23	34,5					80,0	8,9	1 884	0,04	27,1	3,0	3 907	0,007	901,2	100	5 814	0,2	1,0	3,2
1981					854,7	88,0	23	37,2					86,1	8,9	2 008	0,04	30,5	3,1	4 311	0,007	971,3	100	6 342	0,2	1,0	3,3
1982					904,3	87,4	26	34,8					97,3	9,4	2 241	0,04	32,9	3,2	4 779	0,007	1 034,5	100	7 046	0,2	1,1	3,5

N.B.: 1. From time to time Escom sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, particularly those reflecting a percentage of a total.
2. As from 1 January 1971 the reticulation system in King William's Town was taken over from Escom by the municipality.
3. In 1978 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "industrial" column.

PAGE 3 OF TABLE 7G

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1967 TO 1982

BORDER UNDERTAKING

Cal- endar year	Bulk				Retail				Domestic and Street Lighting				Undertaking Total			
	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h
1967				1,0583				2,3092	20,2			1,6760	294,2	1,1	8,0	1,1304
1968				1,1080				2,3471	21,6		6,9	1,7729	310,5	1,1	5,5	1,1819
1969				1,1183				2,3369	24,4		13,0	1,7618	330,5	1,0	6,4	1,1950
1970				1,1224				2,3577	27,7		13,5	1,7374	360,4	1,0	9,0	1,2002
1971				1,1475				2,9528	18,8		-32,1	1,9238	399,9	1,1	11,0	1,2117
1972				1,2049				2,8951	21,5	2,2	14,4	1,9810	448,1	1,1	12,1	1,2724
1973				1,3340				3,1383	24,5	2,2	14,0	2,1384	504,6	1,1	12,6	1,4040
1974				1,3914				3,3093	27,8	3,1	13,5	2,2140	551,5	1,0	9,3	1,4642
1975				1,5857				3,4495	31,2	3,1	12,2	2,4504	597,7	1,0	8,4	1,6658
1976	635,9			1,9755	8,0			4,3490	30,9	2,8	-1,3	3,4869	674,8	1,1	12,9	2,0798
1977	681,4	1,0	7,2	2,7700	16,0	1,4	96,3	5,4601	29,9	2,9	-2,9	4,6777	727,3	1,1	7,8	2,9146
1978	729,6	1,0	7,1	2,7758	23,8	2,1	49,1	5,7838	25,4	2,7	-14,7	4,7023	778,8	1,1	7,1	2,9302
1979	774,2	1,0	6,1	2,9522	25,9	2,1	9,3	6,0321	26,3	2,8	3,1	5,0365	826,4	1,0	6,1	3,1152
1980	844,7	1,0	9,1	3,0684	29,4	2,1	13,5	6,2425	27,1	3,0	3,0	5,3639	901,2	1,0	9,1	3,2410
1981	908,9	1,0	7,6	3,4367	31,9	2,1	8,5	7,0471	30,5	3,0	12,5	5,8831	971,3	1,0	7,8	3,6321
1982	963,4	1,0	6,0	4,0930	38,2	2,1	19,7	7,7002	32,9	3,2	7,9	7,1514	1 034,5	1,1	6,3	4,3234

AVERAGE GROWTH OF SALES AND SELLING PRICE—PER CENT

67-74				4,0				5,3	4,7			4,1	9,4			3,8
74-82				14,4				11,1	2,1			15,8	8,2			14,5
67-82				9,4				8,4	3,3			10,2	8,7			9,4

N.B.

1. Data omitted are not available.
2. From time to time Escom sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, particularly those reflecting a percentage of growth.
3. As from 1 January 1971 the reticulation system in King William's Town was taken over from Escom by the municipality.
4. In 1978 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "retail" column.

PAGE 1 OF TABLE 7H
DATA REGARDING CHANGES IN THE SIZE OF DISTRIBUTION UNDERTAKINGS FOR THE PERIOD 1967 TO 1980
CAPE EASTERN UNDERTAKING

Calendar year	GW.h sold	Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs in R000 excluding electricity purchases	Quantity per GW.h sold					System load factor	Undertaking's operating costs per km of network length in R000	Percentage growth of GW.h sold over previous year's sales	Total costs to consumers in cents per kW.h sold	Increase in costs to consumers over previous year's costs %
							Supply area in km ²	Number of consumers	Network km	Working capital R000	Operating costs R000					
1967	3,2	8 000	355	298	509	28	2 500	110,94	93,13	159	8,75	—	0,09	28,00	3,0830	-3,1
1968	4,1	8 000	436	322	636	38	1 951	106,34	78,54	155	9,27	—	0,12	28,13	3,1917	3,5
1969	5,7	8 000	523	351	699	45	1 404	91,75	61,58	123	7,89	—	0,13	39,02	2,9558	-7,4
1970	6,1	8 000	543	410	1 145	55	1 311	89,02	67,21	188	9,02	—	0,13	7,02	3,1281	5,8
1971	7,1	8 000	584	422	1 196	57	1 127	82,25	59,44	168	8,03	—	0,14	16,39	3,1148	-0,4
1972	8,4	8 000	678	434	1 265	62	952	80,71	51,67	151	7,38	—	0,14	18,31	3,0509	-2,1
1973	9,7	8 000	762	460	1 400	97	825	78,56	47,42	144	10,00	—	0,21	15,48	3,3739	10,6
1974	11,5	8 000	832	477	1 492	129	696	72,35	41,48	130	11,22	—	0,27	18,56	3,4087	1,0
1975	13,5	8 000	877	486	1 675	250	593	64,96	36,00	124	18,52	—	0,51	17,39	3,5844	5,2
1976	14,1	8 000	951	499	1 666	296	567	67,45	35,39	118	20,99	—	0,59	4,44	4,4128	23,1
1977	22,2	8 000	933	533	2 435	420	360	42,03	24,01	110	18,92	—	0,79	57,45	4,9191	11,5
1978	29,6	8 000	931	595	3 262	374	270	31,45	20,10	110	12,64	—	0,63	33,33	4,8987	-0,4
1979	29,8	8 000	954	604	3 275	410	268	32,01	20,27	110	13,76	—	0,68	0,68	5,0851	3,8
1980	33,9	8 000	996	643	3 757	521	236	29,38	18,97	111	15,37	—	0,81	13,76	5,2143	2,5

N.B. 1. As from 1 January 1981 the Cape Eastern Undertaking was amalgamated with the Orange River Undertaking

2. Data omitted are not available.

PAGE 2 OF TABLE 7H

DATA REGARDING CONSUMPTION IN THE VARIOUS SECTORS FOR THE PERIOD 1967 TO 1980

CAPE EASTERN UNDERTAKING

Year	Traction				Bulk supply				Mining				Industrial				Domestic and Street lighting				Total				% of Escom Total	
	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	% of total	Number of consumers	GW.h per consumer	GW.h	Consumers
1967					1,1	34,4	1	1,1					1,1	34,4	62	0,02	1,0	31,2	292	0,003	3,2	100	335	0,01	0,01	8,4
1968					1,1	26,8	1	1,1					1,6	39,0	81	0,02	1,4	34,2	354	0,004	4,1	100	436	0,01	0,01	0,4
1969					1,4	24,6	1	1,4					2,6	45,6	97	0,03	1,7	29,8	425	0,004	5,7	100	523	0,01	0,02	0,5
1970					1,3	21,3	1	1,3					2,8	45,9	109	0,03	2,0	32,8	433	0,005	6,1	100	543	0,01	0,02	0,5
1971					1,5	21,1	1	1,5					3,3	46,5	111	0,03	2,3	32,4	472	0,005	7,1	100	584	0,01	0,02	0,5
1972					1,8	21,4	1	1,8					3,9	46,4	116	0,03	2,7	32,2	561	0,005	8,4	100	678	0,01	0,02	0,5
1973					2,0	20,6	1	2,0					4,3	44,3	143	0,03	3,4	35,1	618	0,006	9,7	100	762	0,01	0,02	0,6
1974					2,3	20,0	1	2,3					5,8	50,4	216	0,03	3,4	29,6	615	0,006	11,5	100	832	0,01	0,02	0,6
1975					2,3	17,0	1	2,3					7,3	54,1	248	0,03	3,9	28,9	628	0,006	13,5	100	877	0,02	0,02	0,6
1976					2,6	18,4	1	2,6					7,8	55,3	292	0,03	3,7	26,3	658	0,006	14,1	100	951	0,01	0,02	0,6
1977					8,5	36,3	2	4,2					9,7	43,7	293	0,03	4,0	18,0	638	0,006	22,2	100	933	0,02	0,03	0,6
1978					14,4	48,6	2	7,2					13,6	46,0	646	0,02	1,6	5,4	283	0,006	29,6	100	931	0,03	0,04	0,5
1979					14,5	48,7	2	7,3					13,8	46,3	665	0,02	1,5	5,0	287	0,005	29,8	100	954	0,03	0,04	0,6
1980					16,3	48,1	3	5,4					16,0	47,2	703	0,02	1,6	4,7	290	0,006	33,9	100	996	0,03	0,04	0,6

N.B.: 1. From time to time Escom sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, particularly those reflecting a percentage of a total.

2. As from 1 January 1978 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "Industrial" column.

3. As from 1 January 1981 this Undertaking was amalgamated with the Orange River Undertaking.

PAGE 3 OF TABLE 7H

DATA REGARDING BULK, RETAIL AND DOMESTIC CONSUMPTION OF ELECTRICITY FOR THE PERIOD 1967 TO 1980
CAPE EASTERN UNDERTAKING

Cal- endar year	Bulk				Retail				Domestic and Street Lighting				Undertaking total			
	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h	GW.h sold	% of Escom total	Increase in sales over those of pre- vious year %	Average selling price c/kW.h
1967				2,6066				3,0292	1,0			3,6938	3,2	0,01		3,0832
1968				2,8231				3,2244	1,4		40,0	3,6822	4,1	0,01	28,1	3,1917
1969				2,3927				3,1992	1,7		21,4	3,7295	5,7	0,02	39,0	2,9558
1970				2,7894				3,2135	2,0		17,6	3,5604	6,1	0,02	7,0	3,1281
1971								3,3488	2,3		15,0	3,3765	7,1	0,02	16,4	3,1148
1972				2,9367				2,9396	2,7	0,3	17,4	3,2863	8,4	0,02	18,3	3,0509
1973				3,3471				3,2582	3,4	0,3	25,9	3,4737	9,7	0,02	15,5	3,3739
1974				3,3086				3,3430	3,4	0,4	0	3,5941	11,5	0,02	18,6	3,4087
1975				3,5935				3,5311	3,9	0,4	11,8	3,7378	13,5	0,02	17,4	3,5844
1976				3,5724				4,8115	3,7	0,3	-2,6	5,3282	14,1	0,02	4,4	4,4128
1977	12,4	0,02		3,2548	5,8	0,5		6,8037	4,0	0,4	8,1	8,2124	22,2	0,03	57,4	4,9191
1978	18,7	0,03	50,8		9,3	0,8	62,1		1,6	0,2	-62,5	8,8714	29,6	0,04	33,3	4,8987
1979	18,8	0,02	0,5		9,4	0,7	0		1,5	0,2	1,5	9,2342	29,7	0,04	0,3	5,0851
1980	21,4	0,03	13,8		10,9	0,8	16,0		1,6	0,2	6,7	9,4615	33,9	0,04	14,1	5,2143
AVERAGE GROWTH OF SALES AND SELLING PRICE—PERCENT																
67-74				3,5				1,4	19,1			-0,4	20,0			1,4
74-80																
67-80																

N.B.:

1. Data omitted are not available.
2. From time to time Escom sells sections of networks in this undertaking as well as in other undertakings to other local authorities. This affects the analogy of the figures above, particularly those reflecting a percentage of growth.
3. As from 1 January 1978 Tariff C (domestic) in this undertaking was made applicable only to consumers residing in proclaimed townships. As a result some consumers were transferred to Tariff B; the consumption by such consumers has been included in the "retail" column.
4. As from 1 January 1981 this Undertaking was amalgamated with the Orange River Undertaking.

ANNEXURE B

ESCOM REPORT

Actuarial valuation of finance

Escom enters into agreements and negotiates loans for, among other things, the erection of power stations, involving liabilities and the acquisition of assets that span several decades. The resultant expenditure and income, whether these vary or not, have an impact on Escom's finances, and this should be noted even at this early stage.

With this in view, the Commission of Inquiry requested a valuation from an actuary, and this should be done regularly in future because it gives a deeper insight. It amounts to estimating the income and expenditure for each applicable year in the future and converting the estimates to the present values.

In addition to items already established, such as the expected life of a power station and its capacity, the following are also calculated every year for the amount indicated and for the sake of reliability are derived from the past as far as possible, so that they will not be unfounded or speculative.

- (a) The load factor of power stations is applied to their installed capacity. It is assumed that the average load over the past five years will continue throughout the life of the power station.
- (b) The electricity supplied in terms of (a) is converted to income at the current average tariff and, as explained later, escalation for subsequent years is estimated in order to make provision for price increases.
- (c) With regard to costs, such as those related to salaries and coal, incurred in respect of existing installations in production, it is assumed that the average escalation over the preceding five years will continue throughout the life of those installations and is therefore always added to the most recent expenditure.

In order to avoid speculation only money plus interest already spent on unproven installations still under construction are included.

- (d) The income and expenditure thus estimated for future years are converted to present values at an interest rate based on that on the loans negotiated by Escom. A margin, which varies by between one and three percentage points is added to the weighted arithmetic average rate of issue of the last half of the total existing loan debt. This margin serves as a safeguard against an increase in interest rates, which would naturally be detrimental to Escom. The greater the certainty of an increase and of its extent, the larger the margin which must be added.
- (e) With assets and liabilities calculated in this manner, it is necessary to maintain a solvency margin set at 50 % of liabilities. In other words, taken as 33⅓ % of assets, it provides a basis for determining the annual tariff escalation mentioned in paragraph (b). It is regarded as reasonable for Escom itself to finance a third of its requirements.

With the long-term prospects thus explicitly converted into figures, Escom's financial position can be more accurately evaluated and kept healthy by means of well-founded tariff determination. There are several votes which can contribute to free reserves and an inclusive amount such as that created here is necessary, in addition to the appropriate breakdown thereof.

The parameters as established may be summed up as follows—

- ☆ the load factor referred to in paragraph (a) as set out in the annexure which follows,
- ☆ the valuation interest rate outlined in paragraph (d) at 14 %. An ample margin is at present required in addition to the average mentioned in this paragraph, as market interest rates are expected to rise substantially,
- ☆ the escalation in costs referred to in (c) at 18 % per annum;
- ☆ the escalation in tariffs referred to in (b) and (e) at 14 % per annum.

This escalation is an ongoing process and the situation is reconsidered from time to time, following further developments and valuations.

ANNEXURE

Power Station	1983 Load factor (%)
Salt River.....	31,4
Klip.....	46,9
Vaal.....	69,1

<i>Power Station</i>	<i>1983 Load factor (%)</i>
Hex River.....	23,0
Umgeni.....	7,7
Taalbos.....	67,8
Wilge.....	58,2
Highveld.....	71,1
Komati.....	57,9
Ingagane.....	11,9
Camden.....	30,5
Grootvlei.....	61,0
Hendrina.....	64,7
Vanderkloof.....	20,9
Hendrik Verwoerd.....	6,9
Amot.....	63,8
Kriel.....	56,0
Matla.....	75,2
Duvha.....	69,9
Acacia.....	0,2
Port Rex.....	0,2
Drakensberg.....	22,3

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