JOURNAL OF ENERGY IN SOUTHERN AFRICA

Vol.5 No.2 May 1994

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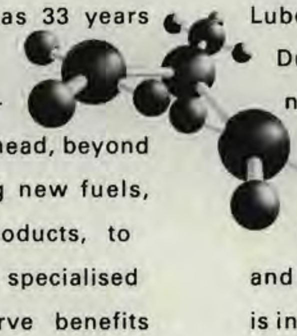

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It is the policy of the Journal to publish, as far as possible, papers covering the technical, economic, political, environmental and social aspects of energy research and development carried out in or applicable to Southern Africa. Only previously unpublished work will be accepted. However, conference papers delivered but not published elsewhere are also welcomed. Short discussions, not exceeding 500 words, on articles published in the Journal are also invited. Items of general interest, news, technical notes, reviews and research results will also be included. Announcements of relevant publications, reviews, conferences, seminars and meetings will be included.

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Profile: Allen Morgan

Chief Executive, Eskom

It seems almost logical that Allen Morgan, a third generation Eskom employee, be appointed Chief Executive of Eskom. His grandfather was a rigger and his father a district supervisor for the company. Allen knows the business and its people. He is committed to the company's vision and is determined to take Eskom into an even brighter future.

Allen Morgan was born in 1947 and grew up in the scenic town of Bot River in the Cape. He matriculated at the De Villiers Graaff High School in Villiersdorp and decided to pursue a career in the electrical field. He graduated with a degree in Electrical Engineering (Heavy Current) from the University of Stellenbosch.

In 1971 Allen started working for Eskom as an engineer-in-training in the Western Cape. Here he gained experience in the generation and distribution of electricity. He is the first to admit that he was not exactly in the corporate "fast lane" in those days. Unflinching ambition and a strong will to succeed drove Allen up the ranks, and he moved on to become a fully-fledged engineer in 1973 and Construction Superintendent in 1975.

Allen says that he was always interested in management. His first step in this direction came in 1981 when he was appointed Distribution Area Manager (East). Allen made his presence felt so strongly here that he was appointed Distribution Divisional Manager in 1988. This led to his role as one of Eskom's top negotiators, dealing with the tough issues of payment boycotts and the negotiated takeover of distribution rights in the townships from the black authorities. He says that the intransigence of the local governments, which usually did not have a mandate, was the hardest part of the negotiations. The tough part was that they were usually holding out for political power.

His role in the negotiation process proved that Allen was a man of strong beliefs, yet always willing to compromise. This dynamic combination of negotiation skills gained him enormous respect among the trade unions – a respect which still stands him in very good stead today.

On 4 November 1988, the Eskom Management Board announced that Allen had been appointed as the new Deputy General Manager of the Distribution and Marketing Group. His main responsibility was to direct the activities of Eskom's twelve Distribution and Marketing regions which distributed electricity throughout South Africa to more than 600 local authorities, large industry and mining customers. His close liaison with Eskom customers led to his appointment as Executive Director of Sales and Customer Services in 1992. Allen's main task in this portfolio was Eskom's nation-wide electrification of underdeveloped areas. He also exploited new markets and developed Eskom's business locally and internationally. He learned to deal with customer expectations, disappointments, anger, mistrust and frustration the hard way, but he has also seen the transformation which takes place when a community gains access to electricity.

In March 1994, Allen Morgan took over as Eskom's Chief Executive from Dr Ian McRae, who led Eskom for nine years. He realises that he has an enormous task to fulfill. He has taken over from a man who has proved, and continues to prove himself to be one of the pillars of the electricity industry and South African society as a whole. Allen says that he hopes that he can retain his personality and also live up to the expectations which go hand-in-hand with his new task. He sees Eskom as a force to be reckoned with and believes that everything possible must be done to bring electricity to as many South Africans as possible. Thus he sees Eskom playing a major role in improving South Africa's economy, making it a country of which all its inhabitants can be proud.

As Eskom's new Chief Executive, the customer will continue to be the focus of Allen Morgan's attention. His plan for the future is to make Eskom orientated to customer service – and that includes the employees as well. The staff cannot be expected to care for their customers if management does not reflect a similar care for their staff. They are important as *they* build the successes on which Eskom prides itself.

Allen is 46 years old, is married and has three children. His interests include tennis, fishing and golf.

*Energy research and development by IEA governments and some comparisons with South Africa

** J A BASSON

Public sector energy research funding for the IEA countries and South Africa is given and compared. In 1990, IEA government-supported energy research and development (R & D) totalled US$7 677 million, of which 51% was for non-nuclear activities. This R & D expenditure is expressed per unit of primary energy consumed, where Italy, Switzerland, Denmark, Netherlands and Sweden have the highest ratios, and Turkey, New Zealand and Spain the lowest. On average, coal and energy systems analysis are the areas for which the strongest support was given. South African public sector non-nuclear R & D in 1990 was R38,5 million or US$14,8 million. This formed 0,11% of energy expenditure, whereas the IEA countries ranged from 0,07% (Austria) to 0,51% (Japan). When expressed per GJ of primary energy consumed, South Africa's expenditure was equivalent to the IEA countries at the bottom of this scale. It is concluded that although direct comparisons are not possible, South Africa's investment in public non-nuclear energy R & D compares with those IEA countries at the bottom end of the spectrum, and this may assist in explaining some of the specific characteristics of the South Africa energy sector.

Keywords: energy research funding; IEA; South Africa

Introduction

Governments have for many years been major sponsors of energy R & D in most countries as energy is considered a strategic, multi-disciplinary and long-term issue. Also, of late the realisation has grown that access to energy is a necessary but insufficient condition for sustained development. Of the questions that arise concerning R & D are the extent and nature of funding, dominant trends over time and comparisons between countries. National energy R & D policies are generally related to the energy situation in a specific country and the resources available both in the energy and research sectors.

Various discreet sources of data are available to provide a perspective on these issues, but arriving at specific conclusions is often difficult as a common approach to data collection and interpretation generally does not exist, detailed data are often not published, major gaps in the data are encountered, and the output (i.e. value) of the research is measured in various non-comparative ways.

The IEA regularly publishes data on the government energy R & D budgets of their members in their *Energy Policies of IEA Countries*. The following analysis is based mainly on information extracted from *Energy Policies of IEA Countries: 1990 Review*[1].

This analysis was carried out so as to determine where South Africa stands in comparison to other countries and to provide an order of magnitude indication as to what needs to be done in this area. Obviously, as stated above, only the input costs were compared since value-addition in terms of outputs was not available. This issue clearly would require further analysis.

Total funding

Figure 1 provides an indication of IEA-government energy R & D budgets related to total energy expenditure (energy GDP) for both total and non-nuclear energy R & D funding. The arithmetic average for total funding is 0,43% of energy GDP, with high percentages occurring for Japan, Italy, Switzerland, Canada, Netherlands, United States and Norway. When the contribution of nuclear energy R & D is removed, the average decreases to 0,27% of energy GDP, with high percentages occurring for Italy, Norway, Netherlands and Greece.

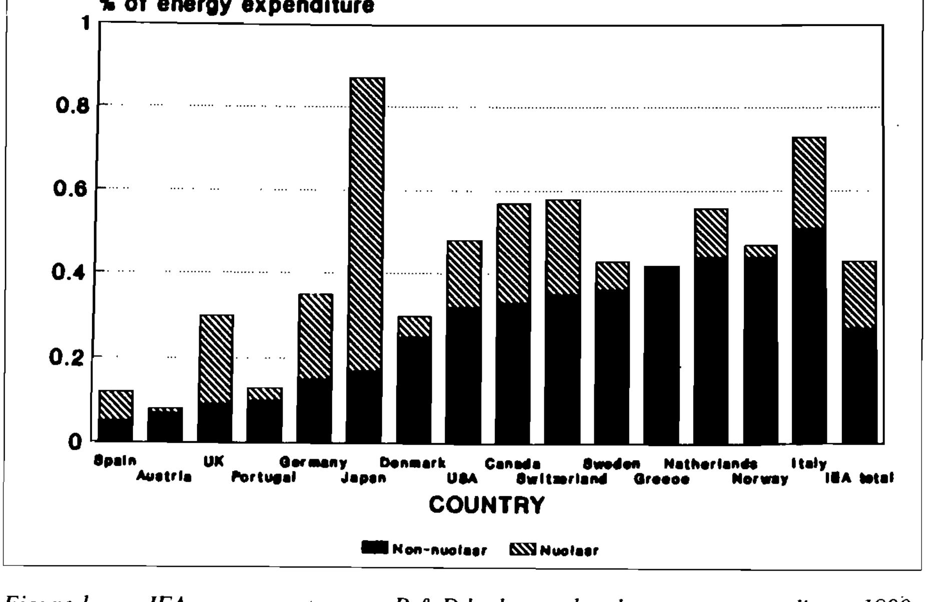

Figure 1: IEA government energy R & D budgets related to energy expenditure, 1990

* The views expressed in this paper are those of the author and not necessarily those of the Department.

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	US$ Million	% of total
Conventional nuclear	2 424	32
Nuclear breeder	656	9
Nuclear fusion	857	11
Oil and gas	291	4
Coal	1 171	15
Conservation	447	6
Electricity	300	4
Renewables	526	7
Energy systems analysis	1 005	13
Total	7 677	100
Total, excluding nuclear	3 739	49

(Source: Appendix A)

Table 1: Government energy R & D funding for IEA countries in 1990 (US$ million)

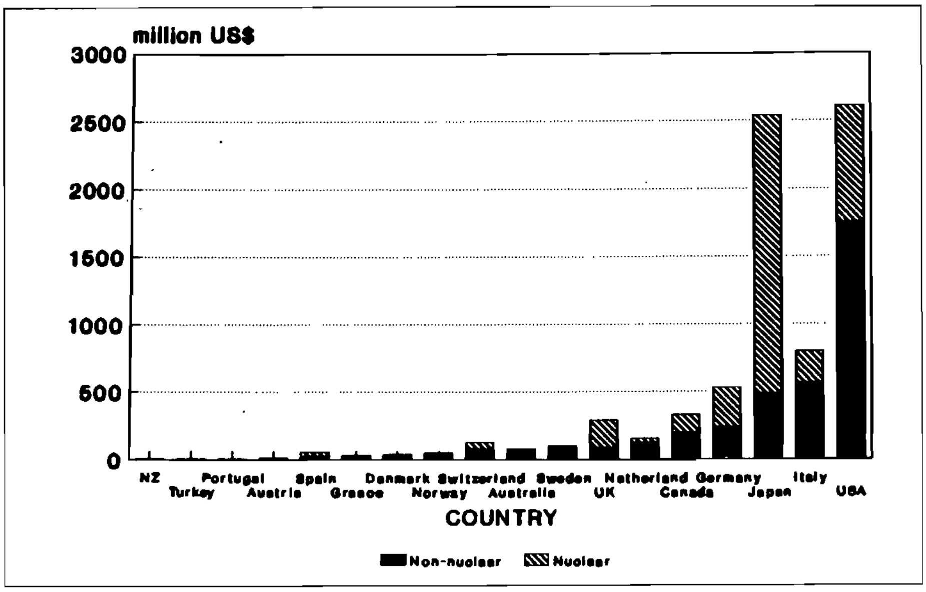

Figure 2: IEA government energy R & D budgets, 1990

Total IEA energy funding is shown in Table 1, but excludes Belgium, France and Luxembourg, for which no data are given in the reference[1]. It can be seen that funding for nuclear and non-nuclear R & D are about the same and that the allocations for coal and energy systems analysis are the largest for the non-nuclear activities. Appendix A provides detailed data for all IEA countries. Total monetary expenditures expressed in US$ are indicated in Figure 2, which are dominated by Japan and the USA, with Germany and Italy the other major players.

> "South Africa spends far less on non-nuclear energy R & D than the smaller IEA countries and possibly even less than comparable developing countries."

Inter-country comparisons

Large differences occur between countries which can be related to institutional, economic, resource and policy variables. To enable a direct comparison to be made, government energy R & D funding has been related to the primary energy consumption in 1990 as the common denominator. The results are given in Table 2 for those countries for which sufficient data are available. Other normalisation approaches, such as, GDP or national energy cost, may also be used and will most likely lead to different results but the same conclusions.

It is clear from this comparison that Italy, Switzerland, Denmark and the Netherlands strongly support public non-nuclear R & D when expressed per unit of primary energy consumed, while limited support is given in Turkey, New Zealand, Spain, Portugal and Austria. On average, coal and energy systems analysis were given the strongest support, with oil/gas and electricity the weakest, the latter possibly because large oil, gas and electricity companies and industry associations are capable of handling most of the necessary R & D themselves.

Different main focuses of government non-nuclear energy R & D support for 1990 are identified in Table 3. It is notable that Switzerland features in four of the 'Strong Support' categories with Denmark, Italy and the Netherlands each in two.

South Africa

South African public non-nuclear R & D expenditure is given in Table 4 and is based on a survey of public energy institutions during 1993 for the African Development Bank. These funds were contracted via the National Energy Council from 1988 to 1991, the Department of Mineral and Energy Affairs from 1992, the Central Energy Fund, Eskom and the CSIR. It includes a Rand for Rand contribution for coal research by the South African public sector up to 1990, based on a levy on coal sales by coal producers, payable to the CSIR. It can be seen that:

- — total expenditure and petroleum funding increased rapidly up to 1989, declined in 1990, and thereafter maintained a nearly constant level;
- — the main contributors are petroleum, coal and lately, electricity;
- — funding for electricity and energy for development, where renewable energy is included, has increased significantly.

For South Africa, two points of comparison with the IEA countries for 1990 are:

(1) Public energy R & D expenditure per unit of national energy expenditure

$$= \frac{38,5 \times 10^6 \times 100}{34\,000 \times 10^6} = 0,11\%$$

Country	Oil and gas	Coal	Conser-vation	Electri-city	Renew-ables	Energy systems analysis	Total
Australia	n/d	n/d	n/d	n/d	n/d	n/d	21,8
Austria	0,1	0,1	4,8	2,5	1,8	0,6	9,8
Canada	9,0	2,1	3,1	0,4	1,2	1,5	17,2
Denmark	4,6	5,2	13,2	6,2	11,1	2,1	42,3
Germany	1,1	7,1	1,5	0,8	9,0	0,2	19,7
Greece	0,1	2,3	3,0	0,6	24,9	1,2	32,1
Ireland	n/d	n/d	n/d	n/d	n/d	n/d	12,8
Italy	0,0	0,1	6,6	16,3	8,3	52,5	83,8
Japan	3,9	11,7	0,2	4,2	5,2	0,9	26,0
Netherlands	0,2	8,9	13,0	0,5	6,9	8,0	37,5
New Zealand	n/d	n/d	n/d	n/d	n/d	n/d	4,2
Norway	11,6	0,1	7,2	3,1	3,3	5,8	31,1
Portugal	0,0	1,4	3,0	0,0	2,3	2,4	9,1
Spain	0,0	2,2	0,1	2,9	2,2	0,0	7,4
Sweden	1,9	1,5	14,2	0,9	8,4	9,3	36,2
Switzerland	6,6	0,5	16,4	17,0	22,1	8,6	71,1
Turkey	0,2	0,4	0,5	0,1	0,3	0,0	1,6
United Kingdom	1,9	0,4	2,9	0,2	3,3	0,9	9,6
United States	0,7	9,7	2,4	0,6	1,4	6,6	21,3
Weighted average	1,8	7,3	2,8	1,9	3,3	6,2	23,2
% of total	7,8	31,5	12,1	8,2	14,2	26,7	100,0

Notes: *EJ = Exajoule = 10^{18} Joule*
n/d = no data given

Table 2: *Government non-nuclear energy R & D budgets in 1990 normalised to primary energy consumption (US$ million per EJ)*

	Relatively strong support	Relatively weak support
Oil and gas	Norway, Canada, Switzerland	10 countries
Coal	Japan, United States, Netherlands	9 countries
Conservation	Switzerland, Sweden, Denmark, Netherlands	8 countries
Electricity	Switzerland, Italy	6 countries
Energy systems analysis	Italy	6 countries
Renewables	Greece, Switzerland, Denmark	4 countries

Table 3 *Main focuses of government non-nuclear energy R & D support (as established from Table 2)*

	1987	1988	1989	1990	1991	1992
Petroleum	7,8	16,7	20,3	13,6	5,4	6,6
Electricity	2,6	2,5	3,3	5,7	7,7	8,5
Renewables, energy for development and biomass	0,6	0,5	1,0	1,6	3,8	2,1
Coal	10,5	20,2	19,9	14,6	17,0	17,0
Energy use/efficiency	0,4	0,4	0,9	1,3	1,5	1,0
Policy	0,7	0,6	0,5	0,5	1,0	0,9
Total	22,9	41,2	46,3	38,5	38,0	37,7

(Source: Survey for African Development Bank, September 1993)

Table 4: *Real South African public sector non-nuclear energy R & D expenditure (million 1990 Rands)*

for South Africa, while expenditure for the IEA countries, as indicated in Figure 1, ranges from 0,07 (Austria) to 0,51% (Japan). This percentage for South Africa is based on a calculated energy expenditure of R34 000 million in 1990 in which energy levies and taxes are included.

(2) Public non-nuclear energy R & D expenditure per EJ of primary energy used, including non-commercial energy, is given in Table 5.

When comparing Table 2 and Table 5 it can be seen that South Africa spent about the same public sector funds on non-nuclear energy R & D per unit of primary energy consumed in 1990 than the lowest of the IEA countries, namely, Turkey and New Zealand. If energy research funding is related to GDP, the figures in Table 5 have to be multiplied by a factor of about 3, as South Africa's energy intensity (i.e. its primary energy use per unit of economic output) is about three times higher than that of most IEA countries. This would move South Africa to about the level of Spain, Portugal, the United Kingdom, Austria and Ireland.

Conclusion

It is clear that large differences in governmental energy R & D funding exist, ostensibly determined by the energy resources, conditions and political factors in each country. Smaller countries obviously have a shortage of financial R & D resources and may decide on policies of monitoring international developments or concentrating on specific issues such as, problem areas or perceived opportunities.

South Africa spends far less on non- nuclear energy R & D than the smaller IEA countries and possibly even less than comparable developing countries. The results of this analysis may present a different picture if the support for nuclear energy research in South Africa is taken into account.

The fact that government non-nuclear energy R & D funding in South Africa is modest may have specific implications for the energy sector and the economy. It may be one of the reasons for the high energy intensity, underdevelopment of specific parts of the energy sector, constraints regarding the supply of appropriate energy to the population at large, with attendant effects on socio-economic development. These issues will have to be addressed appropriately in the future to ensure competitiveness, efficiency and equity.

	US$ million	%
Petroleum	1,45	35
Electricity	0,61	15
Renewables, energy for development and biomass	0,18	4
Coal	1,56	38
Energy use/efficiency	0,14	3
Policy	0,06	1
Total	4,12	100

Note: *Based on primary energy consumption of 3,6 EJ and an exchange rate of R2,60 per dollar.*

Table 5: *South African non-nuclear energy R & D expenditure in 1990 per EJ of primary energy used (US$ million)*

Country	Oil and gas	Coal	Conser-vation	Electricity	Renew-ables	Energy systems analysis	Total non-nuclear	Conven-tional nuclear	Nuclear breeder	Nuclear fusion	Total nuclear	Total for energy sector
Australia							0				0	79
Austria	0	0	5	3	2	1	11	1	0	1	1	12
Canada	100	23	34	5	13	17	192	133	n/a	8	140	333
Denmark	4	4	10	5	9	2	33	3	n/a	3	6	38
Germany	13	83	18	9	105	2	230	142	41	121	304	534
Greece	0	2	3	1	22	1	29	0	n/a	0	1	29
Ireland							0				0	5
Italy		1	44	109	56	351	560	79	8	146	233	793
Japan	72	216	3	77	96	18	481	1 363	477	219	2 059	2 540
Netherlands	1	29	42	2	22	26	120	22	n/a	n/a	22	154
New Zealand							0				0	3
Norway	19	0	12	5	5	9	50	3	n/a	n/a	3	53
Portugal		1	2	0	2	2	6	2	n/a	n/a	2	8
Spain		8	0	10	8		27	31	n/a	3	33	60
Sweden	4	3	33	2	19	21	83	5	0	12	17	100
Switzerland	7	1	18	19	24	9	78	26	1	22	49	127
Turkey	1	1	1	0	1	0	3	0	n/a	0	0	4
United Kingdom	17	4	26	1	29	8	85	40	127	40	208	292
United States	54	796	197	52	13	540	1 753	576	n/a	283	859	2 612
IEA total	291	1 171	447	300	526	1 005	3 739	2 424	656	857	3 937	7 687
% of total	4	15	6	4	7	13	49	31	9	11	51	100

Appendix A: Government energy R & D funding in IEA countries in 1990 (million US$)

Quite clearly, an output-based approach wherein the value/multiplier-effect of the R & D can be reflected may significantly influence decisions on the level of R & D funding. Also, an approach where the objective of energy R & D is coupled to broad developmental goals may influence energy R & D's priority in the overall scheme of things when the enabling value of access to the right forms of energy is brought to the fore.

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Petrol and diesel prices in South Africa

* R K DUTKIEWICZ

This paper examines the South African liquid fuel price structure and the perceptions that exist, particularly those regarding the construction of Sasol and Mossgas. The prices of petrol and diesel are examined respectively, as well as the present tax structure, and compared with overseas fuel prices. The implications of the deregulation of the South African petroleum industry are also briefly discussed.

Keywords: petrol prices; diesel prices; petroleum industry; Sasol; Mossgas; deregulation

Introduction

Recent developments in South Africa following a petrol price increase has highlighted the perception of petrol as a dear commodity, with increases adversely affecting the lives of many, especially the taxi-owners. The price increase in 1993 of approximately 6% sparked off riots, including the barricading of cities by irate taxi-drivers. However, the effect of the price increase had more to do with political opportunism than with any economic effect of the price rise on the economy. Previous similar price-rises had passed without any incidents.

One of the problems of the South African fuel price structure is the perception that the price was fixed to allow for the funding of organisations such as, Sasol and Mossgas, which were brought into being to bolster the sanctions-threatened apartheid government. Insofar as the construction of Sasol, and later Mossgas, was concerned this is correct since the main function of these two organisations was to make the country less reliant on imported petroleum products which were embargoed by a United Nations mandate. However, Sasol II and III were constructed during a period of stress in the world petroleum industry when prices had risen to eight times their previous levels and every country was trying to become less reliant on imported crude, especially from the volatile Middle East. Against this background the construction of Sasol appeared to make sound economic sense.

Whatever the reason for the decision to proceed with the construction of the Sasol and Mossgas plants and whether the decisions were right or wrong, the situation is now that the plants have been constructed and the capital expenditure has been committed. Whether the Sasol and Mossgas plants are closed or not the capital expenditure will continue and only the operating charges are controllable. If it can be shown that the operating costs (the variable costs) of Sasol or Mossgas are less than the alternative of importing crude and processing it, then there is no economic case to be made for closure and it is in the national interest to continue with operation even though it may adversely affect certain parties. Apart from the straight economic consideration there are also the considerations of job creation, foreign exchange reduction and the prospects of developing spin-off technology which can in time be exported, which mitigate against closure.

> "It would therefore appear that tax on diesel fuel in South Africa is too high whilst the tax on petrol is too low. This, in the past, has led to a predominance of petrol vehicles and a dearth of diesel vehicles.."

Analysis of the cost of Mossgas has been carried out by a firm of accountants, Deloitte and Touche, at the request of the Auditor-General[1]. The findings of this analysis show that Mossgas is expected to be cash-positive and economically viable if the sunk costs are excluded. It is also reported that the project has certain positive economic and social impacts, the most important being that of foreign exchange savings.

If it can be shown that Sasol and Mossgas are viable if sunk costs are excluded, then the only question is what the appropriate method of funding the ongoing capital costs will be. The costs will have to be paid by government and therefore it does not make much difference whether the cost is covered from direct or indirect taxation. The point has been raised that the motorist should not have to pay for the past mistakes of the government. Whether the motorist pays through a tax on petrol and diesel, or whether it comes from the motorists, amongst others, from the general tax base, appears to be academic. At present the payments to Sasol and Mossgas are based on the average import price of a basket of finished products from a number of large international refineries. It does not matter unduly what the basis is for the calculation, the capital cost has to be recovered, and any other formula would be as bad or as good as the present.

However, the effect of the Sasol subsidy on the oil price is significant and this needs addressing. It is not intended to do this in this paper.

The price of petrol

Much of the problem surrounding the price of petrol has to do with the perception that the price of petrol is too high and is contributing to the rate of inflation. It is therefore salutary to look at the petrol price in comparison with other countries and over time. Figure 1 shows the price of petrol on the international market relative to the price of petrol in South Africa as it was in 1990. These prices are "pump prices" and therefore include refinery gate, distribution, mark-up, etc., as well as all government taxes and levies.

It is apparent that the South African petrol price is amongst the lowest in the world.

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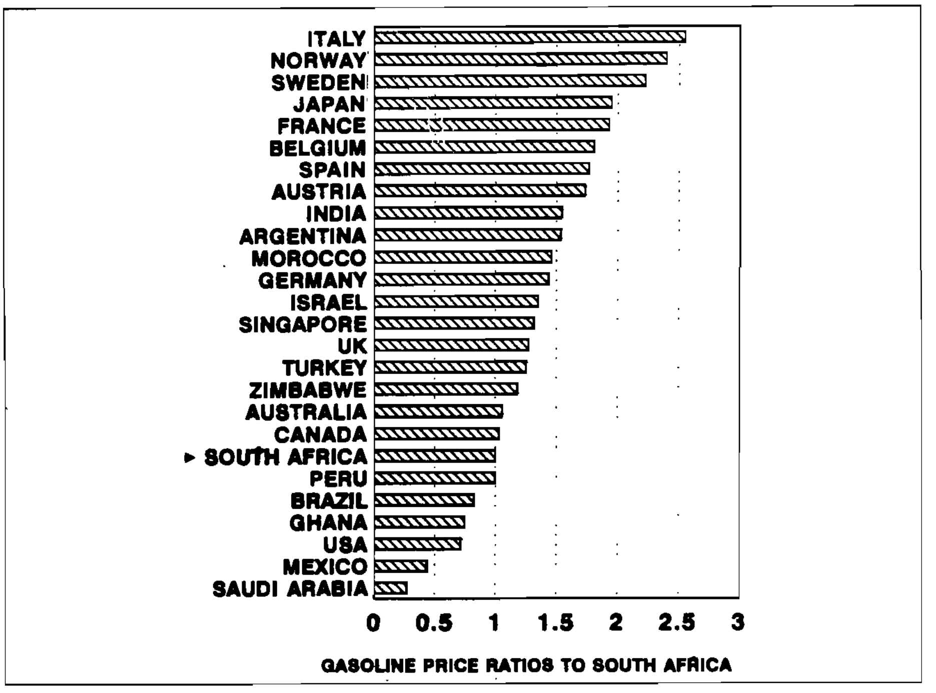

Figure 1: International petrol prices relative to South African price (1990)

The cost of producing petrol from a refinery does not vary greatly from country to country and therefore the differences between countries are mainly due to different tax off-takes by government. Thus in the USA taxes are minimal, and Mexico and Saudi Arabia appear to subsidise petrol sales. At the other end of the scale there are countries such as Italy, Norway, etc., which use a high tax to minimise petrol consumption. It is the difference in tax off-takes which has led to the large-engined vehicle in the USA and the petrol-efficient smaller car in Europe.

> "... while South Africa is seen as having a very low petrol price, it is seen as a high price country for diesel fuel."

The longer-term prices of petrol in South Africa are shown in Figure 2. This figure shows the current ("money-of-the-day") prices and the prices in terms of deflated prices to the 1990 Rand. Prices in the 1920s were amongst the highest that South Africa has experienced, in spite of the perceptions of people who remember prices at pence-per-gallon levels. Following the crude oil price shocks of the early- and late-1970s the price of petrol rose to the highest level in the history of the industry. In keeping with the general crude price reductions of the 1980s the price of petrol has decreased to levels just above the R1 per litre level. In fact, close inspection of the real price over the last three years shows that there has been no increase in the real price of petrol over that time. Except for the time of the crude price hikes in the 1970s the real price of petrol in South Africa has not changed significantly over the last 60 years, and has been at a level of about R1 per litre in 1990 currency.

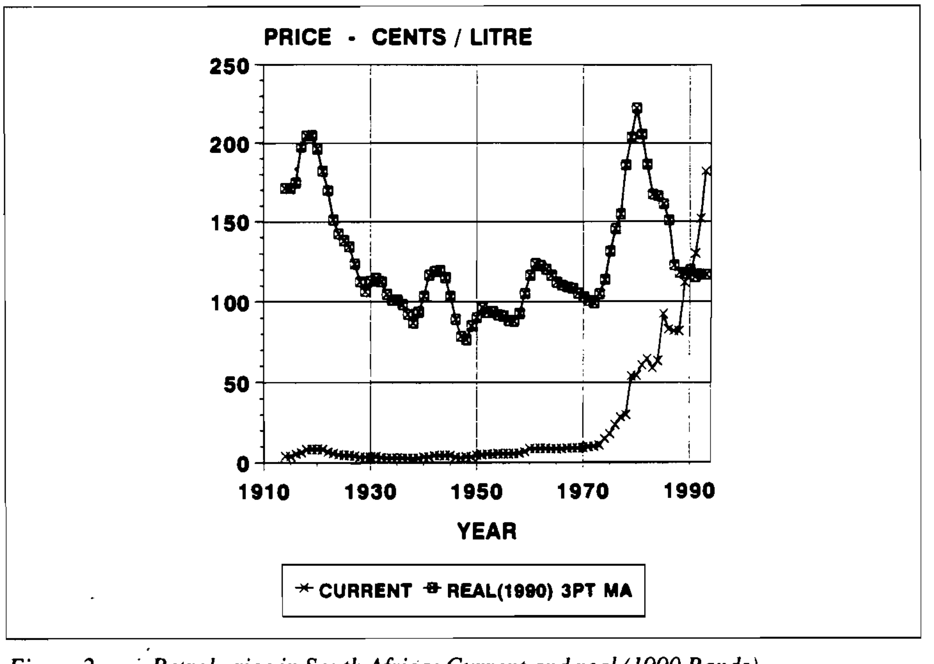

Figure 2: Petrol price in South Africa: Current and real (1990 Rands)

During the same period, from 1915 to 1993, the tax on petrol rose from 4% of the petrol price in 1920 to around 40% in 1935 and has averaged about 35% over the period from 1935 to the present (Figure 3). There have been times of large swing such as, in 1979, when tax went down to 18%. This was however due to a rapid increase in crude price which resulted in a high refinery gate price but tax was not increased until some time later.

In summary, the tax level has been around 35% over a 60-year period and this appears to be in line with many overseas countries, but would be considered low by most European countries.

It has been argued, for instance by the South African Automobile Association (AA), that the comparison of the petrol price with overseas prices is spurious, and that what is more important is the length of time that a person has to work in order to purchase a litre of petrol. The AA claims that a South African has to work twice as long for a litre of petrol as his European counterpart[(2)]. This argument would make sense if the litre of petrol was made from indigenous sources with local labour in each country being compared. However, oil is an internationally traded commodity, the price of crude being approximately the same for all countries and the price of refining being also approximately equal since the main cost is that of the capital cost of the refinery equipment. Moreover, if such a comparison based on "working time" was to be made, it should also include relative productivity levels. Thus the AA type of argument appears to be naive.

The price of diesel fuel

The price of diesel fuel in South Africa has been kept approximately equal to that of petrol. At the beginning of the 1980s the price of the two fuels was identical. Diesel became more expensive in the mid-1980s and is now some 6% cheaper than petrol. For agricultural use diesel receives a significant subsidy. The question is however, whether South Africa is on a par with other countries in its diesel fuel pricing policy. Figure 4 shows the price of diesel relative to other countries.

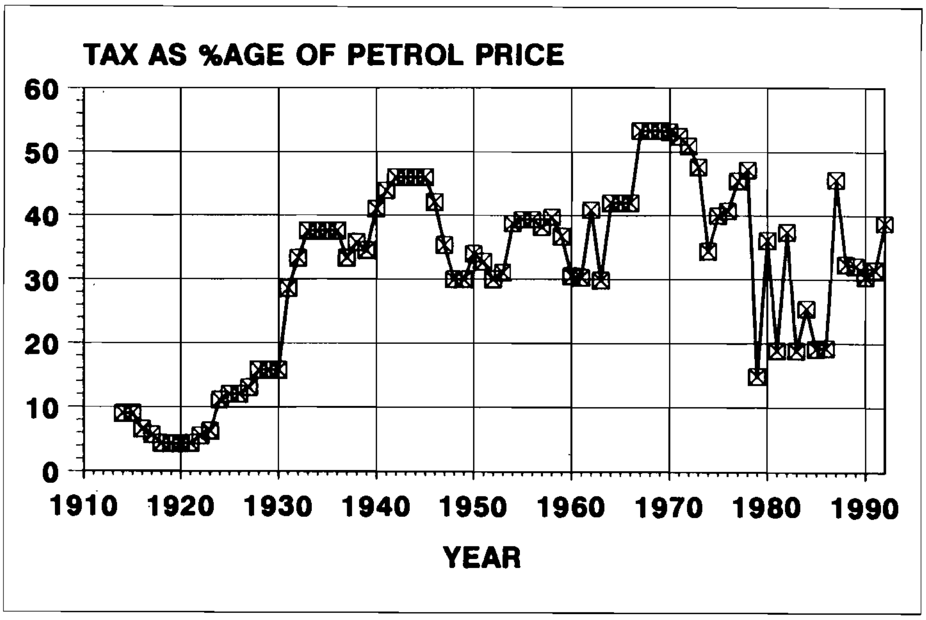

Figure 3: Tax on petrol as a percentage of total price

In this comparison it is seen that the price of diesel in South Africa is higher than that in many other countries, although still lower than in Europe. Thus, while South Africa is seen as having a very low petrol price, it is seen as a high price country for diesel fuel. Figure 5 has been drawn to show the relation between diesel and petrol prices in the countries previously used for the comparison.

This figure, which shows the ratio of diesel to petrol prices in each of the countries, shows that the ratio is highest in South Africa. The reason for this is that in most countries it is accepted that diesel fuel is used mainly in the economically active sector, whilst the petrol market has a large section of non-GDP-creating activity. Therefore tax is lower on diesel fuel than on petrol. This is of course practised in South Africa in terms of the subsidy on diesel fuel offered to farmers, but this is only a small section of the wealth-creating section of the country.

It would therefore appear that tax on diesel fuel in South Africa is too high whilst the tax on petrol is too low. This, in the past, has led to a predominance of petrol vehicles and a dearth of diesel vehicles. When it is considered that the higher efficiency of the diesel engine results in a lower overall crude consumption and a lower total emission level, then the limitation in the number of diesel engines is not in the national interest. One example may be used to illustrate this.

The combi-taxi industry is equipped with petrol engines because of the higher first cost of the diesel engine and the lack of incentive in terms of a lower diesel fuel cost. In terms of the heavy mileage of such taxis it would be economically beneficial to use a diesel engine which would use some 25% less fuel than its petrol equivalent. However, the combi-taxi industry is unsophisticated and life-cycle costs are not used as a basis for engine selection. A switch to diesel engines would result in a 25% reduction in fuel consumption by that sector and an equivalent reduction in crude imports.

A reduction in the diesel price relative to petrol would also encourage the private motorist to move to diesel cars. In South Africa there are virtually no light-duty diesel passenger vehicles. By comparison the percentage of diesel fuel use for light passenger vehicles in this category in other countries is as follows:

Country	Percentage diesel usage for cars
USA	1
Japan	8
France	22
Germany	20
Italy	28
Norway	3
Denmark	11

The economic impact of a move towards a greater reliance on diesel fuel needs to be carried out by the government.

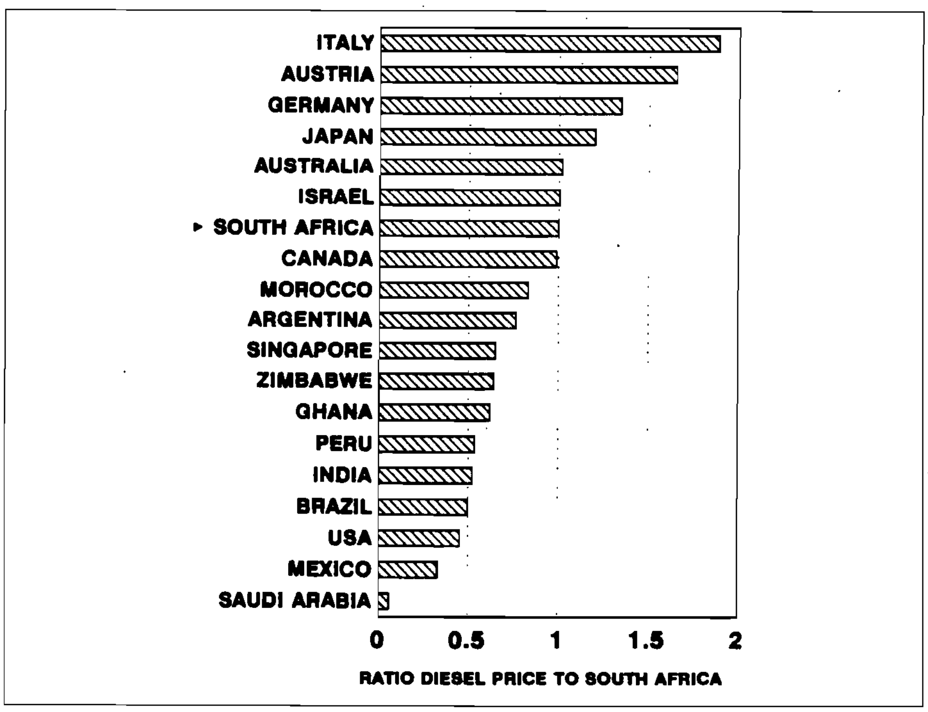

Figure 4: International diesel fuel prices relative to South African price (1990)

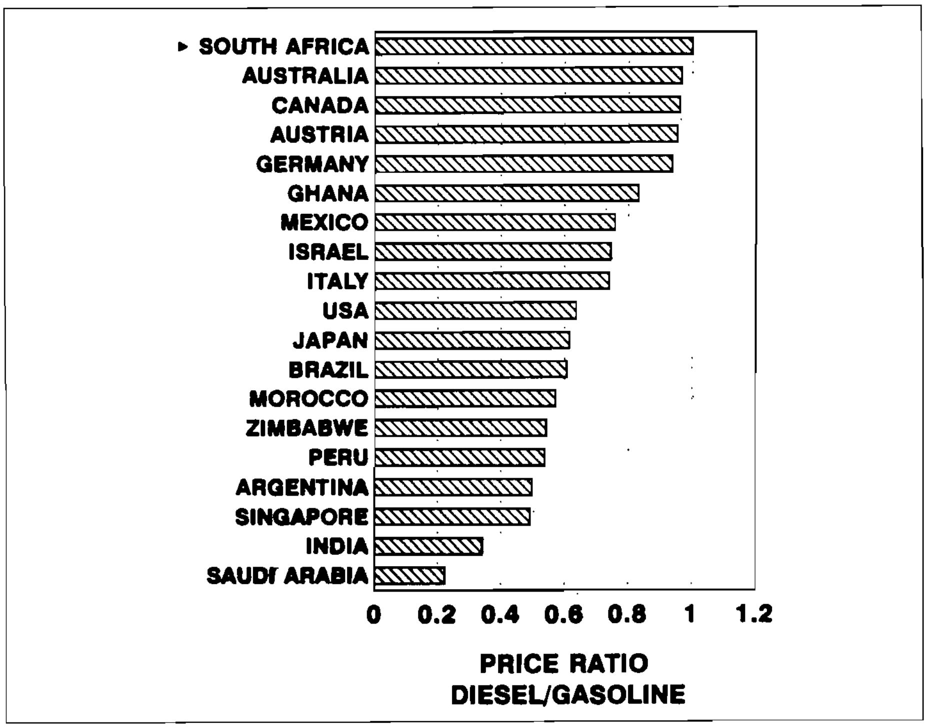

Figure 5: Ratio of diesel fuel prices to petrol prices in various countries (1990)

Changes in the tax structure

It is apparent that the tax structure needs to be changed relative to the tax levels on petrol and diesel. A decrease in the tax on diesel fuel would result in a saving on crude imports and would also go some way to redressing the imbalance which is being created at the refinery due to the petrol demand increasing at a higher rate than that of diesel fuel. This difference in the demand for petrol and diesel is shown in Figure 6.

The effect of the worsening economic situation in the country since the late 1970s is shown here in terms of the flattening out of the diesel demand (which is GDP-driven) whilst the petrol demand carries on rising, though at a lower rate than in the 1960s and early 1970s.

Whilst it is evident that the tax on diesel has to be reduced and the tax on petrol has to be increased the mechanism for achieving this is not obvious. The combi-taxi industry found that they have political strength and are able to disrupt economic activity at will if they see actions which could decrease their earning powers. On the other hand, there must be a change in the price ratio between petrol and diesel in order to encourage people, such as, the combi-taxi drivers and commercial organisations, to change to the more efficient diesel engine. Therefore, for future price increases the tax should be progressively increased on petrol, as opposed to diesel, until the required ratio is reached. If overseas practice is followed it would appear that the ratio of the petrol price to the diesel fuel price should be approximately 1:0,6 or 1:0,7.

If a petrol to diesel fuel price ratio of 1:0,6 was used it is estimated that, following European experience, diesel fuel would account for approximately 15% of light-duty passenger vehicle fuel[3].

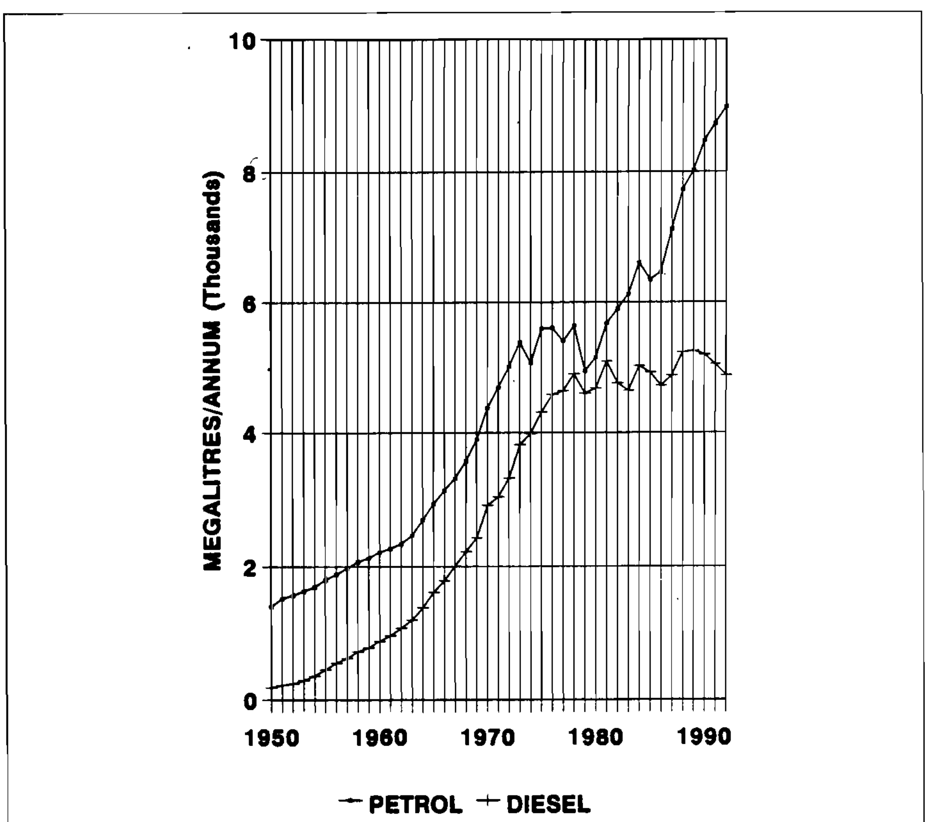

Figure 6: Petrol and diesel consumption in South Africa

Deregulation

Following many years of strict governmental regulation of the oil industry during the sanctions era, there is now a discussion on partial or complete deregulation of the industry. There is a general belief amongst the public and some critics of the oil industry that deregulation will result in a large decrease in the fuel price because of competition between the companies and with potential new entrants. This would only be true however, if there were excessive profits being made in the industry. It is difficult to see how complete deregulation could take place in view of the need to maintain the synfuels industry in the national interest and in view of the developmental stage of the country's economy. Thus deregulation would result in the introduction of self-service stations and in the closure of many unprofitable stations. This action would result in loss of jobs, a situation which should be avoided at present, though it is in the national interest and must occur in the future.

Another undesirable result of deregulation at the present time would be the introduction of discounted fuel at supermarkets. Such discounts would trigger further discounts as each supermarket tried to attract motorists. This would undoubtedly result in loss-leader selling of petrol. Losses on petrol sales would be recovered from cost increases in foodstuffs and household requirements. To the general motorist this would not matter since what he would lose on food would be recovered on petrol. However, a large proportion of the population, the poorer section, who do not drive cars would see only increases in food prices. Thus the sale of petrol by organisations whose main function is food, clothing, etc., should be actively discouraged at this stage of the country's development.

It is difficult to see how deregulation could be introduced in a piece-meal manner because of the complexity of the liquid fuel industry. It is doubtful however, whether there could be any large drop in petrol prices due to deregulation unless self-service is permitted at the pump.

It is thus unlikely that deregulation would result in a significant reduction of liquid fuel prices in the short term. The main way of reducing petrol prices would be to reduce the tax level. However, in view of the fact that South Africa is in line with petrol prices internationally and has, in fact, one of the lower prices, it is unlikely that a reduction in the tax level would be contemplated.

Conclusion

Petrol and, by implication, diesel fuel prices have not changed significantly, in real terms, over the last 60 years and the recent unrest following the increase in the fuel cost can only be ascribed to political opportunism. It is unlikely that there will be any large changes in the fuel price in the medium term. Deregulation may decrease the price by a few cents but the introduction of unleaded fuel will result in overall fuel price increases.

It would appear that the tax on diesel fuel is too high relative to international norms and should be reduced in the national economic interest. This would also redress the imbalance between diesel and petrol fuel sales which has occurred over the last few years, an imbalance that the refineries cannot meet in the local market.

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An Insulated Earth Wire Distribution System (Shield Wire Scheme)

* T D J HENNESSY

An Insulated Earth Wire Distribution System is a concept developed to directly address the problem of providing low-cost electrification to areas with existing high voltage (HV) networks.

This paper examines its merits by looking at single- and three-phase options, along with such considerations as lightning performance, earthing and costs. Its suitability in the Southern African context, in terms of its application within the Eskom network, is discussed and recommendations are made.

Keywords: earth wire; electrification; low-cost

List of symbols

HV	–	High voltage (66 kV and higher)
MV	–	Medium voltage (1 - 33 kV)
ρ	–	Resistivity in ohms metre
ϕ	–	Phase voltage *e.g.* red, white or blue
Ω	–	Ohm
kVA	–	Kilovolt ampere
$V_{p\text{-}G}$	–	Phase to ground voltage
PF	–	Power factor
kV	–	Kilovolt
V_{drop}	–	Volt drop

Introduction

The South African electricity network is characterised in many areas by long HV lines supplying dispersed major towns. The population density in many areas is as low as 4 persons/km[9].

Along the routes of many of the HV lines are situated numerous small committees, very often providing labour for farms or involved in their own farming. Many of these isolated groups do not have access to electricity.

One of key strategic initiatives adopted by Eskom is that of "Electricity for all". Whilst in urban areas, the sheer volume of connections makes achieving this goal cost-effective, in the sparsely populated rural areas this is not the case. Consequently, innovative design techniques to achieve *low-cost* rural electrification are being actively sought.

Table 1 indicates typical costs/km of medium voltage (MV) woodpole lines, the type used in rural areas. Depending on the terrain these figures may vary by as much as 50%.

A technique which insulates the earth (shield) wires of an existing HV line along its length and then energises these earth wires at MV (22 kV) has been developed and put into operation in Ghana, West Africa.

Because of the obvious reduction in materials used (sharing the same structures and using the existing earth wires) a 10-fold reduction in costs has been realised.

This paper will explain the concept of the so-called Insulated Earth Wire Distribution Scheme, pointing out some of the advantages and considerations associated with it, as well as proposing regions within South Africa which may be suitable for the application of such a scheme. Expected performance of this scheme, along with the closely analogous Single Wire Earth Return (SWER) scheme, will also be given.

Insulated Earth Wire Distribution Schemes

A point which requires early clarification is that of drawing a distinction between firstly, insulating the earth wires and allowing capacitive coupling from the parallel HV circuit below to *energise* them, and secondly, that of *physically* connecting one end of these insulated earth wires to a MV source.

The first concept is generally more expensive, and furthermore it is limited in terms of power per km transferred from the main HV line[2,7] to that of the overhead earth wires.

Scheme descriptions

It is considered that two practical options of the Insulated Earth Wire Distribution Scheme exists for South Africa. The first one, a single-phase (1ϕ) balanced scheme and the second, a three-phase (3ϕ) scheme.

(1) Single-phase scheme

Many of the HV lines in South Africa are fitted with two earth wires conventionally providing proper insulation co-ordination and lightning protection to the line. Earthing in South African conditions is often a problem, with high earth resistivities making it both expensive and sometimes unreliable. By using both pairs of the existing earth wires with one as a return, the problem of earthing is to a large extent circumvented. Equally so, the system then lends itself to be upgraded to operate as a 3ϕ one at a later date (see below).

The single-phase systems are shown in Figure 2.

Within South Africa, as with for example, New Zealand, Australia and Canada, SWER is a proven reticulation method. It is, however, limited in its power transfer capacity to the maximum of the permissible earth return current or the current carrying capacity of the conductor.

Voltage (kV)	Line Type	Rand/km	Rand/Connection
11	Woodpole	R25 440	R4 452
22	Woodpole	R26 800	R4 690
22 SWER*	Woodpole	R14 600	R4 230

* Based on limited samples.

Table 1: Rural electrification costs[10]

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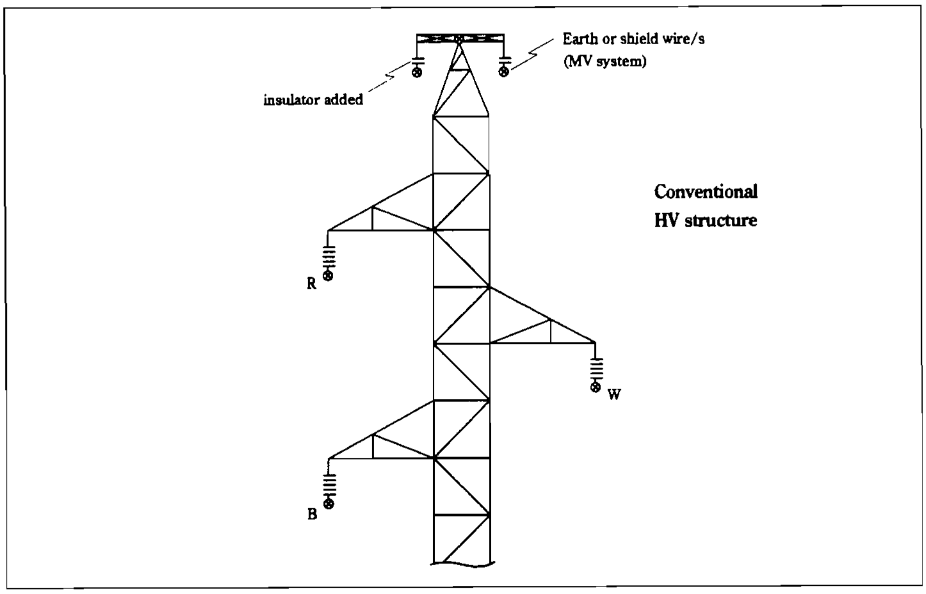

Figure 1: *Typical earth wire tower configuration*

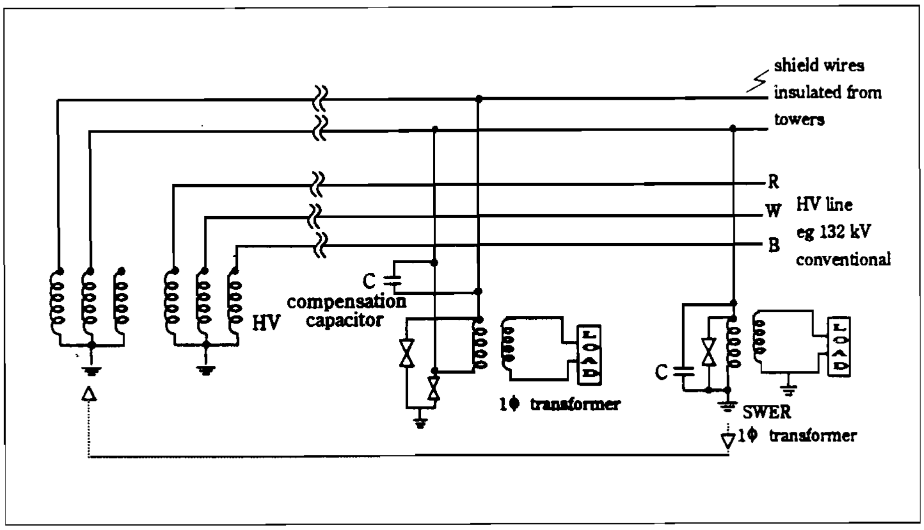

Figure 2: *Single-phase (balanced) and SWER schemes*

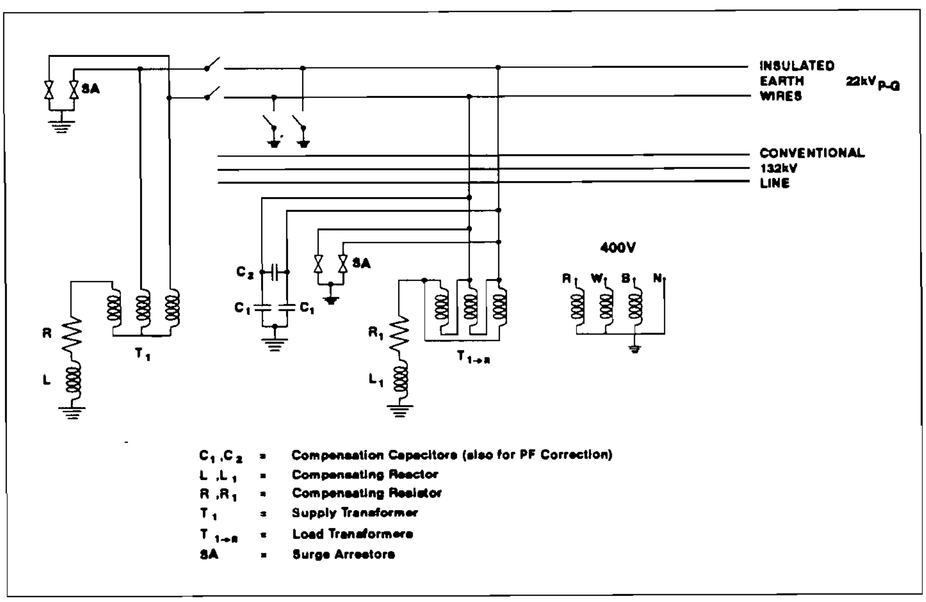

Figure 3: *Three-phase scheme*

Description

The single-phase (balanced) scheme uses the insulated earth wires as the current carrying conditions for tee-offs to various loads along the length of the line.

Using either a dedicated supply transformer or the tertiaries of an existing HV/MV one, the supply at, for example, 22 kV (ϕ to ϕ) can be provided. This permits the use of conventional distribution equipment thus simplifying spares and maintenance requirements.

The power transfer will be limited by the volt drop caused by size and type of existing earth wires. Conventional protection schemes can still be used with this configuration.

Some care with regard to overvoltages caused by ferroresonance needs to be given. To this end capacitors connected between the earth wires will effectively damp any ferroresonances and provide power factor compensation (see Figure 2).

Maintenance

Care needs to be given to operating on a scheme in which earth wires are not at "ground" potential. Either live line techniques or switching off of the line needs to occur during maintenance periods. This is particularly important as the HV line will induce capacitively a continuous voltage, depending upon the configuration, into the insulated earth wires.

As a corollary, because the earth wires are far removed from the physical ground, the frequency of damage due to vandalism and tree contacts is considerably reduced over conventional woodpole MV rural lines. This has been shown in Ghana over the period of installation[(2)]. Hence the need for maintenance is also reduced.

(2) Three-phase scheme

This scheme is designed to provide a 3ϕ balanced load by using the two insulated earth wires as two of the phases and an earth path as the third phase. By including compensation components in this earth path a balanced or symmetrical 3ϕ system is created.

At the supply substation end, the supply transformer has one of its phase terminals grounded, thus providing the earth return phase. This is a specially designed transformer and is one of the drawbacks of the scheme. The compensating components are a series inductance and resistance aimed at compensating for the lower earth path impedance than that of the other two phases, which consist of insulated metallic earth wires.

A schematic drawing of this is shown in Figure 4.

At the tee-off points either 3ϕ or 1ϕ power can be delivered. The 3ϕ tee-off distribution transformers are conventional devices connected in Delta, grounded star (one phase is grounded via compensation components if required. This means two of the primary phases are stressed at phase to phase voltage continuously and the third at phase to ground). The single-phase tee-off requires conventional transformers but with two HV bushings for phase to phase connections.

As described earlier, earthing plays a paramount role in this scheme. It is essential to ensure that a "good" earth is obtained at the supply point. Equally so at each distribution tee-off, it is vital to ensure a "good" earth exists although, because of the lower return current from each tee-off than at the supply point, these earths can have higher resistances.

For example, for a conventional 25 kVA 3ϕ load at V_{P-G} of 22 kV and a touch potential of 25 V, the earth resistance at the distribution tee-off point should be less than 20Ω. This is far easier to achieve than the required 2Ω at the supply point.

Maintenance of this scheme should be, as with the earlier 1ϕ schemes, carefully considered. In addition, however, the earth path is now used as a return and extra caution in terms of isolation and maintenance needs to be exercised. Protection schemes used will be of the overcurrent and unbalanced types.

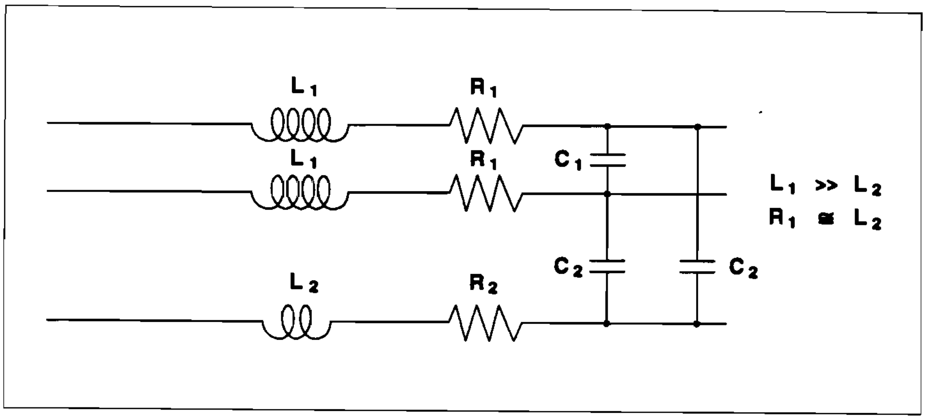

Figure 4: Three-phase scheme phase impedances

Earthing in South Africa

Figure 5 shows the soil resistivity map for the South African region [11] measured in ohms-metre (Ωm).

The earth resistance of a vertical electrode buried in the ground is given by

$$R = \frac{\rho l}{A}\ \Omega$$

ρ = soil resistivity, Ωm

l = length of path, m

A = surface area of hemisphere, m^2

In the Insulated Earth Wire Schemes considered, the concept of a "good" earth is vital. The indicators of this "good" earth are step and touch potentials. Diagramatically these are shown in Figure 6.

By ensuring that the earth connection is "good", the risk of contact electrocution, overheating and drying out of the local

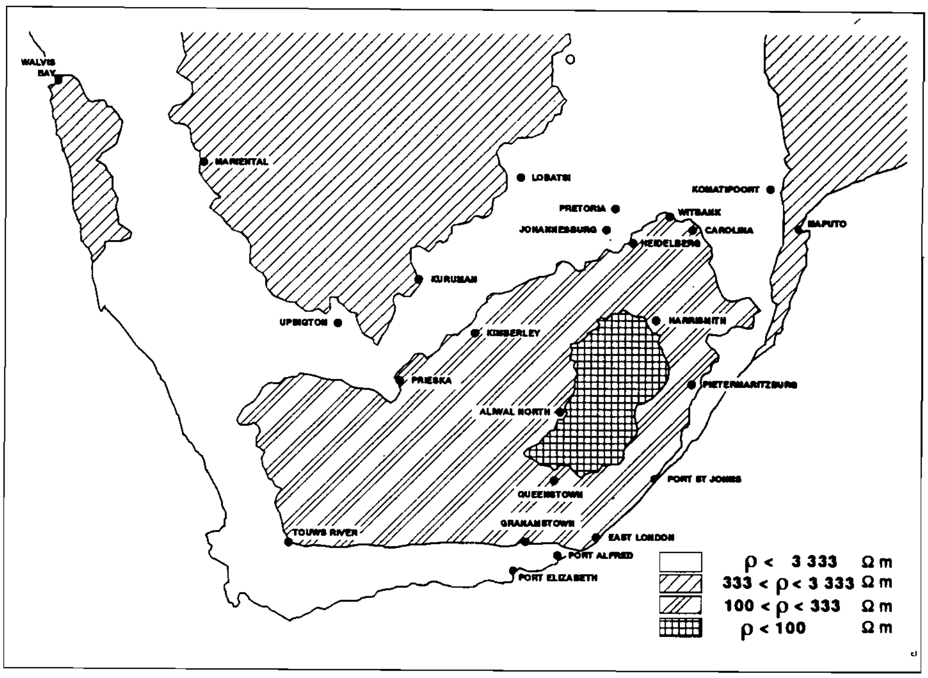

Figure 5: Soil resistivity applicable in Southern Africa [11]

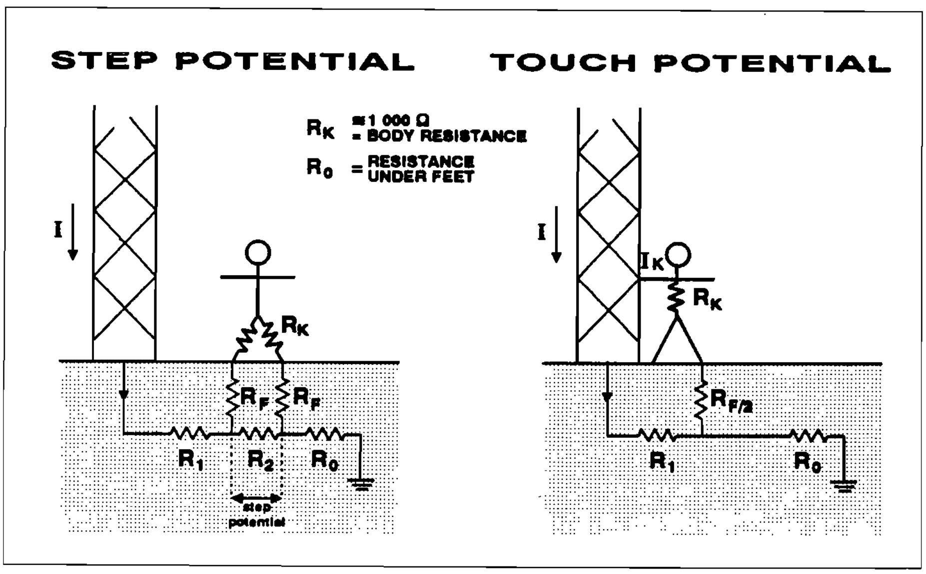

Figure 6: Step and touch potentials

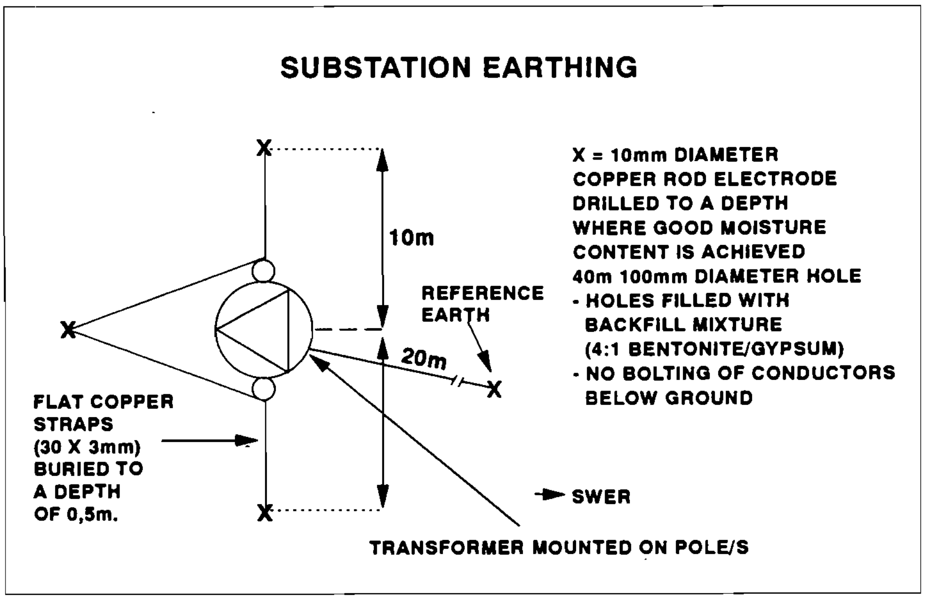

Figure 7: Earthing option for ensuring low earth resistance in high resistivity soils

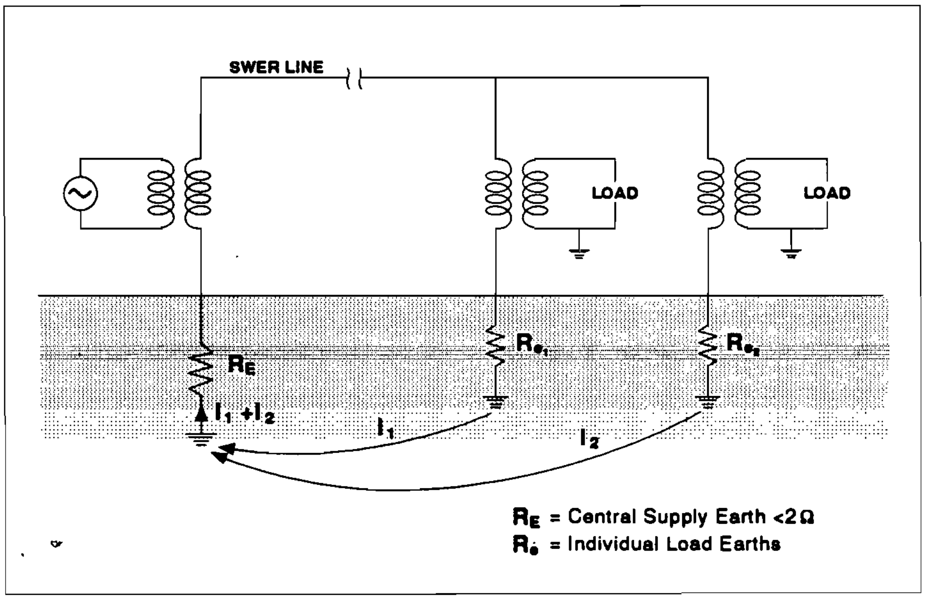

Figure 8: SWER current earth return paths

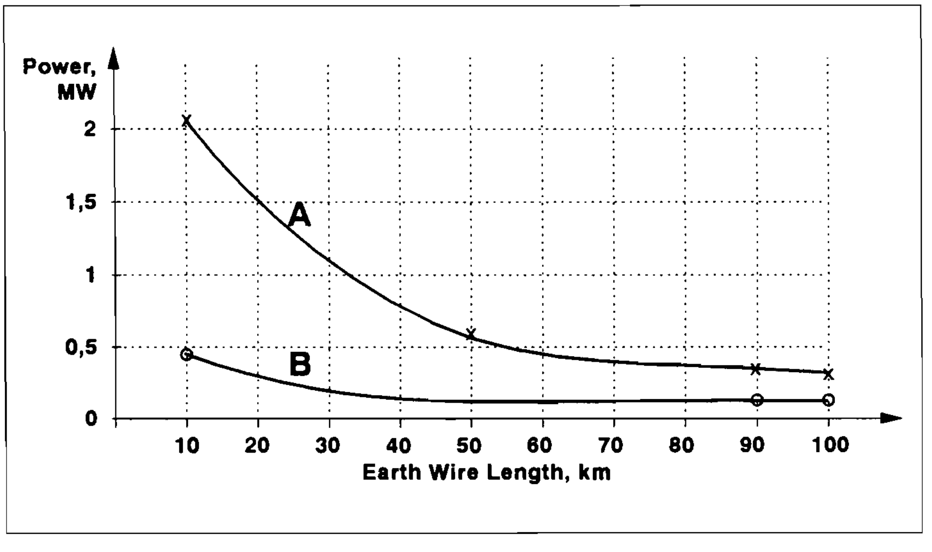

Figure 9: Power transfer capacities of earth wires

ground around the electrode is reduced. For safety, 25 volts touch potential is considered acceptable in South Africa. This equates to an earth resistance of 2Ω for a current of 12 Amps. (Canadian practice permits 50 Amps earth current through the paralleling of numerous earth points).

To achieve earth resistances of less than 2Ω in areas of the Cape Province which are considered suitable for Insulated Earth Wire Schemes, and where soil resistivity may be 1 000 Ωm, an option such as that shown in Figure 7 can be used. This could amount to some R10 000 for an earth return point.

In the Insulated Earth Wire Distribution Scheme with multiple tee-off's earth currents will flow to the central supply transformer (3ϕ scheme or SWER 1ϕ scheme) and only here will an earth of such low resistance be required.

The diversity of loads and types of load will also interact to reduce the combined effect at R_E.

Since the main earth is in the central supply substation, it is well maintained and normally of low value.

By maintaining low earth resistances, earth mat potential rises under fault conditions can also be catered for.

Power transfers

In South Africa, various types and sizes of earth wires are in use. In the case of the retrofit of an existing line, due consideration to the power transfer capacities of the earth wires needs to be given as well as to the physical construction of the line. This is because in some instances earth wires form an integral part of the structural support of the towers. In this case insulating them would need careful consideration.

Figure 9 gives an indication of the power transfer capacities for one size of earth wire when used in the two-scheme configurations previously described. Major factors limiting transfer are the resistive volt drops along the line, short circuit limits and power loss (thermal).

In the case of the 3ϕ scheme, one must note that ground impedance is very much lower than that of the earth wires. Hence power transfer is limited by earth wire capacities in all but the *worst* ground conditions.

Key for Figure 9

A power factor of 0,9 has been used.

Steel shield wires used ≈ 13 m diameter (132mm^2)

The maximum volt drop along the length of line is less than 10% of $V_{nominal}$

Curve **A** shows the power transfer capacity over distance for a 3-phase 22 kV_{P-G} system.

Curve **B** shows the power transfer capacity over distance for a 1-phase 12,7 kV_{P-G} system.

Practical application and performance

One of the important practical considerations is on what voltage HV for lines the above schemes are usable. The controlling factor here is that of fault level and the effect of a HV line fault on that of the Insulated Earth Wire Scheme. An HV fault will induce into the earth wires a transient overvoltage which will depend upon factors such as, earth wire symmetry, separation from HV conductors, fault levels and conductor sizes. In general, however, it is not recommended to use such schemes on HV lines with fault levels of above 5 000 Amperes and 220 kV operating voltage (this to limit the steady state electromagnetically coupled voltage)[2].

A second consideration is that of lightning performance. Conventional MV rural lines in South Africa are 9-12 metres above the ground. By using the earth wires of HV lines this is increased to possibly 18 metres. The effect is an increase in probability of direct lightning strikes of 60%[12]. It is therefore important to choose a scheme in an area in which the incidence of lightning is low in terms of its effects on line performance and hence quality of supply to the user.

With these two considerations as background, along with the other more obvious ones such as, power transfer, the question of where in South Africa earth wire schemes could be used can now be answered.

By referring to the ground flash density map for South Africa[5], it can be seen that nearly the whole of the Cape Province has occurrences of less than 5 strikes/km^2/annum. Demographically this area is also sparsely populated, with much of the population in the rural areas and many settlements without electricity. Also, there are numerous HV lines in the area feeding major towns and railway traction lines.

It is therefore considered most practical that the rural areas of the Cape be singled out for consideration for the use of Insulated Earth Wire Distribution Schemes.

Other areas of the country where similar conditions apply should also be investigated, as with countries further north in Africa.

Conclusions

The direct use of shield (earth) wires for transfer of power is undoubtedly a technique suited to Africa in various geographical regions. Its advantages are:

— optimum use of existing HV backbone structures and hence very low distribution costs of the order of R1 500/km, as opposed to conventional 3φ woodpole construction, costing R25 000 - R35 000/km;

— optimum use of existing servitudes and hence both improved use of scarce land resources as well as better acceptance by land owners;

— proven operation over 5 years in African conditions both in coastal pollution zones as well as in dry hinterland conditions;

— it may be used in various configurations to supply 1φ balanced or unbalanced power, or 3φ power of up to 2 MW over distances of 80 km;

— conventional protection schemes are used by the system and, as with *SWER* systems already in use, have been successfully proven;

— a standard applications package has been developed by Eskom's research group.

Disadvantages of the scheme, or other considerations in its application are:

(1) Lightning activity (isokeuronic levels). If these are too high (greater than 5 strikes/km^2/annum), the performance of the main HV and shield wire scheme *could* be prejudiced. Because certain areas of South Africa e.g. northern Natal, have very high isokeuronic levels (14 strikes/km/annum), this must be considered in the planning stage. (The majority of the Cape, on the other hand, has levels of less than 4 strikes/km^2/annum).

(2) The operation of such a scheme differs from that of a conventional one in that the *earth* wires are permanently energised. Operating procedures have therefore to be reconsidered.

(3) For the 3φ and 1φ unbalanced systems, "good" earthing at two points is required. This is the same as for the SWER requirements and does not pose an insurmountable problem as demonstrated in tens of thousands of kilometers of SWER schemes elsewhere in the world and also in South Africa.

The shield wire scheme, far from being the panacea for cheap distribution, is instead a novel and practical tool to be applied where appropriate, even if only to provide an initial solution. There are many areas in South Africa where such possible applications exist.

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*The SADC energy balance 1990: An overview

** B K KAALE

This is the first part of a two-part paper which focuses on the role of biomass fuels within the SADC energy economy. In order to put this into perspective, energy consumption trends in the SADC region for 1990 are briefly reviewed, contrasting them, where relevant, with the figures for 1980. The energy sources used by the main consumer sectors are described, and opportunities for sustaining energy sources in the SADC region, with specific reference to environmental protection, are discussed. Biomass fuels are emphasised throughout.

Keywords: energy consumption; energy sources; SADC; energy balances; biomass

Comparative SADC energy consumption trends: 1980 and 1990

Total energy consumed in the SADC region in 1990 was 1 548 PJ. The main sources of energy and their contribution to total energy consumption are shown in Table 1.

A comparison of the 1990 energy balance with that of 1980 (Table 2), indicates that the trend of consumption and the division of energy sources to total energy consumed did not change much. Most of the energy consumed in 1980 and 1990 was through the use of biomass fuels.

The main trends which can be identified between the energy balances of 1990 and 1980 are that:

(a) the share of biomass fuels in the total energy balance dropped by 2,9% from 79% in 1980 to 76,1% in 1990. This drop could be attributed to fuel-wood scarcity, on the one hand, and on the other hand, improvement of end-use efficiency;

(b) the share of electricity and petroleum increased between 1980 and 1990. Electricity increased slightly by 1,1% from 3,9% in 1980 to 5% in 1990, and petroleum increased by 2,4% over the same period.

ENERGY SOURCE	FINAL CONSUMPTION (PJ)	CONTRIBUTION (%)
electricity	77,8	5,0
petroleum	201,7	13,0
biomass fuels	1 177,9	76,1
coal	75,2	4,9
coke	15,4	1,0
TOTAL	1 548	100,0

Table 1: Overall energy balance for the SADC region in 1990

ENERGY SOURCE	FINAL CONSUMPTION (PJ)	CONTRIBUTION (%)
electricity	57	3,9
petroleum	155	10,7
biomass fuels	1 150	79,0
coal	93	4,4
coke	0	0,0
TOTAL	1 455	100,0

Table 2: Overall energy balance for the SADC region in 1980

Figure 1 shows the percentage share of the various sources of energy in the SADC region during 1980 and 1990 respectively.

Energy sources used by the main consumer sectors

The main consumer sectors of energy in the SADC region have been categorised into six sectors, namely: household, agriculture, mining, industry, transport and others. Energy sources used in 1990 by these sectors are presented in Table 3 and Figure 2 respectively and discussed further.

Household sector

The household sector relies heavily on biomass fuels. In 1990 biomass fuels accounted for 96,8% of the total energy consumed by the household sector(1) (See Tables 3(a) and (b)). The contributions of other energy sources to the household sector were as follows: petroleum 1,7%, electricity 1,3% and coal 0,2%. Nevertheless, the supply of biomass fuels in the SADC region is dwindling rapidly resulting in energy scarcity and environmental degradation. It is essential that measures be taken which will sustain the supply of energy to the household sector. It should also be noted that women and children are the most affected by household energy scarcity.

Agriculture sector

Biomass fuels accounted for 59,8% of the total energy consumed by this sector in

* Based on a paper presented at the 8th SADC Energy Ministers' seminar on the sustainability of traditional fuels and environmental protection in the SADC region, held in Windhoek, Namibia, 17 June 1993.

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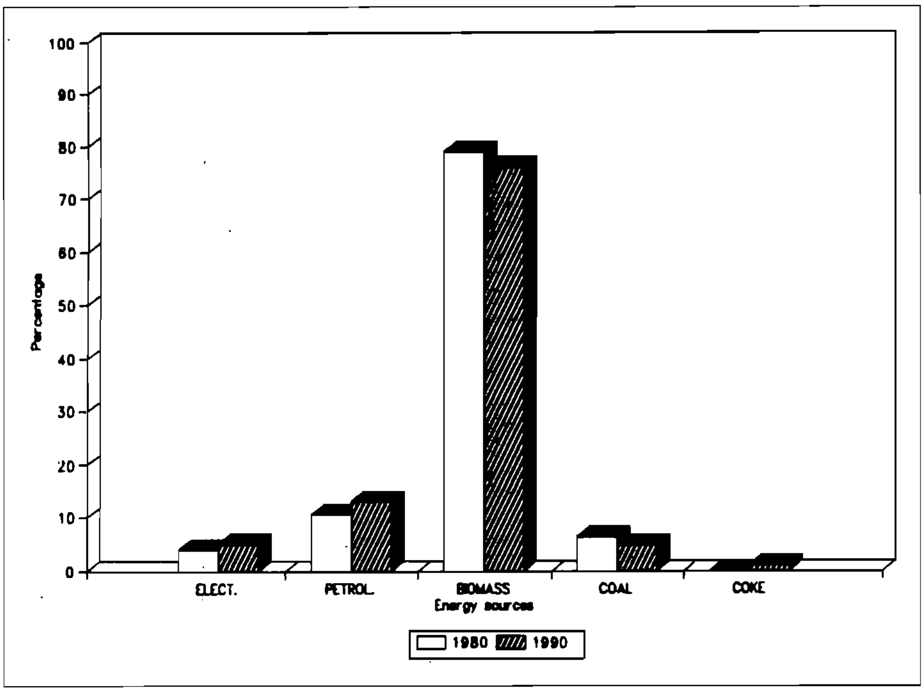

Figure 1: *Energy balances for SADC: 1980 and 1990*

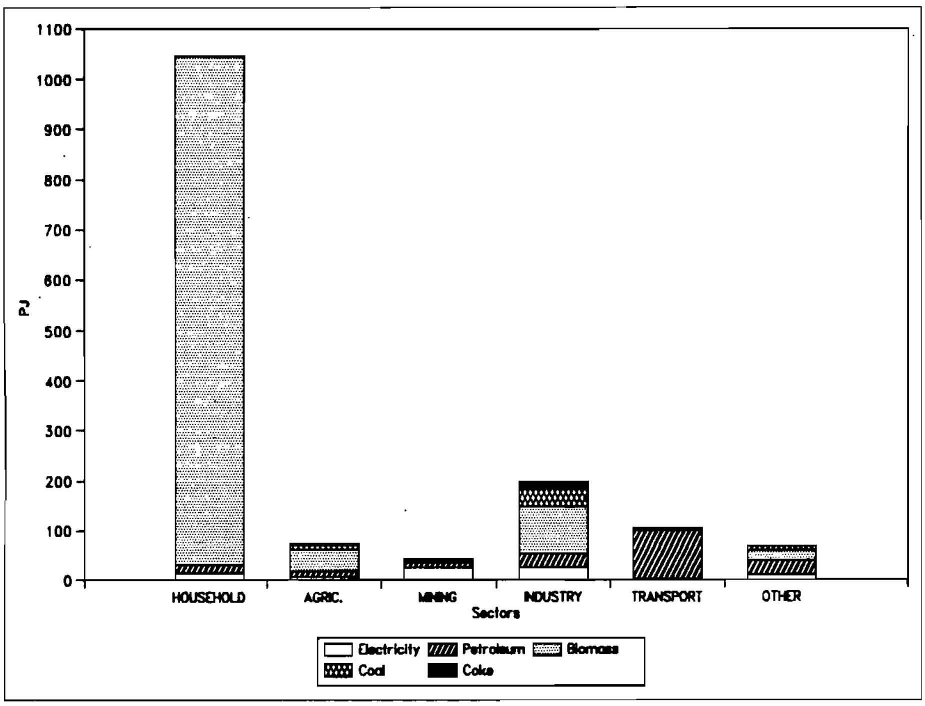

Figure 2: *The contribution of energy sources to the main consumer sectors in the SADC region in 1990*

1990. The contribution of other sources were: petroleum 16,9%, coal 16,5% and electricity 6,8%. Sustainability of energy supply to this sector requires close integration of the energy sub-sectors and the end-users.

Mining sector

Electricity is this sector's main source of energy, accounting for 57,4% of total energy consumed in 1990, followed by petroleum 23,4%, coal 18,6% and biomass fuels 0,6%.

Industrial sector

This sector is more versatile in its energy use. Biomass fuels accounted for 47,7% of the total energy used by industry in 1990, followed by coal 18%, petroleum 14,1%, electricity 12,8% and coke 7,5%.

Transport sector

Petroleum is the main source of energy for this sector, accounting for 93,5% of total energy used in 1990, followed by coal 6,2%, electricity 0,2% and coke 0%.

Environmentally, the transport sector is the main source of carbon dioxide (CO_2) emissions in the SADC region, because of its high fossil fuel consumption. Efforts to improve end-use efficiency, or minimising the need to travel could contribute to a reduction in fossil fuel consumption in this sector.

Other users

Petroleum dominated energy consumed in 1990 by other users, accounting for 43,2%, followed by biomass fuels 29,7%, coal 14%, electricity 12,7% and coke 0,5%.

Opportunities for sustaining energy sources used in the SADC region

Opportunities for sustaining electricity, petroleum, biomass fuels, new and renewable energy sources, and coal, with reference to environmental protection are discussed below.

Electricity

General comments

The electricity sub-sector is the most institutionally developed of the energy sub-sectors at national and regional level in the SADC region. On average, it accounts for over 92% of the total national and regional energy budgets.

Electricity is associated with progress, modernisation and prosperity. When compared with coal, it is fairly environmentally friendly. For these reasons, rural electrification programmes have been initiated to minimise the disparity between rural and urban electricity supply in most SADC states. However, because of the people's low income, the majority of the rural population does not have access to electricity. The subsidisation of electricity is considered unrealistic, as who will bear the costs if everyone is subsidised?

Hydro-electric power

The estimated hydro-electric power potential in the SADC region is about 45 970 MW. However, in 1990, the installed hydro-electricity capacity was 5 460,3 MW. Scope for expansion therefore exists, particularly with inter-regional grid connections to facilitate the export of power between SADC states.

	ELECTRICITY		PETROLEUM		BIOMASS		COAL		COKE	
	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)
Household	13,4	17,3	18,3	9,1	1016,4	86,3	2,2	2,9	0,0	0,0
Agriculture	5,2	6,6	12,7	6,3	45,1	3,8	12,5	16,6	0,0	0,0
Mining	24,5	31,5	10,0	5,0	0,3	0,0	7,9	10,6	0,0	0,0
Industry	25,6	32,9	28,3	14,0	95,4	8,1	36,0	47,8	15,0	97,6
Transport	0,2	0,3	102,2	50,7	0,0	0,0	6,8	9,1	0,0	0,2
Other	8,8	11,4	30,2	15,0	1,8	1,8	9,8	13,0	0,3	2,2
Total	77,8	100,0	201,7	100,0	1177,9	100,0	75,2	100,0	15,4	100,0

Table 3(a): 1990 SADC energy consumption: By sector

	HOUSEHOLD		AGRICULTURE		MINING		INDUSTRY		TRANSPORT		OTHER	
	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)	(PJ)	(%)
Electricity	13,4	1,3	5,2	6,8	24,5	57,4	25,6	12,8	0,2	0,2	8,8	12,7
Petroleum	18,3	1,7	12,7	16,9	10,0	23,4	28,3	14,1	102,2	93,5	30,2	43,2
Biomass	1016,4	96,8	45,1	59,8	0,3	0,6	95,4	47,7	0,0	0,0	20,7	29,7
Coal	2,2	0,2	12,5	16,5	7,9	18,6	36,0	18,0	6,8	6,2	9,8	14,0
Coke	0,0	0,0	0,0	0,0	0,0	0,0	15,0	7,5	0,0	0,0	0,3	0,5
Total	1050,3	100,0	75,5	100,0	42,7	100,0	200,3	100,0	109,2	100,0	69,8	100,0

Table 3(b): 1990 SADC energy consumption: By energy sources

The main constraint within the hydro-electric power sector is the destruction of water catchment areas. This is caused by poor land management which results in soil erosion, siltation and low water flow to dams. This, in turn, lowers power generation capacity and endangers the sustainability of dams[2].

There is also a problem with competing demands for water, which is normally insufficient to meet local needs. Malin[3] indicated that most hydro-electric power planners have failed to recognise that water management is at the core of the general task of improving quality of life and eradicating poverty in areas with water shortages. But how can poor farmers, with no electricity supply, be expected to allow water required for crop irrigation to flow past them to the dams?

Competing needs for water at national and regional levels are likely, in future, to grow into a top priority environmental problem in the SADC region unless integrated strategies for managing water catchment areas and water sharing are developed through multi-sectoral efforts and the active participation of end-users.

Thermal power

In 1990, total installed thermal power capacity in the SADC region was 2 087,5 MW. As use of fossil fuels contribute to environmental degradation, increased thermal power generation is not seen as a priority in the region.

> "Accessibility to biomass resources has been declining rapidly due to increasing population growth, and high dependency on biomass fuels, particularly in the household sector, has resulted in energy scarcity and environmental degradation."

Petroleum

Angola is the only producer of petroleum in the SADC region. For the other countries, importation of petroleum products places major constraints on their national budgets. The general strategy for SADC states is to minimise consumption of petroleum products. However, over the past few years, a trend of increasing consumption of petroleum products has been experienced. For example, overall petroleum products consumption in the SADC region has increased by 3,4% between 1989 and 1990[1].

Coal

Proven coal reserves in the SADC region have been estimated at 1 737 million tonnes. However, in 1990, the total production of coal in the SADC region was 284 000 tonnes. Coal is mainly used for electricity generation in Zimbabwe and Botswana, and for mining in Zambia[1].

There is wide scope for intensifying the use of coal in the region. But coal has serious implications for the enhancement of global warming and acid rain. It is suggested that future coal utilisation should be analysed in order to minimise its negative environmental impact wherever possible. In 1992, the Dutch Development Cooperation[4] showed that coal combustion releases 60% more CO_2 than oil. Globally, more than 60% of acid rain is caused by sulphur oxide emissions, largely from coal-fired power stations.

The growing use of coal, particularly high-sulphur coal, in the SADC region and in other developing countries may, in the long run, increase acid deposition unless suitable so-called clean coal technologies are applied. Technologies to minimise air pollution from coal-fired power plants exist, but they are expensive and most developing countries are unable to afford them.

New and renewable sources of energy (NRSE)

The contribution of NRSE to the total energy balance in the SADC region is presently insignificant[5,6]. However, at the local level, NRSE technologies, like windmills for water-pumping and utilsation of solar energy, have provided important alternative sources of energy.

NRSE technologies are environmentally friendly and thus their large-scale adoption is encouraged.

Biomass fuels

Biomass fuels used in the region include fuelwood, charcoal, agricultural residues and animal wastes. Fuelwood and charcoal are the preferred fuels, but because of a scarcity, people are substituting fuelwood for agricultural residues and animal wastes[7]. Accessibility to biomass resources has been declining rapidly due to increasing population growth, and high dependency on biomass fuels, particularly in the household sector, has resulted in energy scarcity and environmental degradation.

Biomass removes CO_2 from the atmosphere through photosynthesis and releases the same CO_2 when it is burnt or decays. Current estimates indicate that about 20% of the world's net CO_2 emissions are the result of deforestation. However, use of biomass fuels on a sustainable basis is environmentally friendly. A suitable slogan could be, "PLANT A TREE BEFORE CUTTING A TREE".

Although biomass fuels are the main source of energy in the region, they do not feature to any large extent in national energy budgets, their share often insignificant (between 1-3%). An analysis of the funding status for the SADC Energy Sector's regional projects at the end of 1991 revealed that only 2,7% of the sector's total project development funds were earmarked for the development of biomass fuel projects.

Problems associated with biomass fuels scarcity and opportunities for sustaining them will be discussed in more detail in the second part of this paper.

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COMPARATIVE ENERGY COSTS IN SOUTH AFRICAN CITIES RELATED TO HEATING VALUE

MAY 1994											
Energy source	Consumer prices			Cost of energy (c/MJ)			*Relative heating costs			Heating value	
	Coast	Inland	Units	C.T.	Jhb	Dbn	C.T.	Jhb	Dbn		
Coal A (Peas)	245,20	68,40	R/Ton	0,88	0,24	0,56	3,41	1,00	2,30	28,0	MJ/Kg
Elect.	18,50	19,76	c/kWh	5,14	5,49	4,84	21,04	22,47	19,81	3,6	MJ/kW
Heavy Furnace Oil	47,06	61,36	c/litre	1,15	1,50	1,15	4,70	6,13	4,70	41,0	MJ/litre
Illum. Paraffin	85,63	97,53	c/litre	2,31	2,64	2,31	9,47	10,79	9,47	37,0	MJ/litre
Petrol (Premium)	164,00	175,00	c/litre	4,73	5,04	4,73	19,35	20,64	19,35	34,7	MJ/litre
Diesel	143,90	154,40	c/litre	4,02	4,28	4,02	16,46	17,51	16,46	38,8	MJ/litre
Power Paraffin	90,00	101,90	c/litre	2,40	2,72	2,40	9,82	11,12	9,82	37,5	MJ/litre
LPG	95,00	108,80	c/litre	3,47	3,97	3,47	14,19	16,25	14,19	27,4	MJ/litre
Gas											
Cape Gas	45,60	–	R/GJ	4,56	–	–	18,67	–	–	–	–
Gaskor		16,50	R/GJ	–	1,65	–	–	6,75	–	–	–

This table shows comparative energy costs (in SA cents/MJ) in selected South African Cities (coastal and inland) based on a range of energy sources. The following criteria were taken into consideration in the calculation of the cost of energy.

(1) Transport costs for coal were obtained from Spoornet. Railage of coal was calculated from Saalwater to Cape Town and from Saalwater to Durban respectively.

(2) The energy cost has been calculated on the bulk delivered price for consumers, i.e. includes 14% VAT and other charges.

(3) All figures for electricity have been based on energy requirements for large commercial users.

(4) Electricity prices have been based on typical monthly accounts for large users (see Table 5 in the Energy Price List in *Selected Energy Statistics: South Africa*).

(5) A 75% load factor has been used in the calculation of the Gaskor prices.

(6) The relative heating costs are shown in relation to the cheapest source, i.e. coal in Johannesburg)

(Source: *Selected Energy Statistics: South Africa*, No. 29, May 1994)

Energy news in Africa

Coal

Iscor has been awarded coal exploration rights in Block RA287 near the town of Moranbah, Queensland, Australia. Trans-Natal Coal was also awarded exploration rights in the Togara South area.

The area allocated to Iscor has a potential *in situ* reserve of approximately 700 million tons (Mt) of high-grade coking coal. The deposit is less than 200 km from the nearest large export harbour at Mackay and apart from its favourable situation for exports, has a relatively developed infrastructure.

Iscor currently imports 14% (600 000 t/year) of its coking coal requirements. Because of dwindling local coking coal reserves, it is estimated that within the next ten years, some 1,5 Mt/year of coking coal would have to be imported. At present, the only coking coal mine in South Africa is Iscor's Tschikondeni in the Far Northern Transvaal.

(Source: Mining Mirror, March 1994)

Electricity

A 420 kV transmission line that will link the grids of South Africa and Zimbabwe is to be financed with a loan from the European Investment Bank. An amount of $44 M will be lent to the Zimbabwe Electricity Supply Authority (ZESA) for the construction of a 400 km line that will run from Matimba in the Northern Transvaal, through Botswana, joining the Zimbabwean grid near the country's western border. The total cost of the link is expected to be $110 M.

Import of excess power from South Africa has been estimated to be the lowest cost method of satisfying demand in Zimbabwe over the next 5-10 years.

(Source: Modern Power Systems, January 1994)

Electricité de France (EdF) and SAUR Afrique have signed an agreement to take over the commercial management of the Electricity Corporation of Ghana (ECG) under a performance contract. The agreement calls on the EdF and the affiliate of the Bouygues group to set up a customer's services directorate (400 000 consumers) and to take over the company's commercial management. The Caisse Francaise de Developpement has already provided an initial loan and is to finance the management contract with two loans worth Ffr6 M and Ffr53,4 M respectively. Part of the loan will cover the purchase of equipment for management purposes, mainly computers, and the acquisition of vehicles for commercial services. The ECG's managing director, John K Hagan, said that more efficient commercial services need to be set up as the utility has major plans to extend its transmission and distribution networks.

(Source: Africa Energy & Mining, 16 March 1994)

A tender has been issued for a project to boost the capacity of the Tombo diesel power station in Guinea and bids must be in by the 16 May. The project is part of Guinea's Energy II programme co-financed by the IDA, ADB, the European Investment Bank, the European Development Bank (EIB), the European Development Fund and the Caisse Francaise de Developpement. The extension of the power station will be financed to the tune of $50 M by the IDA and a $28 M loan from the EIB. This will include the supply and installation of a fuel storage facility with pipes and accessory equipment; a building for new generators; three 10-12 MW generators able to run on heavy fuel oil; provision of maintenance services, spare parts and staff training for a five-year period.

(Source: Africa Energy & Mining, 16 March 1994)

Work has started on the new Katende power station on the Lulua river near Kananga, capital of Western Kasai, Zaire. The study was carried out by the Belgian-Zairois engineering consultancy, Enegetec. The power station will cost $18 million. Initially, the installed capacity will be 4,8 MW. On completion, the final installed capacity is expected to be 15 MW. The power station will supply Kananga and services such as, Regideso (water supply), which have ceased operating or are functioning below capacity because of insufficient electricity.

Energie du Kasai will operate the power station and will also carry out a project intended to double the Lubilanji power station's capacity.

(Source: Africa Energy & mining, 16 March 1994)

Hydro-electricity

Zairan hydro-electricity will be sold to Libya under an exchange trade agreement whereby Libya will sell petroleum to Zaire. Libya could take delivery of Zairean electricity only via a link to a transmission line from Zaire's Inga Dam to Egypt.

France's EdF International and Germany's Lahmeyer are nearing completion of a feasibility study on the multi-billion dollar Zaire/Egypt link. Their contract is being funded by the African Development Bank (ADB).

(Source: International Water Power & Dam Construction, January 1994)

Petroleum

Pluspetrol, an independent Argentinian oil company, has entered into various agreements with African countries, such as, Tunisia, Algeria, Mozambique, Ivory Coast and Gabon. It is also interested in operating in Angola.

In Mozambique, Pluspetrol has set up a joint venture with Enpresa Nacional de Hidrocarbonetos (ENH) and Sasol to develop the Pande gas field, linking it to the Pretoria-Witwatersrand region in South Africa, by a 900 km gas pipeline. Pluspetrol will be in charge of gas production. Recoverable reserves have been estimated at between 28-56 billion m^3.

Some sources believe that if exploration continued, the reserves could reach over 100 billion m^3.

In the Ivory Coast, the Panthere block could hold reserves to close on 10 billion m^3 of gas and 50-100 M barrels of liquid hydrocarbons.

Pluspetrol has also expressed an interest in exploring the Cabinda area in Angola, although the political situation has so far prevented this.

(Source: Africa Energy & Mining, 16 March 1994)

Negotiations are underway for the European Investment Bank (EIB) to finance a technical and economic feasibility study on an oil products pipeline running between Kenya and Uganda. The project involves a bi-national line that will run to Kampala, capital of Uganda. The entire project could cost $100 M and will involve 330 km of pipeline, the construction of a terminal at Kampala, as well as a possible intermediate terminal and equipment to operate the line.

(Source: Africa Energy & Mining, 16 March 1994)

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Johann Basson was born and educated in Pretoria. His experience includes consulting engineering in the design and contracting of energy systems in buildings; research on the use of energy in buildings (National Building Research Institute); the management of national research programmes on energy efficiency (in developing areas), statistics, economics, modelling, and renewable energy (Foundation for Research Development); and electricity and energy efficiency policy development (National Energy Council).

In 1993, he was transferred to the Department of Mineral and Energy Affairs (DMEA) as Director: Electrical Energy. In December 1993, he was appointed Chief Director: Energy, which made him responsible for the management of the energy function of the Department and for national energy policy analysis and advice.

Johann is also a member of the Management Committee of the National Electrification Forum and chairman of the Working Group on End-use of Energy and the Environment.

He is happily married, has four sons, and enjoys jogging, hiking and squash.

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Professor Dutkiewicz was born in Poland and obtained his schooling in the United Kingdom and South Africa, his B.Sc.(Eng.) and M.Sc.(Eng.) degrees from the University of the Witwatersrand in South Africa, and his Ph.D. degree from Cambridge University in the U.K. His Ph.D. degree was on heat transfer in nuclear engineering. He joined the General Electric Company in the U.K. as a nuclear engineer and worked on the design of the Hunterston Nuclear Power Station in Scotland and the Tokai Mura Nuclear Power Station in Japan.

He returned to South Africa to the Electricity Supply Commission, and was appointed Head of the newly formed Research Laboratory. Promotion saw him in the position of Deputy Chief Mechanical Engineer (Construction) and later as Manager of System Planning.

He joined the University of Cape Town in 1975 as Professor of Mechanical Engineering. Whilst in the Department of Mechanical Engineering he started the Energy Research Institute, which is now a separate entity in the Faculty of Engineering. He is currently Professor of Applied Energy and Director of the Energy Research Institute.

Professor Dutkiewicz served as President of the South African Institution of Mechanical Engineers in 1978/1979. He presently serves on a number of international committees dealing with alcohol fuels, energy demand-side management, environmental matters, etc.

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In 1977, Mr Kaale graduated with a B.Sc. (Hon.) in forestry from the University of Dar es Salaam, Tanzania. He was awarded a M.Sc. in Forestry Planning from the Australian National University, Canberra, specialising in Biomass fuels and environmental protection in developing countries. He undertook further postgraduate study between 1982 and 1991, locally and overseas.

Mr Kaale is currently Technical Adviser to the Ministry of Water, Energy and Minerals in Tanzania on the implementation of the SADC Energy Sector Project AAA.5.15 "Improvement of woodfuel end-use efficiency in small-scale rural industries of the SADC region", on a part-time basis. He is also the regional biomass fuels expert for the SADC Energy Sector (part-time).

Forthcoming energy and energy-related conferences: 1994

1994

JUNE

27-30

ANNUAL TRANSPORTATION CONVENTION Pretoria, South Africa

Theme: Capacity enhancement for transportation in South Africa

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OCTOBER 1994

13-14

REGIONAL ENERGY FORUM FOR SOUTHERN & EASTERN COUNTRIES Cape Town, South Africa

Theme: Mobilising energy for growth strategies for the Nineties for sustainable development into the 21st century

Enquiries: Mr Ian Israelsohn/
Ms Wendy Izgorsek,
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P O Box 1091,
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18-21

2ND SOUTHERN AFRICAN INTERNATIONAL CONFERENCE ON ENVIRONMENTAL MANAGEMENT (SAICEM II)
Victoria Falls, Zimbabwe

Enquiries: SAICEM II Secretariat,
c/o P O Box BW 294,
Borrowdale, Harare, Zimbabwe
Tel.: (263) (4) 739 822
Fax.: (263) (4) 739 820
Telex: 22126 ZW

NOVEMBER 1994

24-25

A RESPONSIBLE APPROACH TO CLEAN AIR Cape Town, South Africa

Organiser: National Association for Clean Air (Western Cape Branch)

Enquiries: Hans Linde
Tel.: (021) 400 3080
Fax.: (021) 211 980

Recent energy publications

DAVIS M *et al.*

Institutions and financing for effective dissemination of PV systems for rural development. February 1994. 140p.
Report No. EO9302

The project attempts to investigate the institutional and financial arrangements for the effective dissemination of photovoltaic (pv) systems in rural areas. This includes the dissemination of domestic pv lighting systems in rural areas of South Africa as well as the use of pv pumps in communal rural water supply schemes.

***DUTKIEWICZ R K and ALLISON C B**

The impact of battery vehicles on the environment and the energy balance. April 1994. 52p.
ERI Report No. GEN 166
R34,20

This report investigates the possible effect that the introduction of electric vehicles could have on pollution levels in certain South African cities. At present the low driving range of battery vehicles makes them unattractive for the primary personal vehicle and it is therefore considered that the greatest impact of battery vehicles on air pollution would be if in-town delivery vehicles became battery driven. The study has therefore concentrated on the effect of the penetration of battery vehicles into the light delivery vehicle market. The effect of changing over from gasoline to electric vehicles has been estimated.

***DUTKIEWICZ R K and ALLISON C B**

Guide to the computer model for calculating the effect of electric vehicles on emissions and the energy balance. April 1994. 5p.
ERI Report No. GEN 167
R5,70

The report describes the EVFORECAST computer program that has been developed by the Energy Research Institute to evaluate the number of electrically driven light commercial vehicles or if a regulation was introduced making electric vehicles preferable to petrol-driven vehicles.

GOLDING A P

The socio-economic impact of electrification on a peri-urban community in Bophuthatswana. March 1994. 134p.

A variety of issues in the electrification process, in addition to the socio-economic impacts on a peri-urban area, namely, Bapong in Bophuthatswana, are investigated. The findings show that the socio-econo-demographic profiles of the two groups investigated are markedly different with the income differential remaining over time. The entry costs remain a major barrier to the majority of people, which in addition to technology transfer, quality of service provision and lack of community participation, result in a slow sub-optimal substitution process which is characterised by multiple fuel use and duplicated expenditure until households are finally able to use electricity exclusively.

***SCHABERG P W**

Knock meter. April 1994. 86p.
ERI Report No. GEN 163
R34,20

A need exists for a simple knock detection device. Detailed fundamental investigations into the mechanism and characteristics of knock-induced noise and vibration showed that a simple acoustic technique is feasible. The technique utilises the finding that the baseline noise level of most spark ignition engines can be modelled by a simple two-slope function of engine speed.

***SIEMELINK J J**

Fuels for racing engines. March 1994. 107p.
ERI Report No. GEN 162
R45,60

In this report the interaction between engine and fuel is described in achieving maximum performance output. Suggestions are given for increases in mechanical and thermal efficiencies, both for naturally-aspirated and for turbocharged engines. Because of the non-standard application of these engines, non-standard or modified automotive fuels are required. Paraffins, olefins, aromatics, alcohols, nitrogen-containing compounds, ethers, and commercial South African gasolines have been investigated, and performance factors are proposed to provide ratings in selecting potential high-performance components.

A listing of commonly used racing fuels, with their performance expectations, is given, together with the necessary engine modifications. Methanol, ethanol and toluene are the most popular racing fuel components, and linear octane blending charts are presented using South African gasolines as the base fuel.

A fuel performance model is proposed, indicating the complexities involved in modelling the performance of any fuel in an actual engine and racing car.

THOM C

A socio-technical study to develop biogas as an energy source for rural South Africa. March 1994. 176p. + appendices.
Report No. EO9009

This project investigated the implementation of relatively low-cost biogas technology in South Africa, with particular emphasis on the utilisation of the technology by lower-income groups in the rural areas, such as, what was then known as the homelands. Four biogas plants were installed during the project, while fifth was constructed as part of a parallel project. Three of the plants were built at "real-life" locations with the aim to demonstrate the technology to potential users and obtain a response from them on the technology. The installation of the biogas units also provided the opportunity to test various biogas plant designs, to gain some experience regarding the operation and utilisation of biogas plants, to assess the energy costs of biogas, etc.

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