JOURNAL OF ENERGY IN SOUTHERN AFRICA

Vol.6 No.1 February 1995

Special Issue
Regional Energy Forum for Southern & East African Countries,
held in Cape Town, South Africa

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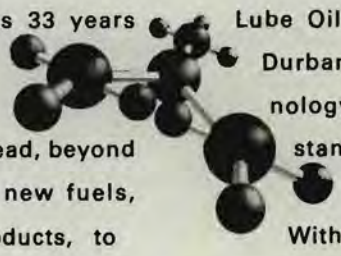
In 1905 Albert Einstein showed the direct relationship between energy and matter. Energy equals mass times a constant, the speed of light squared. It revised the concept of infinity. It was 33 years before scientists could split the atom and use the knowledge. Engen is also looking ahead, beyond the next century. Developing new fuels, lubricants and chemical products, to make the future work. Every specialised lubricant application we serve benefits from the world's finest technology. Adapted to South African conditions and the ideal specifications of our customers. Only the finest mineral base oil is blended at our Lube Oil Blend Plant at Island View, Durban, where the most modern technology ensures an extraordinarily high standard of quality management. From manufacture through to delivery. With these specialised products, service and backup, the benefit to our customers is infinite.



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Journal of Energy in Southern Africa

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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 Only previously unpublished work will be accepted.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.

Those wishing to submit contributions for publication should refer to the guidelines set out in *Information for Authors* in the Journal. All papers are refereed before publication.

The Editorial Committee does not accept responsibility for viewpoints or opinions expressed, nor the correctness of facts or figures.

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Guest Editor: Janet Jackson

JOURNAL OF ENERGY IN SOUTHERN AFRICA

INFORMATION FOR AUTHORS

Contributions to the *Journal of Energy in Southern Africa* from those with specialist knowledge in the energy research field are welcomed.

1. All contributions should be submitted in English.

2. Only original work will be accepted and copyright in published papers will be vested in the publisher.

3. The suggested length for articles and research notes is 2 500 to 5 000 words, and for book reviews,approximately 1 000 words.

4. The contribution and references should be typed double-spaced with a wide left-hand margin and single-sided using one of the available word processor packages listed at the end. The name and version of the word processor package used must be indicated on the disk. Illustrations, photographs and diagrams should be submitted on separate sheets.

5. Tables should be numbered consecutively in Arabic numerals and given a suitable caption.

6. All graphs, diagrams and other drawings should be referred to as Figures. These should be numbered consecutively in Arabic numerals and placed on separate sheets at the end of the contribution. Their position should be indicated in the text. All illustrations must have captions, which should be typed on a separate sheet. Graphs, diagrams, etc. should be printed with a laser printer, using the high quality option. If possible, all graphs should be produced with Harvard Graphics, Quattro Pro or Lotus 123.

7. The format for references should follow that as for footnotes where a number, in superscript, indicates the reference, as shown below:

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8. Standard international (SI) units must be used.

9. All mathematical expressions should be typewritten. Greek letters and other symbols not available on the typewriter should be carefully inserted in ink. Numbers identifying mathematical expressions should be enclosed in parentheses. A list of symbols marked for the use of the Production Editor, if not included in the body of the text,should accompany the contribution on a separate page. A nomenclature defining symbols must be included, where applicable. All tables and mathematical expressions should be arranged in such a way that they fit into a single column when set in type. All table columns should have an explanatory heading. Equations that might extend beyond the width of one column should be rephrased to go on two or more lines within column width.

10. Line drawings (not photocopies) and accompanying lettering should be of sufficient size to allow for reduction if necessary. Photographs of equipment must be glossy prints and should be used sparingly.

11. The body of the contribution should be preceded by an Abstract not exceeding 500 words, which should be a resumé of its essential contents, including the conclusions. Below the Abstract, a maximum of six Keywords should be included which reflect the entries the author(s) would like to see in an index. The Keywords may consist of more than one word, but the entire concept should not be more than 30 characters long, including spaces.

12. No contribution or figures will be returned following publication unless requested by the author(s) at the time of its original submission.

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14. Authors must supply the following personal information: surname, initials, address, qualifications, occupation and/or employment.

15. Authors whose contributions are accepted for publication will receive a free copy of the issue and 3 copies of their contribution.

16. Neither the Editor nor the Publisher accept responsibility for the opinions or viewpoints expressed, or for the correctness of facts and figures.

17. The Editorial Committee reserves the right to make editorial changes to all contributions.

18. All contributions and enquiries should be addressed to: Production Editor, Journal of Energy in Southern Africa, Energy Research Institute, University of Cape Town, P O Box 207, Plumstead 7800, South Africa.

Contributions must be submitted either on a 5¼ inch floppy disk or 3½ inch disk (stiffy), and use must be made of one of the following word processor packages:

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PC-Write
PFS: Professional
PFS: Write
Wordperfect
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In all other cases the file should be saved in ASCII format.

The disks must be adequately packed for postage.

INTRODUCTION

B H A Winter

This issue of the Journal represents a departure from its usual format in that it is devoted to reprints of the Keynote papers and Rapporteurs' reports presented at the Regional Energy Forum for Southern & East African Countries, organised by the World Energy Council, held in Cape Town, South Africa on 13-14 October 1994. This was regarded as an extremely important event coming, as it did, shortly after the radical political changes in South Africa which have made possible a completely new set of relationships between that country and its neighbours in Africa. The possible ramifications with respect to energy usage in the region are explored in the papers presented and will, we are sure, be of interest to all in the field of energy.

We would like to thank all organisations who by their generous financial contributions in the form of advertisements and donations have made the publication of this issue possible. A special word of thanks in this respect goes to SANCWEC. Other contributors are:

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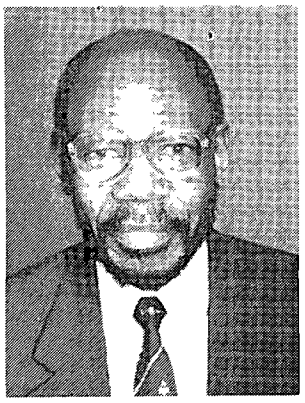
Profile:

Hon. Tseliso Makhakhe,
Minister of Natural Resources (Water, LHWP, Energy, Mining, Science and Technology, and Environment), Lesotho.



Tseliso Makhakhe has been involved with two important activities during most of his adult life: teaching and politics.

After matriculating, he attended the University of Fort Hare, majoring in English and Southern Sotho. He then obtained a postgraduate Certificate in Education from the University of Bristol in the United Kingdom.

Mr Makhakhe started his teaching career in 1951 in Lesotho, and in the 1970s and 1980s in Botswana. In 1988-90, he worked with the Institute of Development Management (IDM), which focussed on the in-service training of headmasters for secondary and high schools in Botswana, Lesotho and Swaziland. In 1991-92 he was Senior Lecturer in English, and Head of the English Department at the National Teacher Training College in Lesotho.

His political career began in 1970 when he contested and won the election in 'Maliepetsane as a candidate for the Basutoland Congress Party (BCP). The results of this election were later nullified by the then Prime Minister. Mr Makhakhe was subsequently imprisoned for his political views in 1970-72. Then in March 1993 he won Lesotho's second national election for the BCP, and represented the 'Maliepetsane constituency in the Mafeteng district.

In May 1994, Mr Makhakhe was appointed Minister of Natural Resources. He is presently also the Chairman of the National Executive of the BCP.

Mr Makhakhe's hobbies include choral music and singing, and the analysis of musical items. He also enjoys English literature. His other great interest is the excavation of fossils.

He is married to 'Makarabo, and has three sons and four daughters.

Profile:

Hon. Andimba Toivo ya Toivo,
Minister of Mines and Energy, Namibia

Mr Toiva ya Toiva was born in a village in the Ondangua district of Namibia (then South West Africa). His initial schooling was at the Ongwediva Industrial School, and lasted three years. After returning to the school in 1942 to train as a carpenter, he joined the army. In the army he took various leadership courses both in Namibia and South Africa.

After being discharged from the army, he returned to South Africa as a farm worker. Mr Toiva ya Toiva then decided to return to his studies and attended St Mary's School for 6 years, graduating in 1950 as a teacher. He taught for about a year.

In 1951, he returned to South Africa and joined the Railway Police. However, he did not enjoy this work and resigned in 1953.

At an informal meeting at Hout Bay during the 1954 Easter weekend, Mr Toivo ya Toivo met members of organisations actively involved in the "freedom struggle", like the ANC and SACPO. On his return to Namibia, he became involved with the Ovamboland People's Organisation (OPO). This organisation eventually merged with other like-minded organisations which led to the formation of SWAPO in 1960, and in which he later held the position of Secretary-General. After being actively involved in the armed liberation struggle, Mr Toivo ya Toivo was arrested and tried in 1967. He was imprisoned with other political activists on Robben Island until 1984.

Profile:

Hon. R F (Pik) Botha,
Minister of Mineral and Energy Affairs,
South Africa

Mr Botha finished his schooling at Potchefstroom, and graduated from the University of Pretoria, majoring in law. He then joined the South African Foreign Service and was posted to Sweden and Germany.

Thereafter he returned to Pretoria and served first in the Africa Division, then as a law adviser within the Department, and finally, as Under-Secretary responsible for the then South West Africa and the United Nations in the South African Department of Foreign Affairs.

Mr Botha was a member of the South African legal team in the South West Africa case at the International Court of Justice from 1963-1966, and was South Africa's Agent to the Court in 1965/1966. He represented the South African delegation to the United Nations General Assembly six times, and was South Africa's Ambassador to both the United Nations and the United States.

In 1970, he was admitted to the Bar as an advocate of the South African Supreme Court, and was also elected as a Member of Parliament, a position he has held for the past 25 years.

In 1977, he became South Africa's Foreign Minister, a post that he held for 17 years until May 1994. He was appointed to his current position as Minister of Mineral and Energy Affairs in the same month.

Profile:

Hon. Robert Denis Norman,
Minister of Transport and Energy,
Zimbabwe

After obtaining a joint Oxford/Cambridge School Certificate in the U.K., Mr Norman started farming in Oxfordshire. In 1953 he emigrated to what was then known as Rhodesia to work on a mixed farm. From 1961 onwards, he became involved in various agricultural organisations. In 1978-80 he was President of the Farmers' Union, and in 1980-85 was appointed as Minister of Agriculture. During this period, Mr Norman represented Zimbabwe at the Food and Agricultural Organisation of the United Nations, and was also a negotiator during the ACP/EEC Lomé discussions.

In 1985, he left politics briefly and joined a number of companies, mainly in the agro-industry field. In 1987, he once more became involved in politics when he was appointed to the Senate. In 1990, Mr Norman was appointed as Minister of Transport and National Supplies, and in 1992, Minister of Transport and Energy.

Apart from his political career, Mr Norman was the founding Chairman of the Beira Corridor Group. He has also written a book entitled, *Present farming in Zimbabwe: 1980 to 1985.*

Mr Norman is married and has four children - three daughters and a son. The son is in charge of the family farming enterprise.

Regional Energy Forum of Southern and East Africa, held at the Good Hope Centre, Cape Town, South Africa on 13-14 October 1994

* R F BOTHA

I am honoured to be addressing you on behalf of President Mandela who has asked me to convey his sincere regrets that he is unable to be present on this occasion.

The World Energy Council, with its objective of "promoting the supply and use of energy for the greatest benefit of all" is one of the most important organisations in the world. It may not be well known, but it deals with one of the most fundamental human needs - energy. This need goes hand-in-hand with other basic needs: food, clothing and shelter. It is essential for any society seeking to provide a better life for its people. It is equally essential for economic growth. Without it, programmes for social upliftment are worthless. That is why energy is a vital element of the South African Government's Reconstruction and Development Programme which expresses our commitment to transforming our society.

The South African Government appreciates especially the opportunity to express, in a practical way, its resolve to play our part, on the basis of partnership and co-operation, in the development of this continent and particularly this Region. This meeting will pursue the achievements of the first World Energy Council Regional Forum in 1990, namely the establishment of "a platform for regional dialogue among the members of the energy sector throughout Southern and East Africa".

Not only is energy itself constantly changing, but also its prevailing policies and usages. For many centuries, man relied on traditional fuels. Today we are drawing on the energy which the sun gave us over long periods many millions of years ago. In 15 minutes, the sun radiates as much energy onto the earth as mankind consumes in every other form during an entire year. This planet, with no guidance or assistance from man, stored all this converted sunshine deep in the earth. Knowledge of this access to energy has been acquired from dead plants and ancient aquatic animal life.

In the 30 years after the Second World War, from 1945 to 1975, we burnt as much coal as had been consumed in our previous history. The world's consumption of organic fuel sources is exploding at a remarkable rate. The use of coal, petroleum, wood and agricultural wastes in this century alone is two to three times greater than the combined consumption of previous centuries. But the supply of these fuels, although abundant, is eventually limited and their use has polluting side-effects. It will be necessary to balance environmental considerations with the development of the human environment. In order to maintain the Region's international competitive edge, we must ensure that research and development of our energy base keeps pace with the need for energy to support economic growth.

It was thought that nuclear energy would be the new source for the coming millennium, bearing in mind that five tons of uranium fuel yield the same amount of energy as 125 000 tons of coal or 500 000 barrels of oil. Unfortunately nuclear energy has been presented in such a way that its image has damaged its potential.

New possibilities lie in the use of renewable sources of energy. However, at present, the successful exploitation of these is costly.

Perhaps existing energy providers, such as oil companies, coal mines and electricity utilities, etc., will see the renewable sources as an opportunity for us all rather than a threat to their livelihood. We would all benefit in a new era where the coal mine methane explosions and the oil spills become things of the past.

Energy is essential to all aspects of production and natural resources use. The theme "mobilising energy for growth" is central to the development of the Southern and East African Region. Economic growth depends on the effective use of energy, and this is demonstrated by the correlation between per capita gross national product and per capita energy consumption.

But there are other, less evident, benefits: better health; education and training; greater social cohesion; and steadier, less disruptive, urbanisation.

Exploitation of coal in this region, even at double our present rates of extraction, will still leave sufficient reserves for another century. Meanwhile, the region's untapped hydro power has more than twice the capacity of all electricity plants in Africa.

The other major lifeline of a developing economy is oil. A second South African licensing round for offshore oil and gas prospecting was launched in London and Houston recently. With the increased expertise and resources of the international prospecting community, there should be potential for oil and/or gas finds. The Pande and Kudu fields off Mozambique and Namibia could make a significant contribution to the development of our region.

The countries of this region must co-ordinate their investments in energy generation because of the way our resources are distributed, the high capital outlay of energy-generating projects and the opportunity afforded by energy as a trade commodity in an area where inter-regional trade is flourishing. With vast hydro power potential in the north and substantial coal fields mainly in the south, a synergy can be struck in electricity

* Ministry of Mineral and Energy Affairs, Private Bag X646, Pretoria 0001, South Africa

generation and its cross-border transmission.

A specific case is the Cahora Bassa hydro-electric project, which must be rehabilitated soon if at all. It is hoped that, with peace in Mozambique and a new political era to be entered into after the elections, Cahora Bassa will soon be seen to be playing an important role in a common power grid, the Southern African Power Pool. The first steps in formalising the Pool have already been taken between Botswana, South Africa, Zambia and Zimbabwe. This could well be extended into East Africa.

Industrialised countries looking for a practical way to become successfully involved in African development should take a closer look at Cahora Bassa. They should buy it and then place it at the Region's disposal. Cahora Bassa offers the industrialised countries an opportunity to make an immediate contribution towards development in the Southern African Region.

Other areas of possible co-operation are:

- Oil
- Natural gas and coal exploration
- Solar energy
- Designing heat-retaining, low-cost housing
- Finding alternatives to traditional fuels.

In South Africa one third of the population depends on wood fuel, whereas elsewhere in the region the figure is as high as 92%.

The Reconstruction and Development Programme of the South African Government is people-centred. The most fundamental thrust in South African energy policy will be to provide electricity to the people and communities who, until now, have not benefited from this source of energy.

The RDP aims to provide electricity to 500 000 homes per year until the end of this century. The number of electrified homes will then have been increased by an additional 2,5 million - more than double the existing 2,1 million - and will increase the percentage of electrified homes from the present 35% to about 65%.

Those without domestic electricity use a wide range of fuels for their requirements. The RDP identifies these as inferior and expensive. Many turn to traditional but inefficient and unhealthy firewood, gathered from the natural woodland and generally without cost except for the effort required to obtain it. This is usually borne by rural women.

The RDP indicates a need to improve the management of natural woodlands, to set up programmes where the people take control of the afforestation of their area as a permanent fuel source, and to introduce systems of transporting woodfuel to areas of need.

On the other hand, a large and still growing sector, both rural and urban, is switching to higher order commercial fuels like coal, illuminating paraffin, liquid petroleum gas, candles and commercially exploited firewood. As pointed out by the RDP, except for coal, these are relatively high-cost items. Even in electrified houses, a number of fuels are still used, often with negative environmental effects such as the severe air pollution experienced in the PWV area. Policies to meet energy needs must therefore include a low-smoke coal programme and the reduction as far as possible of gas and paraffin prices.

Energy needs should be weighed up against other needs and also in relation to each other. Future energy policy must concentrate on meeting the basic requirements of poor households and community services such as schools and clinics. Extreme poverty, the need and demand for accelerated socio-economic development and the negative environmental impact of many of our fuel use patterns require us to adopt a holistic and well-focused approach. The way energy is provided must be determined by the way it is required. The provision of cheaper, more efficient energy will assist people to make logical, self-enhancing choices and to budget for life necessities other than merely basic needs for survival. Rather than assume that fuel sources should be either of one or another, the optimum combination of fuel provision should be examined. For example, the combination could be electricity plus gas and/or coal, rather than either electricity or gas or coal.

Africa south of the Sahara faces tremendous problems: population growth is too high; food production too low. The expectations of the people are too high; achievements too low. Industrialisation is not keeping pace with urbanisation. Critics from the USA, Europe and the Far East state that Southern Africa is in dire straits socially and politically, and in a quandary economically . Some predict an irreversible process of entropy for many countries of this region which will lead to marginalisation.

Those people who travel to the United States, Europe, Japan and other countries often return with the tormenting thought: Will we ever reach the level of those countries? Observing this vast gap is frustrating and becomes a nightmare. However, we do have the resources; and modern technology is making it possible. We need clean water at our disposal; more protein in our diet; the shelter of a home; transport and communication systems connecting us with the developed world.

Our success is inextricably bound to the effective and efficient generation and distribution of low-cost energy. We have sufficient resources of energy and we need to pool and co-ordinate those resources.

I hereby declare on behalf of President Mandela the Second Conference of the Southern and East African Regional Energy Forum open. I hope the insights gained and the practical improvements effected, as a result all your work here, will be so widespread that our people will find their lives improved.

Today's global energy scene

* G OTT

This is a Forum concerned with energy and, although the World Energy Council, constitutionally, is a non-governmental organisation, I should like to comment briefly on the truly remarkable **political transformation** that has occurred in this country before, during and after the elections held in April 1994. On behalf of the World Energy Council, I congratulate sincerely all who have participated in this process, in this unique achievement. It must have taken much courage and enthusiasm to start and carry through this difficult, sensitive and risk-laden process.

The World Energy Council's presence here at this important Forum should be viewed as a symbol: as an encouragement for all races living in South Africa to continue with their effort in jointly shaping a new future, equal and prosperous for all; and as a signal to the outside world, whose co-operation and investment is so essential to strengthen the basis of this country's economy.

Turning now to the **global energy scene,** it is **change**, above all, which should be highlighted as the most striking and dominating factor:

(1) Looking to Eastern Europe, just three years have passed since the putsch of August 1991 in Moscow. Since then, the old Soviet Union has collapsed, the first putsch was followed by a second putsch, and who would predict that this was the last such dramatic development? The Soviet Union is the largest energy producer in the world, and therefore predominantly political developments in this region are also directly relevant to the global energy scene.

(2) In the Asia-Pacific region, the economic development continues to boom. A certain setback in some countries is more than made up by the breath-taking growth particularly, but not only, in China. The 16th Congress of the World Energy Council to be held in October 1995 in Japan will, without doubt, demonstrate that it is energy which is an indispensable element for this impressive growth.

(3) As a last example, there is Latin America, which is often overlooked. The North-American Free-Trade Agreement, concluded between Canada, the USA and Mexico will most certainly stimulate economic development, even beyond these three countries, and will have a positive effect on all Latin America. This effect will be strengthened by the determined course of privatisation taken, for example, in Argentina and Chile. Again, energy is an essential part of this overall economic change.

As change is characteristic of the world energy scene of today, the **mental changes** that have been witnessed over the past years should also be mentioned. The industry sees its role less in producing large quantities of energy, but rather in offering a sophisticated service. The energy consumer is becoming aware that, in the end, he decides on - and pays for - the kind of comfort he wants. Both industry and the consumer are acquiring a deeper understanding of the many interconnections between energy and the environment.

In this period of many fundamental changes, the World Energy Council has presented its Study Commission, *Energy for Tomorrow's World: The Realities, the Real Options and the Agenda for Achievement.* It can be said, without false modesty, that this publication has become a standard, and is an authoritative work essential for any serious discussion on energy, from both economic and environmental points of view.

Three specific aspects, which are often overlooked, are highlighted:

(1) The **problems of energy and the environment** are **shifting** more and more to the so-called **Third World.**

In less than 20 years more than 80% of the total world population will live in the Third World. (Is it not an anachronism, that - and this will be a reality in the year 2020 - a group of over 1 billion people calls the rest of the world, with some 7 billion people, "Third World"?)

In less than 20 years, this so-called Third World will be responsible for some 70% of all global sulphur dioxide and nitrous oxide emissions, and will account for over 50% of all carbon dioxide emissions.

From these facts, two points emerge:

(a) Industrialised Countries should not be content with putting and keeping their own house in order; that is, investing increasing funds in ambitious projects with decreasing improvements to energy efficiency. Nor should they be content with selling their sophisticated technology to Developing Countries - passing this off as an example of leadership in and transfer of technology. What is really needed is to bring the know-how - the financial power of industrialised countries right into the developing countries - "on site". It is investment and not sales which creates a lasting interest and real commitment.

(b) The countries of the Developing World, on the other hand, should realise that the problems they will face tomorrow are too large, and also too specific to the particular situation of each individual country, to be solved through external help alone. Although external help may be an important stimulus, lasting, "sustainable" solutions cannot be imposed on Developing Countries from outside. They need to come from within, from the people living in this region, from their motivation, and from their skill and persistence.

It is an open-minded give-and-take between Developed and Developing Nations, therefore, which is needed and which the World Energy Council wishes to bring about. One question in this context certainly will certainly be whether the developing countries have a realistic chance to leap-frog, that is, to start off from a higher technological level by taking advantage of the experiences of other nations and the technology they have developed. (The author's view is that the answer is not simply Yes or No.) Undoubtedly, there are opportunities to leap-frog, but they will be limited. In some instances leap-frogging might not even be desirable.

(2) The element of **security of supply** will become increasingly important

* World Energy Council, 34 St. James's Street, London SW1A 1HD, United Kingdom

in the planning of energy in the future. Energy may well become one of the key factors in **geopolitics**.

Today the thinking is primarily in terms of **technopolitics**. For instance, the fascinating and at times merciless competition between Europe, America and Japan for superiority in high technologies might lead to the impression that only technopolitics will count in creating a new world order. That assumption the author thinks is incorrect. With the world population increasing at an exponential rate, providing energy, food, water, and access to natural resources will be the determining factors. With luck and planning, high technologies will help us use these resources more wisely, but they cannot substitute for them.

Likewise, the concept of the **diversification of energy sources** has become acceptable. This concept, without doubt, has made much sense both for energy-poor countries and for individual consumers, but it is now approaching its **limits**. These limits are finite because they are set by nature, by geology. As *Energy for Tomorrow's World* has shown, the number of countries dependent on energy imports will increase sharply over the next decades. Whereas today some 50% of the world's population live in countries dependent on energy imports, this figure will rise to over 80% by 2020! In the best of all worlds this could be a welcome opportunity for expanding world trade, but looking at the world as it is, the possibility should not be excluded that this growing dependency of many nations on a few net exporters of energy could well lead to severe social and political tension.

The reason behind this development is, of course, the uneven **geographical distribution of energy resources** on earth.

Oil is the most striking example with more than two thirds of its reserves concentrated in the Middle East, a region which - even recognising the latest encouraging developments in and around Israel - may not yet be described as stable. On the other hand, it is not only the size of these reserves that matters, but also their low cost. Compared with this concentration, finds in Alaska or the North Sea give us some time to take breath, a temporary reprieve, so to say, but not a lasting, independent and alternative basis.

- **Natural gas**, as a younger form of energy, is still making the headlines with new discoveries. Nevertheless, 50% of global reserves are concentrated in the countries of the former USSR, and another 40% in the Middle East. Meanwhile, the gas industry is more and more voicing itself against a euphoria related to gas. This euphoria is to be found, not so much within the industry itself, but rather with consumers and politicians.

An example of where the geographical distribution of energy resources might become a very practical factor in geopolitics is in the Asia-Pacific region where the economies are soaring. They all have a great hunger for energy, and an unquenchable thirst for oil - the one resource they lack most. This is already so for Japan and India, and it will become a harsh truth for China and even oil-rich Indonesia around the year 2000. It is necessary, therefore, to prepare for a scenario in the immediate future in which these newly-emerging economies, with their aggregate purchasing power, will turn increasingly to the Middle East and to the former USSR for the oil and gas they need to fuel their economies. These are the same resources that many Europeans and Americans tacitly assume are reserved for the West.

It would be an illusion to assume that there could be diversification, in the next two or three decades, away from oil and gas, and possibly away from coal and nuclear, to rely on fast-growing contributions from renewable forms of energy (often misleadingly called "alternatives"), or on a fast exploitation of the theoretical potential of energy savings. All this will emerge, no doubt, but only in due time - and with considerable capital investment.

The new task for the future, therefore, might be "Sharing limited energy resources", substituting for the old formula of diversification. Moreover, the recommendations given in the WEC's regional report for **Sub-Saharan Africa** point precisely in this direction:

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

(3) Whatever the decision to improve the quality of the **energy and the environment,** there will always be a price to pay.

This may be obvious. However, after hearing political and public discussions in many countries, you may come to a different conclusion.

To be able to pay for securing energy supplies and protecting the environment - a cost which will increase rather than decrease in the future - countries depend on a functioning, prospering economy. What is often overlooked, however, is the fact that an economy will only grow if there is, in parallel, a continuous process of **innovation**. It is innovation which has to take the lead, because today's economy and employment rests on innovations made yesterday.

Energy, meanwhile, offers many possibilities for such **technical innovation**. It should be stressed every one of these possibilities should be pursued, without discarding any as not needed or not wanted for subjective or ideological reasons. In some countries, for instance, government and industry might be tempted - in view of growing public opposition - to discard the further use and development of nuclear technology. This would certainly not make nuclear energy disappear world-wide, but it would mean a lasting set-back for a country's economy and for its technological reputation, It would also be irresponsible to discard the further development of certain renewable forms of energy just because, as of today, they might not yet be economic.

Innovation, however, needs to be understood in a wider sense. It should include the **innovation of the institutions** which are governing the economy in general, and the energy sector in particular. This is a message should be directed at Developing Countries and Economies in Transition. Again, I quote from the WEC's *Regional Report for Sub-Saharan Africa*:

"Economic systems that do not provide for **competition and incentive** cannot command efficiency and growth. For instance, arbitrary price controls have been the major disincentive for efficiency and conservation as well as for investment and growth in energy supply. Price

deregulation is painful and will demand unprecedented political austerity, particularly as past energy consumption which was supplied at sub-economic rates but nevertheless still reflected in deficits or foreign capital and interest debt, will have to be repaid. However, this burden worsens with each day of postponement of the day when markets will have to determine prices."

During this Forum many problems will be put forward. Indeed, most of the long-term prospects on population growth, the resulting increase in energy demand, and the negative impacts on the environment are threatening rather than encouraging. However, before becoming pessimistic, it should be remembered that over the last 40 years the world population has more than doubled without the planet having sunk in chaos.

This is no guarantee for the future, but, in the end, the future lies in our own hands. We have the chance to shape and form the world of tomorrow, and we shall succeed in doing so if we base our actions on reality rather than on romanticism, and on ideas rather than on illusions and ideology. In concluding, I quote René Dubos: "Human beings, after all, have been and remain uniquely creative because they are able to integrate the pessimism of intelligence with the optimism of WILL".

Energy for tomorrow's world: The realities, the real options and the agenda for achievement

* I D LINDSAY

This is a brief overview of the World Energy Council's Commission *Energy for Tomorrow's World*. This report which took three years to produce, involved some 500 specialists the world over, and cost approximately US$5 million to assemble. It has been built "bottom up" from local knowledge and perspectives and has now been translated in whole or in part into 13 languages. It is a report which takes into account all the major energy and energy-related issues which together make up the possible developing energy scenarios to the year 2020, as seen by the WEC. These may seem disturbing but hopefully of considerable interest. But their message is simply that there must be a change in attitude to energy use fundamentally before it possibly becomes too late to do so.

Origin

The World Energy Council was founded in London in 1924, as the international association of the electricity sector. However, in 1968 it changed its constitution to cover all forms of energy (oil/gas/coal/nuclear/renewables ..... and of course electricity) and its objective is "to promote the sustainable supply and use of energy for the greatest benefit of all".

The World Energy Council is now an organisation of over 100 member countries, covering 90% of the global consumption of energy. It is non- governmental, non-political, and non-commercial, and this allows for both objectiveness and pragmatism in its work.

The Commission itself was launched in 1989 primarily for two reasons:

(1) to ensure that energy was properly represented following publication of the UN Brundtland Report in 1987 which raised the question of the earth's sustainable development but which hardly mentioned energy;

(2) in anticipation of the out-turn of events at the UN Rio Srth summit of June 1992 where direct energy representation was minimised.

Objectives

The Commission's aim is "to identify a realistic framework for the solution of regional and global energy issues, whereby adequate sustainable energy, at acceptable costs, can be supplied to meet all needs, using optimal production and end-use efficiency, whilst achieving socially acceptable care and protection of the environment".

Quite a job to carry out in a time period of only 3 years!

Organisation

The horizon year was set at 2020, although as the Commission progressed, it became apparent that several features required to be examined beyond that date. The report, therefore, carries an epilogue extending to 2050, beyond which clearly shows the potential growing problem of the availability of certain traditional energy sources for the world's greatly expanded demand from 2020 onwards.

The Commission's work was initiated through a supervisory board and nine inter-disciplinary regional co-ordination groups, comprising not only representatives of all forms of energy, but also academics, economists, financiers, environmentalists, consumers and government. These regional groups also contained balanced national representation from within the regions, and these dual compositions - functional and national - have led to a balanced report with balanced findings which we feel few, if any, other organisations could produce.

Structure

Although a qualitative document, the nature of the Commission required the incorporation of a quantified framework. This was constructed on the basis of the initial local regional findings which were built into four separate Cases to reflect possible global development. These Cases all contain the UN median population growth estimates, but contain varying economic growth factors, energy intensities, financing constraints, transfer rates of technology, etc.

What is of considerable importance is that there is no place in today's world for a "business as usual" case, and consequently none has been included.

The results of the four Cases confirm, despite projected energy intensity achievements and other objectives, that the world in the space of the next 25 years will probably almost double its consumption of energy, and that some 85% of this increase will occur in the currently defined developing countries. These countries will also absorb 90% of the world's population increase.

In 1990 75% of the world's population living in the developing world consumed only 33% of the energy it used. By 2020 this pattern will have changed radically. The developing countries by then, with 85% of the total world population, will have an energy demand of nearly 60% of the world's total.

Will global energy demand be satisfied? And how best can preparations be made now to ensure that this huge future global demand is met in a sustainable manner? These and the allied issues are the fundamental questions which face the world's energy sector today.

From a total global energy consumption of 8.8 Gtoe in 1990, the four Cases

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provide a range of global demand from 17.2 Gtoe in the high economic growth case, to 11.3 Gtoe in the ecologically led case (which is, however, considered to be almost unachievable). The most likely 2020 global demand range would appear to lie between 13.0 Gtoe and 16.0 Gtoe, that is an increase of between 70% and 90% over the 1990 consumption.

The Commission next examined how that demand might be satisfied. Fuel mix projections are always speculative, but those of the Commission for 2020 demonstrate that the world will need to use nearly all forms of energy available if demand is to be met. The fuel mixes to meet this 2020 potential demand show, in many cases, marked increases over 1990, but having been studied in depth, they are considered to be both available and operationally feasible, despite the long project long development lead times involved - except for Case C where the degree of penetration by new renewable energy forms is questionable.

Vastly increased energy consumption will also mean major increases in greenhouse gases. The Inter-Governmental Panel on Climate Change estimated the total 1990 CO_2 source emissions at 200 GtC of which 194 GtC were absorbed by sinks, mainly oceans and forests. Global fossil fuel burning produced another 6.0 GtC. Energy use, therefore, accounted for about 6.0 GtC, or only some 3% of total CO_2 source emissions.

Ironically. however, it is this 3% which represents the crucial element in the balance to determine whether man-made sources of CO_2 create serious global climate change or not. The Commission estimates 2020 CO_2 emissions to increase over 1990 by between 40% and 90%.

The Commission's findings

Low prices and high technology have led many people in the world to become quite relaxed about energy. Low prices have created the impression of abundance; high technology has suggested that it can always find a solution - at a cost - for every problem, including ultimately, if proven, the threat of global warming. Such complacency is, however, unfounded.

Today's world has more than 50% of the human race living without supplies of commercial energy. The total per capita energy consumption (including traditional fuels of wood and animal waste) in areas such as South Asia, is only 5% of that of North America.

By 2020, with a world population of 8 billion, 85% of the population will live in what today are classified as the developing countries. This means that either billions more people will continue to live without even the most basic requirements for reasonable living or the demand for energy will grow prodigiously.

Change is therefore required - change of attitude, change of systems, change of dimensions and, not least, change of energy development planning and government's role within it. This is the urgent contextual message of the Commission, if the divide between the developed and the developing worlds is not to become greater.

The alternative is equally clear: those countries, which do not or cannot change and improve their energy systems, are likely to become energy poorer, and therefore even less likely to achieve the economic development they aspire to today.

But energy change can only come about slowly. The energy operatives who have worked in the industry know this. It will involve phasing out old and phasing in new policies, systems, technology, and investments. Realising that energy systems cannot be changed overnight, however, is no reason for *laissez-faire* attitudes today. On the contrary, the next 25 years will represent a critically important period of transition decision-making if long-term goals are to be achieved, and in all this the handicap of energy's extended project lead times should not be forgotten.

The Commission's principal messages

These can be summarised as follows:

(1) With world population expected to double in the coming decades, and urban populations to more than triple, we cannot merely carry on using energy as we do at present.

(2) Within the huge global energy consumption increase, well over 85% will be attributable to the developing world. However, some regions, such as Sub-Saharan Africa, may well not achieve greater per capita energy consumption than it had in 1990. Economic stagnation or regression could result, and with it the attendant risk of destabilisation.

(3) The Commission found that the development of the rational use of energy, on a cost/benefit basis, was an immediate and universal priority. Interestingly, it is the change of capital stock (that is, the modernisation or replacement of equipment) which achieves results, rather than the express alteration of regulation or price. Governments should be responsible for modifying relevant tax depreciation rates, etc., in order to encourage the modernisation that is needed.

Energy efficiency will occur step by step. Few developing countries, for example, can be expected to achieve major positive energy intensity results until they are also efficient in their use of manpower, capital, training and management skills.

(4) The development of technology to assist in meeting global energy requirements, and to manage both local and global environment issues, is of crucial importance. Technology transfer from north to south requires to be expedited, preferably through the market system, and with proper protection for intellectual property. The major responsibility of the industrialised world is to develop the required technologies for the future, and to make them globally available. Such initiatives as that taken by the E7 major industrialised country power corporations to make available modern up-to-date environmental technology free to the developing world should to acclaimed. However, there needs to be more initiative of this kind.

(5) Fossil fuels, particularly coal with some 250 years of reserves at current consumption rates, will continue until 2020 to provide the bulk of energy needs. Oil at 40 years, and natural gas at 70 years, appear to come under pressure towards 2020, but import dependency on oil, gas and coal will certainly increase. Supply lines will lengthen, which again will impact on prices and may add to supply security apprehension.

(6) Nuclear power is currently faced with a dilemma. The world will need to use all forms of energy to satisfy demand during the next 30 years, but public acceptance currently curbs nuclear development in many countries. The Commission assumed, after considerable debate, that nuclear power would develop but only on the basis that solutions can be found for the whole fuel cycle.

(7) The Commission's rational views on the development of renewable

energy forms, particularly solar, photovoltaics, hydro and wind, are realistic and balance out many of the views expressed today in parts of the world.

Renewable energy contributed a total of 18% of the world's 1990 consumption, mainly in the form of major hydro and traditional biomass (regarded by many as not being truly renewable).

Within this 18%, if little or no government development support is available, the 2% currently derived from new renewable sources, such as solar, photovoltaics, wind, tide, modern biomass, ocean thermal, might double to about 4% of the expanded global consumption by 2020. If government support, and particularly supra-national government support, is given, however, this latter figure could rise to as high as 12% to 14% of global supply, but for many reasons this is unlikely to occur within the next 25 years.

(8) There is no realistic possibility of meeting the global stabilisation objectives for greenhouse gas emissions written into the Rio Climate Convention. The Commission sees no way, at the moment, of obtaining comprehensive, worldwide CO_2 abatement action without substantial north/south assistance, even though the Convention has been signed by some 179 countries and ratified by 70. It cannot therefore be used as a basis for an international treaty, but merely as a catalyst to obtain one.

The overall problem of an effective global climate convention therefore remains unsolved, and may remain so for some time to come. In the interim, the WEC Commission advocates taking specific practical and cost-effective "precautionary measures" for global environmental protection now.

[These include;

* Greatly increased governmental funding of scientific climate research
* Positive and pro-active leadership to achieve national energy intensity objectives
* The spending of such funds as become available for the mitigation of CO_2 effects where they will be most effective
* Action to curb some of the uses of fossil fuels where alternatives are available at a similar or acceptable cost.]

(9) The developing countries give high priority to local and regional pollution issues. Understandably, developing countries will not sacrifice economic growth by allocating scarce resources to global environmental concerns, although many are becoming aware of the true meaning of global concerns. It is interesting to note that of the nine regional work groups into which the Commission was divided, only one considered potential climate change to be a priority.

(10) Finally, and of major significance, energy represents some 5% of global GDP but consumes about 15% of global financing. It is highly finance-intensive. Although difficult to identify, constraints to financing over the next 25 years and beyond do appear in the Commission, particularly among a number of developing countries. Significant investment in global energy systems will be required, possibly as much as US$30-40 trillion (1993 money) over the next 25 years. To put this figure into context, it compares with the total 1990 world GDP of only US$20 trillion. Competition for international financing, which may cover 15%-20% of future requirements, will become increasingly intense, and will be totally inadequate for many local energy requirements. There is, therefore, a need for much more local capital than was the case hitherto. However, this capital will require radical changes in order to improve local institutions, energy price structures and returns, markets, efficiency, and energy management, if it is to be raised and channelled into commercially attractive local investment in many parts of the world. In addition, many governments will simply not be in a position to raise the energy capital required for capacity build and, rather than contribute to constraining demand, will wish to examine such options as deregulation and privatisation.

Summary

In conclusion, the WEC Commission has drawn together the principal energy and energy-related developmental elements into one single report. It has identified the key issues and offered at least partial solutions. It has clearly identified the main priorities and required action for global sustainable energy development, and it has demonstrated the likely pathway of such integrated energy development over the next 30 years.

The energy decision-makers, and particularly the politicians, should take note of these findings which we hope will act as a catalyst to start the vital process of change we advocate. Above all, we believe that the world cannot wait much longer for such changes if it is to avoid major global energy problems, particularly within the developing world, within the next 50 years.

Energy for tomorrow's world: The realities, the real options and the agenda for achievement. Regional summary for Sub-Saharan Africa

* Z S GATA

Introduction

Sub-Saharan Africa has 9% of the world's population, but is responsible for only 2.5% of world economic activity measured by volume. It consists of 47 countries, most of which have low income and largely rural, agrarian communities. There is a wide linguistic and cultural diversity across the Region, as well as sharp contrasts in lifestyles and standards of living. It is in a general state of transition, with widespread aspirations for political reform, and social and economic development.

The Region consumes 2.7% of world commercial primary energy, as well as a large amount of biomass energy, principally fuelwood. The Region has 2% of world proven reserves, 3% of the world's gas and 6% of its coal. There is massive hydro power potential, together with extensive uranium deposits and a consistently high level of solar irradiation. In spite of the extensive primary energy resources, the Region's per capita commercial use is the lowest in the world, at about 16 GJ per annum compared with the world average of 30 GJ per annum.

The main energy issue affecting Sub-Saharan Africa is supply; that is, how to ensure adequate, reliable, environmentally acceptable and economically sustainable supplies of energy to a Region which has not only the lowest per capita income in the world but also the fastest growing population, at over 3% per annum. The Region shows a need for new initiatives in the following areas:

* To increase the awareness of governments of the critical importance of adequate and reliable energy supply for economic development and social uplift
* To sustain fuelwood supplies, and to plan and develop rural afforestation programmes
* To redress adverse macro-economic policies and correct institutional deficiencies
* To inject massive local and international capital and technology in the energy sector, including private equity participation
* To take economic advantage of numerous opportunities for regional co-operation in the energy markets
* To introduce incentive energy policies and institutional measures that enhance energy efficiency, conservation and environmental protection
* To reinforce efforts to restructure the terms of international trade between Sub-Saharan Africa and, especially the OECD countries, and to increase the level of aid and its accountability.

Energy supply and socio-economic development

The main factors in the demand for energy in the Region are population growth and economic development to support improved standards of living. The Region is already a net importer of commercial energy and more than half the countries spend over 25% of their total export earnings on petroleum imports, making them vulnerable to increases in oil price. Improving the supply of energy and attain the planned transition from wood fuel to commercial energy will require considerable new investments. Furthermore, the lead times for the planning and development of further supply facilities, the sheer magnitude of its infrastructural investment requirements, relative to the economic capacity of most countries in the region, and the heavy cost of supply failures, all indicate that energy should be considered as a top priority, both nationally and internationally.

The population growth rate of 3.2% per annum may result in an increase from the present 500 to 1200 million inhabitants by 2020. If sustained, there can little prospect of improving the per capita energy supply or the quality of life.

Wood fuel in the Regional energy balance

The Region depends on wood fuel for about 60% of the total final energy consumption. The more desirable end-use forms of energy, such as electricity, are still beyond the economic means of the majority of its communities.

Furthermore, the concern for commercial energy supply is far outweighed by the pressing need for more basic services, such as water, health, education and food. Hence, under all realistic scenarios, fuelwood continues to be the dominant energy resource despite the range of environmental, social and economic problems associated with its use. Governments and Development Agencies need to invest intensively in rural reforestation and afforestation programmes.

Macro-economic policies and institutional development

There are several causes of the inadequate performance of the Region's energy sector:

* Regional Co-ordinator, WEC Commission

* Inappropriate macro-economic policies
* Weak energy institutions
* Over-centralisation of ownership and control of the supply side
* Uneconomic pricing
* Ad-hoc and frequent negative interference by governments in energy supply entities.

New policy designs should be directed towards the evolution of a market economy, with disparity and competition, and with incentives for new private capital and technology, as well as transparency and accountability of public energy enterprises and their regulatory agencies.

Energy financing and technology transfer

The energy sector is a large consumer of national resources, demanding large capital expenditure, skilled manpower and the steady outflow of foreign exchange. Invariably, energy financing has been the exclusive prerogative of government finance ministries whose capacity to finance new investments is now quite inadequate.

The practice of arbitrary price subsidies has also meant that the economic cost of service is not recovered. This has led to widespread technical bankruptcy of energy enterprises in the region and to the misuse of energy resources.

Constraints in energy financing, as well as distortions in energy pricing, have contributed significantly to the legacy of inadequate investment, uneconomic choice, and poor overall performance. Clearly, other sources and mechanisms of finance are now required.

Regional co-operation in the energy markets

There is an uneven distribution of primary energy resources in the region. Too often, the size of the domestic market alone is too small to justify economic exploitation, by one country, of an energy resource such as a major hydro site.

However, the policy and institutional defects already noted are inhibiting factors, and there are others:

* National investment planning, which does not take account of opportunities in neighbouring states
* Pricing, or exchange rate distortions, which inhibit regional energy trade
* Application of punitive transit or wheeling charges or royalties
* Political instability.

Taking account of the economic opportunities for co-operation will require a greater political will from governments and a market culture and attitude, as well as appropriate regional institutional structures capable of sustaining joint development, ownership and the operation of energy facilities.

Energy efficiency, conservation and the environment

Throughout the Region, the efficiency of energy production and use is unsatisfactory. The main cause is invariably the lack of incentives, particularly through pricing. Electricity tariffs are, on average, one third of the prices in OECD Countries and access to appropriate efficient technology is also constrained. However, many countries have started to reform energy pricing policies, aiming at the eventual recovery of full economic cost.

The main environmental problem facing the Region is the local degradation of land through deforestation. This is mainly the result of clearing land for agriculture and overstocking. Dams for hydro power projects have also flooded land, otherwise needed for agriculture, so that the quality of life worsens in settlements downstream. Future hydro power and modern biomass developments will need to balance energy availability requirements against environmental impacts, in order to ensure such developments are not counter-productive.

Meeting legitimate aspirations for economic development is likely to take priority over any investments or pricing penalties purely for environmental protection.

In summary, energy efficiency, conservation and environmentally responsible action will only be possible when driven by appropriate policy and pricing incentives. There is a need to develop adequate policy instruments and pricing systems that promote the efficient use of energy.

Considerable technical assistance is required to improve the operation and maintenance of energy production and supply facilities, as well as in the design of country programmes for energy conservation, and the transfer of energy efficiency technology, particularly in the form of local demonstration projects.

The energy economy and international trade

The energy sector is the single largest consumer of resources, particularly in the form of capital and foreign exchange, and in some countries it has accounted for up to 40% of the public guaranteed foreign debt. Yet the main product of these countries – agricultural commodities – continue to lose value on the international markets and are subjected to tax barriers in the hard currency markets.

There is a widely held view that agricultural subsidies for farmers in the OECD countries, for instance, cannot be justified in the circumstances where economic restructuring, competitive market systems and open deregulation are being advocated for developing countries.

Sub-Saharan Africa is still the least favoured region for foreign aid. With 500 million inhabitants in 47 countries, the Region received less aid than a single country elsewhere with 13 million inhabitants, in 1990.

To summarise, overall, the structure and terms of international trade between the Sub-Saharan African Region and the OECD countries are considered to be discriminatory, through excessive protectionism, transfer pricing and other negative practices. These can be reviewed and rectified. The overall level of aid to the region will have to be substantially increased before there is any prospect of economic recovery and growth. The co-ordination and accountability for development aid should be improved.

The WEC Commission

At its 14th Congress held in Montreal, in September 1989, the World Energy Council established a Commission on "Energy for Tomorrow's World".

The aim of the Commission was:

"To identify a realistic framework for the solution of regional and global energy issues whereby adequate sustainable energy at acceptable costs could be supplied to meet the needs of all people, using optimal production and end-use efficiency while achieving socially acceptable care and protection of the environment. The emphasis will be upon real options as a credible pathway to achievement."

KEYNOTE PAPER

Energy demand in the SADC region

* K MBUENDE

The world in general, and Southern Africa in particular, has witnessed many dramatic changes over the last decade. Part of these changes has been the transformation of our organisation SADC from a mere co-ordinating function, to that of integration. This came about when the Heads of State and Government of the then Southern African Development Coordination Conference (SADCC) adopted a Declaration and Treaty establishing the Southern African Development Community (SADC) in August 1992. By this action, the summit transformed an organisation, hitherto an informal and loose group of countries into a formal body, with legally binding obligations on the member states. All the founder member states of SADC, namely, Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zambia and Zimbabwe have since ratified the Treaty which came into force in October, 1993. The 11th member, South Africa, acceded to the Treaty in August 1994, thus further consolidating and reinforcing the prospect of integrating the region into a prosperous Community of Southern African States.

The theme for this session is "Demand for Energy in the SADC Region". In order to put the issue of energy demand in its proper context, it would be worthwhile to first consider the socio-economic characteristics of the region. The entire SADC region of eleven member states has a combined population of about 120 million. The population growth rate of the region is slightly over 3%, which is very high in relative terms. According to the World Bank, six of the eleven SADC countries are classified as low income economies, four are classified as lower-middle income and one as an upper-middle income. Hence, the majority of the people in the region are comparatively poor by world standards.

The structure of gross domestic product (GDP) in SADC countries has a strong correlation with the structure of energy demand. It also exhibits variations depending on the extent to which manufacturing, mining and industrial production or agriculture predominates. More than half of Angola's GDP is accounted for by oil production, whereas half of Botswana's and one third of Namibia's GDP is accounted for by mining. In Malawi, Mozambique and Tanzania, agriculture is the predominant economic sector. There are, therefore, wide variations in energy consumption in the region, depen-ding on the nature of the economic activities and size of the population of the various countries. Those countries where mining and industrial production predominate consume a lot of energy as opposed to those where agriculture is the dominant economic activity. The region thus needs to plan for increased energy for the future as industrialisation gears up.

Energy is an essential factor in the economic and social development process. In Southern Africa, the majority of the population reside in rural areas. Hence, the supply of energy for rural development, particularly adequate, secure and low-cost supplies of various forms of energy, is critical for economic development and social progress. Commercial energy sources, which include electricity, liquid fuels, natural gas, coal and coal derivatives, are used mainly in large-scale mining and industrial activities. They are also being used to some extent in agriculture and small-scale rural industries.

Available statistics indicate that, excluding South Africa, hydro-electricity constitutes 63% of the net power supply in the region, with a total installed hydro-electric capacity of 7 548 MW, supplying a total of 24 410 GWh. South Africa alone has a capacity of over 40 000 MW, supplying about 165 385 GWh, which is seven times greater than the hydro-electricity generated by the other SADC member states. Thermal generation accounts for 93% of South Africa's supply, largely based on coal. Thermal generation which is coal-based is environmentally unfriendly, so that South Africa, in particular, and the region in general need to replace thermal power in the long run with other sources of energy, especially hydro power. The region is not well endowed with oil and natural gas. Only one country - Angola - produces oil. Sizeable deposits of natural gas have been found offshore in Mozambique, Tanzania, South Africa and Namibia, but these are yet to be exploited.

For the SADC region to achieve a certain degree of industrialisation, it is essential to develop commercial energy supplies, particularly electricity. Through its rivers and dams, the region has great potential for the development of a cost-effective and environment friendly hydro-electricity energy source, which remains to be tapped to its full potential. Furthermore, the region enjoys sunshine for a greater part of the year. It also experiences strong winds. There are forests containing a variety of timber, appropriate for various uses, including fuelwood. Therefore, there is scope for the development of new and renewable sources of energy, such as solar, wind power and woodfuel, which can meet, in particular, the energy needs of the majority of the people who live in rural areas. Woodfuel continues to be the major source of energy in the region, accounting for 75% of the total energy consumption. It contributes most to the household sector, where it accounts for about 90% of the energy used, mainly for heating and cooking. Woodfuel also continues to be the major source of energy for rural industries, such as tobacco curing, tea drying, fish smoking, brick burning, pottery, ceramics, salt production, etc. Woodfuel covers fuelwood, charcoal, agricultural residues and animal wastes, which are sometimes referred to as traditional fuels. However, as the forests of the region disappear, the supply potential of woodfuel is declining rapidly, resulting in an acute scarcity of woodfuel and environmental degradation. The region could be locked into a vicious circle of energy scarcity, environmental degradation and poverty if the current woodfuel scarcity continues unabated.

The Windhoek Treaty has underlined the need for sustainable exploitation and utilisation of natural resources and that development should not reduce or impair the diversity and richness of the region's resources or the environment. The Windhoek Treaty thus challenges the various sectors of SADC to define appropriate

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policy measures and mechanisms, to protect the environment and manage natural resource utilisation in order to achieve optimum sustainable benefits for the present and future generations of Southern Africa. Energy exploitation, conversion, transmission or conveyance and use can have a negative impact on the environment. The extent of the impact varies according to the source, technology, and management practices associated with the exploitation of the relevant energy system. The environmental impact of hydro power development arises mainly from the need to create large dams and reservoirs to store water. Displacement of people, loss of flora and fauna and other natural heritage and ecological effects are some of the considerations which have to be taken into account during the early stages of project design. Environmental impact, arising from petroleum and coal-fired power stations, is from the emission of pollutants such as sulphur, carbon dioxide and other greenhouse gases resulting from the combustion of oil or coal. Petroleum production, refining and trans- por-tation can similarly impact on the environment. The link between energy and the environment is even more evident in the SADC region due to woodfuel being the main source of energy. In this respect, measures have been instituted by SADC to address this particular concern through various projects. These projects include "Intensification of People's Participation in Tree Growing and Environmental Protection"; "Assessment of the Environmental and Socio-Economic Impact of Woodfuel Scarcity", etc.

The link between energy demand and the gender dimension, more specifically, the role of women in energy demand, has not been addressed adequately in the region. Analysis of the consumption pattern in the SADC region indicates that the household sector accounts for the largest share of the actual energy consumption. In most countries, biomass is the main fuel for household use. The collection and conveyance of biomass for domestic use is largely carried out by women. Land use practices in the region are such that biomass energy resources are becoming scarce, and are now further from centres of population. This adds to the drudgery of women's lives. Efforts to improve the situation have, in many cases, not involved the would-be beneficiaries. Not much effort has been made to involve women in the energy sector. The main challenge in the region, therefore, is to evolve mechanisms which will ensure that SADC women participate fully and actively in the energy sector.

There is potential for regional integration in SADC in the development of various energy forms, i.e. electricity, petroleum and gas, coal, woodfuel, new and renewable sources of energy, etc. Integration would minimise the cost of supply arising from the economies of scale of large regional energy supply systems. It would also enhance reliability and security of supply and minimise adverse environmental impacts. Investment in energy tends to be large and lumpy, and has long gestation periods. Therefore, integration and the joint development of these resources will offer member states the opportunity to share the investment burden and to avoid a situation where investment in energy development crowds out other national priorities. Integration would also minimise costly under- or over-planning, because energy can be imported in the event of a national shortage. In addition, integration would increase trade as it would have a positive impact on the overall economic performance of the region. Other benefits include joint purchase and refining of petroleum products, and the minimisation of the adverse environmental impact of energy development and supply arising from the ability to use a variety of energy sources.

The energy source which offers the most opportunities for regional integration, with almost immediate benefits, is electricity generation and distribution. The region's hydro power potential, which offers cheap and environmentally friendly energy, remains under-utilised. The irony is that there are power shortages in many parts of the region and there is reliance on coal generation, which has a serious adverse impact on the environment. In 1993, SADC, assisted by the World Bank, carried out a study on the interconnection of electricity grids in the region. The study concluded that the optimum use of regional resources and installations would provide a total saving of approximately US$1.6 billion, compared with a development based on individual transmission and generation expansion plans for each country. The ADB Study on Economic Integration in Southern Africa, launched last January, also concluded that the most viable trade in the electricity sector would be the establishment of a common electricity grid in Southern Africa. With this background, the desirability and feasibility of a regional electricity grid have been accepted in the region. The SADC countries have also, in principle, accepted the concept of a Southern African Power Pool (SAPP). A Memorandum of Understanding to this effect will be signed by member states early in 1995.

In addition, there is scope for the joint exploitation of the region's natural gas, co-ordination of petroleum procurement, refining and marketing. All these will require agreement on tariff, pricing and management policies. Currently, SADC is involved in a "Joint Petroleum Exploration Programme" (PEP) whose objective is to improve the geological database and allow individual member states to evaluate their petroleum potential. This will place member states in a better position to formulate petroleum exploration strategies and to enable them to negotiate with international oil companies. The project is costed at about US$50 million, with two thirds of that amount secured.

Since the signing and entry into force of the SADC Treaty, the region has been engaged in community building, which includes the holding of national and regional seminars and workshops aimed at mobilising the various constituencies. In this respect, an Energy Workshop was held in Windhoek, Namibia, from 11-15 April 1994. The objective of this workshop was to consult with the main stakeholders on how the community should be built with respect to the energy sector; to concretise ideas on the role that the various constituencies are willing to play in the integration process; and to ensure that the views expressed at the workshop are captured in the drafting of an Energy Protocol that will determine the nature of co-operation in the future. Currently, the consultants are preparing a protocol in energy that will be widely discussed and eventually signed by all member states, hopefully before the end of 1995.

In conclusion, the demand for energy in the SADC region should increase, depending on the degree of modernisation and industrialisation that will take place in the region. The region is also likely to move away from traditional sources of energy (traditional fuels and thermal power) to hydro-electric power and other new and renewable sources of energy. It is predicted that thermal power use will decline, as the use of fossil fuels contribute to environmental degradation. Currently, the region is experiencing a surplus of hydro-electric power. However, its usage is mainly restricted to urban areas. The real challenge facing the region will be to intensify already planned or existing rural electrification schemes, in order to reduce dependence on woodfuel in the rural areas. Even in urban areas, a critical test would be to provide cheap and secured power to the vast majority of people in the region.

The demand for energy in Southern Africa

* J A BASSON

This is a summary of the 13 papers that were submitted on the demand for energy. They covered a diversity of topics, including energy demand, energy and the economy, electricity demand, demand side management, liquid fuel demand, industrial energy efficiency, integrated resource planning and energy planning and statistics.

The regional demand for energy was 3 313 PJ in 1990/91, of which South Africa accounted for 53%. Whereas the SADC countries largely rely on biomass, South Africa has a relatively small biomass consumption and the major energy carriers are electricity, liquid fuels and coal. Total final energy intensity in the region varies from 0.5-6.58 kgOE per 1988 $ of GDP. The structure of the economy has a considerable effect on the type and extent of energy use. Those countries with more industrial activity have a higher energy consumption per capita. The increase in the demand for energy in the region has decreased considerably over the last decade, and varies from 1%-3.1% per annum whereas the population growth varies from 2.6%-3.4% per annum.

A number of energy efficiency projects have been carried out in the region during the last five years. It is concluded that there was a strong bias towards audits and attendant training, the number of specialists did not expand appreciably, little progress was made in the development of intermediate structures, and minimal capacity building occurred in energy ministries and parastatals. Attention is now becoming focused on integrated resource planning, including demand side management. Projects to determine the potential and the development of expertise are being carried out but no national policies have been made. Energy statistics are essential for this purpose, but are not yet adequately developed.

There is potential for extensive co-operation on energy demand matters in the region. This relates to information databases, energy efficiency programmes, demand side management research, planning and implementation, the training of specialised manpower, the development of appropriate national policies and institutions, energy service companies, utility investment in energy efficiency programmes and performance related regulation.

It is concluded that some activities are taking place in the demand field in the region. However, this is possibly sub-optimum if the needs and challenges are considered. In addition, adequate institutions do not exist and official policies are not supportive of demand actions.

Introduction

This is a report on the 13 papers that were submitted on the demand for energy in Southern Africa. Five of the papers were from South Africa, two each from Zimbabwe and Zambia, and four from authors outside Africa. These papers cover a diversity of topics, including energy demand, energy and the economy, electricity demand, demand side management, liquid fuel demand, industrial energy efficiency, integrated resource planning and energy planning and statistics.

Regional energy demand

The demand for energy in the region is shown in Tables 1 and 2. These show that South African energy demand is greater than that of the SADC countries. Whereas the SADC countries largely rely on biomass (76% of total), South Africa has a relatively small biomass consumption (14%), and the major energy carriers are electricity, liquid fuels and coal. Households account for 68% of SADC energy use against an evenly spread use of energy in industry (39%), transport (25%) and households (20%) in South Africa.

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Energy indicators

A number of indicators are used to compare the use of energy in different countries. Table 3 indicates the total energy use (i.e. commercial and traditional energy) per capita and energy intensity, defined as total energy use per unit of economic output (GDP), and listed per increasing GDP per capita. It can be seen that energy intensity generally decreases as the GDP per capita increases, but that no clear trend in the energy use per capita exists. It is known that the energy intensity of a country initially increases as it develops, until it reaches a maximum during the secondary/tertiary phase of industrialisation. It then starts to decrease. All developed countries are in the decreasing energy intensity phase and the indications are that South Africa has entered this phase, as its final energy intensity decreased in the 1950s. However, it has been relatively static for more than the last decade (Basson, 1992).

Energy economic interaction

Energy and the economy

Sampa (1994) analyses the effect of the structure of the economies of five SADC countries (Botswana, Malawi, Tanzania, Zambia and Zimbabwe) on energy use,

CARRIER	SADC 1990	%	SOUTH AFRICA 1991	%
Electricity	78	5	455	26
Liquid fuels	202	13	523	30
Biomass	1 178	76	239	14
Coal and coke	91	6	547	31
TOTAL	1 549	100	1 764	100

Table 1: Final energy use by carrier (PJ)

CARRIER	SADC 1990	%	SOUTH AFRICA 1991	%
Households	1 050	68	352	20
Agriculture	76	5	68	4
Mining	43	3	135	8
Industry	200	13	681	39
Transport	109	7	437	25
Other	70	5	92	5

(Source of data: Kaale (1994) and Cooper (1992))

Table 2: Final energy use by sector (PJ)

COUNTRY	ENERGY/ CAPITA (kgOE)	GDP/ CAPITA (1988US$)	ENERGY INTENSITY (kgOE/$GDP)
Mozambique	220	85	2.59
Tanzania	862	131	6.58
Malawi	194	145	1.34
Uganda	318	170	1.87
Zaire	266	192	1.39
Lesotho	337	244	1.38
Burundi	211	245	0.86
Rwanda	213	311	0.69
Kenya	392	374	1.05
Zambia	450	530	0.85
Angola	299	599	0.50
Zimbabwe	494	683	0.72
Swaziland	461	827	0.56
Namibia	892	1 460	0.61
Botswana	746	1 542	0.48
South Africa	1 344	2 441	0.55

(Source of data: Dutkiewicz, 1993)

Table 3: Energy use indicators, 1988 (commercial and traditional final energy)

based on the premise that economic growth determines energy demand. He concludes that the structure of the economies and major economic activity correlate with energy consumption, as those countries with large industrial and mining sectors (Botswana, Zambia and Zimbabwe) consume more energy per capita (see his Table 7) than countries with large agricultural sectors (Malawi and Tanzania). Population growth rates for these countries from 1980-1992 averaged 3.2% per annum and urbanisation 8.3%. By comparison, the growth in GDP varied from 10.1% per annum for Botswana to 0.8% for Zambia.

Kuni *et al.* (1994) present a more philosophical analysis of the relationship between energy and the economy. They indicate that the development of the world economy since the 1700s was strongly influenced by energy developments such as:

* Wind and water power in agriculture and industry,
* Coal in the iron and steel industry,
* The steam engine in industry and later in railroads and marine transport, all linked to coal as energy carrier,
* Liquid fuels and the internal combustion engine and its effects on the petrochemical industry and the transport sector, including air transport,
* Electric motor electricity, where the most dramatic development in industry was the electric motor that displaced steam as motive power and increased flexibility and efficiency,
* The electronic industry, many years later, with its many implications and economic developments.

The effect of these developments on society should be noted, in terms of changes in job attributes and skills, urban planning, the development of a diversified economy, pollution and new technologies. It is stated that "it can be observed that as new industries or processes are introduced there tends to be a higher return for each unit of energy expended. This actually exacerbates the difference in economic performance and energy consumption between the developed and less or underdeveloped countries."

The relationship between energy use and the economy is complex and not fully understood, partly due to a lack of appropriate data. Dube (1994) indicates that many and diverse variables contribute to the problem of forecasting electricity demand. These variables include climate, population growth, education, income, life-style, equipment availability, investment activities, tariffs, demand side management, availability and cost of other energy sources, governmental policies, design of houses, technology used, knowledge of consumers and the availability and use of infrastructure. In addition, some of these variables are changing in an unpredictable way.

Energy sector related to total economy

Little research has been done in Africa on the economic impact of the energy sector on the national economy. Preliminary work in South Africa has indicated that the total cost of energy to the final energy consumer, i.e. including energy levies and taxes, amounts to about 15% of the GDP. This should be compared with an average of 8% for the IEA countries, notwithstanding that South Africa's average energy price is the second lowest in the world (van Deventer, 1993). Attention is given in many countries to minimising the cost of energy but it is clear that low energy prices lead to high consumption unless the consumer is motivated to use the energy effectively. Similar work should be carried out in the other countries in Africa.

Energy imports

The import of energy, especially liquid fuels, is important for the region, as its own resources are limited. Surprisingly, this aspect is not addressed by the authors, except the indication that local production of liquid fuels in South Africa leads to a foreign exchange saving of R5.3 billion per annum, which is 9.6% of total imports, and produces 7 600 Ml of liquid fuels or 45% of total demand (Swanepoel, 1994). The export and import of electricity is limited, but there is significant potential for expansion in this activity as

there are a number of countries in the region with a surplus of generating capacity (see Figure 1 of Viviers, 1994).

Energy prices

Linked to the analysis of the impact of energy use on the economy is an analysis of price trends. It is not known whether any work has been done in this regard in Africa. None was indicated in the papers that were submitted. The initial work, which has been started in South Africa to develop time series data on energy prices per energy carrier and per sector, and to indicate the cost and levy/tax components of the price, is proving a most difficult and complex task. This is particularly so in those sectors where market pricing applies and transport costs vary.

Energy demand policy

A surprising feature of the papers that were submitted is that not one referred explicitly to the national policy regarding energy demand. Of the nine local papers, four were from national utilities, two from energy ministries and three from researchers working closely with energy ministries. Many conclusions can be drawn from this observation, some possibly erroneous. It seems that policies on energy demand either do not exist or are silent as focus has been and is on the supply of energy.

Energy demand

Growth in demand

The increase in the demand for energy in the region has decreased considerably over the last decade, and varies from 1% per annum (Malawi) to 3.1% (Botswana), whereas the population growth varies from 2.6%-3.4% per annum (Sampa, 1994, p.17). This should be related to poor economic conditions, as stated earlier. These were, *inter alia*, caused by poor international economic conditions, droughts and political stress.

Electricity

Past efforts to make adequate forecasts of electricity demand have proved to be extremely difficult and inaccurate (Akapelwa, 1994; Dube, 1994). One reason for this is a decrease in national economic performance, generally leading to a surplus of capacity in many countries (Viviers, 1994). Another reason for poor forecasting performance may be not knowing what the demand for energy consists of and the factors that are possibly affecting this demand.

Dube (1994) postulates on the complexity of forecasts for electricity demand for Zimbabwe, based on a low growth (2.5% per annum), medium growth (5%, most probable and linked to the Structural Adjustment Programme) and high growth (7.5%) scenarios linked to past population growth of 3.13% per annum. The results of these forecasts are not given, but it is clear that serious attention is being given to urban and rural electrification, demand side management, energy efficiency (the ZEEP and NEEIP programmes) and the impact of pricing as the introduction of long-run marginal cost based pricing is being planned.

> "Taken collectively, however, these (demand side) initiatives represent a bare minimum of effort and do not constitute a major force in comparison, say, with the effort expended on supply side planning and development. The region continues to lack a co-ordinated and integrated energy efficiency programme which would fill the institutional and training gaps and provide an impetus to further development of efficiency in all sectors of the economy."

Zambia's electricity load is mainly mining and industrial as only 10% is for the domestic sector (Akapelwa, 1994).

Two forecasts that have been carried out as part of a SADC project indicate that the existing available capacity, including a 16% operating reserve, will be sufficient until 2003, but only until 1999 if a massive electrification programme of 60 000 houses in a five-year period is included in the last forecast.

Liquid fuel

Substantial information on the supply and use of liquid fuels in South Africa is given (Swanepoel, 1994). It indicates that imports of crude oil followed a decreasing trend (Graph 1), that more petrol was exported than imported in 1993 (Graph 2) and that diesel exports exceed imports (Graph 3). The per capita consumption of petrol (Graph 4) was relatively constant for the 1973 to 1986 period and then increased by 2.9% per annum. In absolute terms, the use of petrol increased from 1979 at a rate of 4.3% per annum. The use of diesel was relatively constant (Graph 5), especially after 1981 and showed a decreasing trend when expressed per capita. These trends need to be related to the price of petrol and diesel that both increased in nominal terms (Graph 7) but decreased in real terms (Graph 8). A forecast for the period 1994 to 2000, based on an economic growth rate of 3.9% per annum, indicates growth rates of 2.2% for petrol, 2.7% for diesel, 1.4% for aviation fuel and 1.7% for illuminating paraffin which is generally used for domestic purposes in the developing community.

Biomass

It was shown in Table 1 that the SADC countries rely extensively on biomass, particularly where limited industrial development has taken place. Sampa (1994) states, "Like in other Sub-Saharan countries a striking feature of the energy sector is the substantial reliance by the SADC countries on traditional or biomass energy .... as a proportion of total energy supply biomass energy on average accounts for over 70%".

The international dimension

The IEA's *World Energy Outlook* projects global energy to the year 2010 and states that there is considerable uncertainty, such as policy changes, technological developments, new energy resources and future preferences of energy users (Welham, 1994). The following points are important:

* Crude oil price will increase from $17 per barrel in 1994 to $28 by 2005, expressed in constant 1993 dollars.

* The price of internationally traded coal is assumed to increase to $55 per ton by 2005.
* OECD economic growth is assumed to be 1.9%-2.6% per annum, Eastern Europe 0.8%-2.5% and the rest of the world (ROW) 5.3%-6.2%, of which Africa is 3.1%-4.5%. If the latter is compared with the expected popu-lation growth rate of 2.8%, the per capita income is expected to rise only moderately.
* World primary energy demand is expected to increase by 2.1% per annum from 7 845 million tons of oil equivalent (MTOE) in 1991 to 11 560 in 2010, and the ROW by 4.2%. This indicates "a significant shift in shares in world energy demand in favour of ROW countries" that increases from 27% to 40% of the total, as caused by increasing commercial energy use, continued relocation of energy intensive industries and increasing penetration of electricity.
* Energy intensity in ROW countries increased by 1.1% from 1981 to 1991 and it is expected that this will decrease in the future (see his Figure 2).

This study concludes that "under a plausible set of assumptions, the importance of energy demand in countries outside of the OECD, the former Soviet Union and Central and Eastern Europe is set to rise significantly .... . An important conclusion to be drawn is that the effort spent in analysing the patterns of energy demand in countries in a lesser state of development, is an effort that will be repaid significantly in the future".

Energy efficiency

Mining and industry in South Africa

The use of energy in South Africa, with industry and mining forming 50% of the total, was analysed and scenarios for future use were developed (de Villiers, 1994). The three scenarios for the period 1995-2015 were "frozen efficiency" as a reference, "business-as-usual" and "energy effective". It was determined that the decrease in energy intensity with the "business as usual" scenario was 0.94%-1.38% per annum and with the "energy effective" scenario 1.56%-2.18%, in comparison with the "frozen efficiency" scenario. Electricity demand alone could be reduced by 18% by 2015, deferring investment in new electricity facilities of R7.3-R11.7 billion at the cost of investment of R2.7-R4.9 billion in energy efficiency measures in industry. The question is, who will be making this investment and under which conditions? The advantages of the "energy efficiency" scenario are reduced energy expenditures, capital investment and environmental effects.

South Africa has devoted limited public resources to energy effectiveness in the past and generally left the allocating of energy resources to the market. It is a strong view of some of the major energy users in the private sector that the government should not interfere in this process. There are specific barriers that constrain the effective use of energy, such as domination by large energy suppliers, non-inclusion of environmental costs in energy prices, non-application of integrated resource planning principles, lack of knowledge by consumers and the high perceived risk of energy efficiency projects linked to high rates of return.

Energy efficiency projects were investigated in other countries and a limited State programme was proposed covering a general energy awareness, education, supported audits and demonstration schemes, at a cost of approximately R10 million per annum in the medium term. It is estimated that this may lead to savings of R483 million per annum.

SADC energy efficiency activities

A number of projects have been and still are being carried out to improve the efficiency of using energy in SADC countries (Stiles, 1994). These are:

* The SADC Industrial Energy Conservation Pilot Project (1983 to 1991)
* A range of follow-up projects in individual countries,
* The new Canadian International Development Agency-sponsored "Industrial Energy Conservation Project" (1994 to 1999),
* "Opportunities for Demand Side Management among SADC Utilities"
* "Energy Efficiency for SADC Heavy Industry".

The initial results of these projects were reduced as the "bilateral donors and multilateral lenders have had a dominating effect on project definition and mode of delivery".

Table 1 of the Stiles paper summarised these different activities and concluded that there was a strong bias towards audits and attendant training. The number of specialists did not expand appreciably, and little progress was made in the development of intermediate structures. Only minimal capacity building, therefore, occurred in energy ministries and parastatals. The author concluded that "efficiency programming in the region remains at a fairly rudimentary level. Several member states ... have developed or are developing stand-alone energy efficiency programmes ... utilities are receiving institutional support for DSM programmes". Stiles postulated that national or regional energy efficiency centres, conservation strategies, and training programmes should be considered. In addition, energy suppliers and industrial and professional associations should be involved in information programmes.

Energy planning

A number of papers addressed the topic of energy planning, generally related to the electricity sector. Viviers (1994) states that "utilities in developed countries have recognised that demand side management (DSM) is as important a part of utility management as supply side management". This is generally applied as Integrated Resource Planning (IRP), also known as "Least Cost Planning", that consists of "the systematic evaluation of resource options available to a utility to minimise the long-term costs to the society served by that utility". The key planning objectives are to maximise customer and societal value and to minimise societal and system short- and long-run cost. Specific basic steps are required, such as:

* Understanding of the end-use of energy
* Identifying the technical potential of DSM activities
* Evaluating the societal benefits of these activities
* Analysing the engineering and economic aspects to arrive at an "optimum" point of improved energy efficiency.

Traditional DSM measures should be investigated and should be added to other measures that may be applicable to the domestic sector of developing countries where the demand of energy per consumer is low. These measures are pricing signals, market research, education of consumers, the role of other energy carriers and the use of the right equipment, especially the thermal design of dwellings.

Adequate energy data are required for planning and policy formulation purposes (Cooper, 1994). As developing countries are focusing on the supply of energy and as policy has not addressed the demand for energy, data on its use are unsatisfactory. Cooper indicates that policy formulation moves through phases of intelligence (problem identification and data gathering), the development and design of alternative options, the selection of the most appropriate option and the monitoring of its application. It is indicated that "for South Africa the issue of adequate energy data for assessing policy options has become critical. The recent political changes have accounted for changes that will need to be incorporated into State and provincial energy policies. Unfortunately, the quality of energy data falls short of what is required for developing adequate energy policies for the various provinces as well as for the entire nation". It is proposed that:

* That the State takes the responsibility in developing such a data system.
* This system should be managed by a single body.
* It should utilise existing expertise and systems.
* It should be based on an appropriate geographical, energy carrier and economic activity classification system.
* The appropriate legislative powers be provided so as to ensure that the necessary data can be collected from energy suppliers and consumers.

Co-operation

Many of the papers indicate the potential for extensive co-operation on energy demand matters in the region. This relates to information databases, energy efficiency programmes, demand side management research, planning and implementation, and the training of specialised manpower, as well as the development of appropriate national policies and institutions. In addition, some of the international papers indicate the potential for the implementation of new activities that are being carried out in developed countries. For example:

(a) The use of energy service companies (ESCO), better known as third-party financing companies, to reduce the need for the construction of new energy supply facilities. (For instance, power stations are projected in India at 100 000 MW in the next ten years and China at 50 000 MW per year). These companies are specialists in energy efficiency and energy management and would contract with the owner of a facility, or large buildings or factories, to identify energy efficiency activities. They would also propose improvements in their energy systems, finance the energy efficiency options and share in the savings that are realised, based on demonstrated performance (Limaye, 1994b). These companies are active in developed countries, and "successful establishment of ESCOs to implement energy efficiency options in developing countries can lead to a truly win-win situation in that benefits are created for customers, utilities, trade allies, and society". There are several barriers that need to be removed to allow ESCOs to make their contribution. Most significant is that energy prices do not reflect the true cost of production and supply, and should be addressed by appropriate policy action.

> "... at this stage the supply of cheap and sufficient energy in the region is still more important than knowledge of and activities related to the use of energy. There is vast potential for co-operation between energy organisations in the region and those organisations with similar experience in developed countries. These approaches can be used to develop the skills that are necessary to implement active demand side activities involving all energy carriers."

(b) Utilising the knowledge and experience that has been developed on demand side management in the developed countries by specialised consultants (Limaye, 1994a) and utilities (Boye, 1994). These could consist of technology transfer options where manufacturers, suppliers, trading organisations and research and development institutes are the primary agents to be involved in these activities.

(c) EdF is active in a number of French territories in Africa, and electricity tariffs are fixed by legislation at the same level as in France. Boye (1994) describes a compact fluorescent demand management lighting programme conducted in partnership with ADEME, the French energy efficiency agency, in Guadeloupe and Martinique. This led to peak demand savings of 7 MW or 6%. Institutional co-operation in Tunisia, again with ADEME on energy efficient lighting, led to a peak demand saving of 6.5% in the pilot project that indicates a total potential of 110 MW. These experiences can also be shared with utilities in Southern Africa.

Conclusions

This summary is concluded by quoting from Stiles (1994): "Taken collectively, however, these (demand side) initiatives represent a bare minimum of effort and do not constitute a major force in comparison, say, with the effort expended on supply side planning and development. The region continues to lack a co-ordinated and integrated energy efficiency programme which would fill the institutional and training gaps and provide an impetus to further development of efficiency in all sectors of the economy."

There is some activity in the demand field, but this is possibly sub-optimal if the needs and challenges are considered. In addition, there are no adequate institutions and official policies are not supportive of demand actions. One avenue used to good effect in certain developed countries is the use of a regulator to ensure that energy suppliers implement IRP strategies. Geller (in Nadel, 1992) states, "As a strategy for increasing utility investment in end-use

efficiency and thereby reducing the total cost of energy services, regulatory incentives move beyond trying to coerce utilities or appeal to their sense of public duty. Rather they attempt to establish a system of rules that whereby DSM investments are at least as profitable if not more profitable, when successfully executed, as conventional supply-side investments." It is not known if such plans exist in the region.

The papers, to a certain extent, indicate that at this stage the supply of cheap and sufficient energy in the region is still more important than knowledge of and activities related to the use of energy.

There is vast potential for co-operation between energy organisations in the region and those organisations with similar experience in developed countries. These approaches can be used to develop the skills that are necessary to implement active demand side activities involving all energy carriers.

One mechanism that is used to good effect in many developing countries to ensure that energy systems are efficient, is the use of direct and indirect competition, even between publicly owned suppliers. DSM plays an important role in this as the rationale is the supply of energy services at minimum cost without minimising the cost per unit of energy supplied.

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African Energy Programme

* K SALL

Abbreviations

ADB	African Development Bank
ADF	African Development Fund
AEP	African Energy Programme
AMU	Arab Maghreb Union
APPA	African Petroleum Producers Association Association
DDSMS	Department of Development Support for Management and Services
ECA	United Nations Economic Commission for Africa
ECCAS	Economic Community for Central African States
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization
IEA	International Energy Agency
OAU	Organization of African Unity
PTA	Preferential Trade Area for Eastern and Southern Africa
SADC	South African Development Community
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UPDEA	Union of African Producers and Distributors of Electricity

Introduction

The African Energy Programme (AEP) was launched in May 1992 with the assistance of the United Nations Development Programme, after a series of visits to the African and international institutions in the energy sector and organisation of workshops and seminars on strategies for energy development in Africa. All this preparation enables the African Development Bank clearly to define the objectives and terms of reference of the African Energy Programme.

The Programme is supervised within the ADB by a steering committee for the orientations and a technical committee for all operations. The Programme was co-ordinated in terms of all its activities.

The Bank Group has, since its creation, approved funding for 80 projects in the energy sector amounting to $2.6 billion.

The majority of the loans went to the electricity sector with 87% of the funding for 70 projects, whilst the oil sector received only 5.2%. Multinational projects represented only 2.5% of the Bank's commitments.

In spite of all the investments made with the assistance of the World Bank, the ADB and other development finance institutions, the energy sector in Africa on the whole has degenerated, resulting in the current crisis facing nearly all African countries.

This situation is characterised by:

A biomass-dominated energy system

A major feature of the African energy system is that nearly two thirds of final energy consumption is made up of biomass (some studies estimate this at 75%) whereas the average in developing countries - according to BUN/1992 figures - is around 36%. This ratio is about 31% in Asia and a mere 16% in OLADE countries (Latin America).

The consumption of biomass, which is predominant in final consumption, poses major problems in the acquisition of statistical data. All existing evaluation methods are based on partial survey and the use of ratios, but these cannot be bypassed pending the outcome of the AEP studies which would offer a more reliable approach (roughly estimated at 78% for domestic use and 22% for industry services in the studies mentioned in the sectoral report on forestry and biomass).

An extroverted energy system

At the level of primary energy (excluding biomass, which is not classified as commercial energy), with the structures of production and consumption indicating identical ranks for oil, coal and gas respectively, Table 1 shows variations from one structure to the other depending on production or consumption.

The extroversion of the African energy system is striking, if not shocking, considering that Africa has a low per capita energy consumption.

This table shows:

* a dramatically low per capita energy consumption,
* a dependency on oil as a commercial fuel to the extent that the latter represents nearly 50% of the energy bill,

	1982	1992	Increase (%)
Production (Mtep) incl. crude oil	255 (220)	392 (316)	+54% (+44%)
Export (Mtep) incl. crude oil	187 (148)	306 (279)	+64% (88%)
P&G retransformation (Mtep)	14 092	18 354	+30%
Export/Production	73%	78%	
Reserves/Production	55 ans	47 ans	

Table 1: Extroversion of African oil and gas policies

* African Energy Programme, African Development Bank, 01 BP 1387, Abidjan 01, Ivory Coast

Sub-region	Southern	Central	East	North	West
Population	10	12	23	23	32
GDP	19	7	7	37	30
Resources					
Hydrocarbon	14	**58**	15	4	9
Gas	3	3	2	56	**36**
Oil	μ	6	μ	65	**29**
Charcoal	**99**	μ	μ	μ	μ
Consumption					
Electricity	55	3	3	**31**	8
Oil	24	μ	μ	**57**	18
Gas	μ	2	μ	**87**	16
Charcoal	**99**	μ	μ	μ	μ
Wood	14	14	30	6	**36**

Source: Compilation of Sectoral Reports [μ = low]

Table 2: Sub-regional energy disparities in Africa: 1990/91 situation (%/Africa)

* a sub-regional energy disparity which should initiate the creation of energy exchanges,
* a persistently low level of energy exchanges between African countries.

The African Energy Programme (AEP)

It is on the basis of all these observations that the African Energy Programme was designed with the following objectives:

* Analysing in depth Africa's energy situation in all its aspects
* Organising a think-tank on the energy situation in order to propose development orientations
* Defining a regional strategy and a programme of multinational projects or national projects with an integration component for the optimal development of the energy sector.

The AEP, as designed by the ADB, can serve as a basis, in the countries and sub-regions of Africa, for the elaboration of coherent energy policies to pave the way for a smooth integration of the energy sector.

The three phases of implementation were designed as follows:

(1) A first phase comprising visits to all African countries and the systematic study of the six energy sub-sectors: namely, oil and gas, coal, electricity, forest and biomass, renewable energies, and nuclear energy. These studies cover the entire fuel cycle from the evaluation of resources to the determination of end-use consumption.

During this phase, the Bank recruited international consultants to develop the three analytical tools of energy systems with particular emphasis on their adaptability to African conditions. These tools include an information system and databanks, an energy accounting system and a demand forecast model.

Specific studies on the interface between energy and the other sectors, as well as the social, institutional and economic aspects of energy development and utilisation, were undertaken and are being implemented. They should be completed by the end of 1994.

The synthesis report, *Energy situation in Africa*, is presently being prepared.

(2) The second phase was designed as a think-tank during which the Bank plans to organise workshops on major themes related to energy and a think-tank on the orientations that should be given to the energy sector to ensure its controlled and sustainable development. The various themes include the impact of energy use on the environment; women and energy; and energy in agriculture development.

At the end of this phase, the AEP experts will prepare technical briefs on the national or multinational projects identified in Phase 1. This second phase should be completed by the end of the first quarter of 1995.

The first two phases were entirely financed by the ADB Group through a grant from the African Development Fund and complementary financing from the Dutch government, representing nearly 20% of the overall budget.

(3) The third phase, whose funding is not included in the current financing plan, will consist of projects and programmes identified during the first two phases and the implementation of policies adopted by decision-makers on the recommendation of the think-tank.

Preliminary conclusions of the AEP

The preliminary conclusions of the synthesis report in preparation are as follows:

(1) The mastery of the development of the energy sector in order to increase its contribution to the economic development of the continent is crucial in preventing Africa from becoming, as described by one African Head of State, "The only continent endowed with immense natural wealth which continues to hold out its hand in the world concert"

(2) The potential balance between the energy resources and needs of Africa means that the continent has some capacity of energy self-sufficiency provided that it organises and co-ordinates actions at all the levels. Success in integration is a pre-requisite of this self-sufficiency.

(3) Africa should ultimately, and within the shortest time possible gradually move away from unprecedented dependence on wood energy to commercial energies for a better equilibrium of its energy balance. A transitional plan should be devised and launched at continental level.

The widespread deficit of commercial energy services in most African communities is therefore synonymous with poverty and the prevalence of an underclass. Consequently, planning for the delivery of adequate, appropriate and affordable commercial energy services is integral with overall socio-economic development planning.

At the outset, it is essential to introduce the concept of energy needs and to draw the essential distinction between energy needs for sustainable for commercial energy.

The demand approach alone (obtainable through statistics from trade reports between economic agents) clearly seems to be insufficient in Africa. It only reveals surface phenomena.

Based on statistics from the International Energy Agency (IEA), the total consumption for Africa of 220 MTOE in 1990 (population = 640 million) is expected to increase to 393 MTOE in 2010 (population estimate = 11 555 million). As a result, the per capita consumption of commercial energy remains static at 340 KEP in the year 2010 as it was in 1990! The consequent implication is that there will be no real shift from dependence on traditional fuels, forestry and biomass to commercial energy forms. Such a scenario would not become a reality. What makes this scenario possible is the inertia of African countries (which have decided not to join hands in order to change the persistent trend) whereby:

* Africa has for a long time consumed as much fuelwood as China and India together;
* The growth rate of the consumption of fuelwood in Africa is the highest of all the continents;
* Six African countries consume more than half of the firewood produced on the continent;
* Nigeria, although a major producer of oil, for a long time has been burning out its gas. Meanwhile, it absorbs nearly a quarter of Africa's fuelwood consumption.

(4) In meeting energy needs, there is a risk of generating adverse effects on the environment. The impact of these effects should be taken into account in the recommended transition process.

(5) The increase in energy costs leads to a commensurate increase in factor costs of the economies of Africa. For the continent to ensure its competitiveness, it requires the implementation of an energy conservation and efficiency strategy.

(6) The solution to the problem of supplying energy services in African countries, through the optimal exploitation of resources of the continent, requires:

(a) The creation of an African integrated oil market, and

(b) The restructuring and rationalisation, on a regional basis, of the system of refining and distributing oil products to meet domestic demand effectively on the continent.

(7) The creation of sub-regional connections in areas with natural gas resources and distribution networks, as well as industries for manufacturing gas cylinders and stoves should facilitate the maximal use of African gas. This will help to reduce the high pressure on African forests.

(8) The integration of electric systems at the sub-regional and even continental level is necessary for optimising electricity production in order to increase the low rate of access to electricity in most African countries.

(9) In the African context, coal is almost exclusively mined in Southern Africa and prospects in this sub-region are good. The role that coal can play in Africa's energy integration will be more effective through electricity interconnections with other sub-regions on the continent.

The following action should be undertaken:

* To promote the development of new clean technologies;
* To promote the use of coal in large-scale electric power stations, thus allowing for economies of scale and reducing the cost of transporting coal;
* To promote the integration of the sub-regional electricity systems to ensure the security of power supply and improve the development of the electricity sector.

(10) Biomass should be taken into account in the primary energy balance. It is a resource that should be properly managed and planned at the multinational level in the framework of national town planning programmes.

At the national level, the management of resources implies:

* The establishment of organs for evaluation, planning and economic studies on resources;
* The promotion of research/development on bio-energies with the view to making industrial use of residues;
* Rational supply in the rural areas;
* The management, follow-up and control of the supply of charcoal to urban centres.

Institutional management facilities at the level of the sub-regions and countries in order to ensure the continued availability of potential resources should be created.

(11) Promoting the use of renewable energy technologies in all sectors of the economy calls for the devising and launching of a plan for the development and production of renewable energy equipment. This is possible at the level of a continent like Africa.

This will help to develop local engineering and maintenance capacities, and industrial capacities for the production of renewable energy equipment.

In terms of commercial energy, in Africa there has always been a history of consumers and not innovators, such that all great technological revolutions have bypassed this continent. With renewable energies, the development of which has just started, Africa can become operators and active partners. This opportunity should not slip by.

(12) Finally, for nuclear energy, uranium should be used as an energy source. Even if Africa has no means for a large-scale nuclear energy programme, for numerous reasons, it should maintain a technological watch, which should be organised at the level of electricity utilities, as well as research and development centres.

Uranium also has applications in other areas such as agriculture, medicine and food conservation. It is possible to identify national and sub-regional projects among these applications.

At institutional level, a specific study is being carried out with the assistance of the Department for Development Support and Management Services of the United Nations and major areas of reflection have been defined which will feature in workshops and the think-tank.

Recommendations of the AEP

From the situation analysis of the energy sector in Africa, urgent actions are called for, namely:

(a) The formulation and adoption of a continent-wide legal framework consisting of an African Energy Charter and common guidelines adopted by the states at the Organization of African Unity (OAU) summit level. This would include the definition and promotion of the implementation of common regulations and guidelines to foster a multinational co-operation geared towards:

* Increasing access to commercial energy;
* Evaluating and developing common energy resources in hydrocarbons, hydro-electricity and biomass;
* Setting up a databank, harmonisation of legislative instruments, specifications of norms;
* Exchanges between energy enterprises within the framework of optimal and inexpensive management of resources in general, and of electrical interconnection in particular.

(b) The creation of an African Conference of Energy Ministers and an African Energy Commission consisting of representatives from African co-operation organisations (ECOWAS, ECCAS, SADC, UMA, PTA, CEPGL, APPA, UPDEA). A permanent secretariat comprising an African Energy Observatory, a Strategy/Regulation unit and a Common Programmes/Projects Unit would serve as the permanent implementing body of the Commission.

This study should take into account the conditions in the creation and operation of existing institutional bodies, in the hopes of avoiding their mistakes.

(c) The creation, within the African Development Bank, of a unit for the planning, programming, evaluation and promotion of regional, sub-regional and national programmes and projects geared towards dynamic integration.

(d) The creation in some towns, selected for their communication facilities, of regional research and training centres on renewable energy technology, in the image of the Bamako Center. Three such centres would be sufficient for Africa: one for West and Central Africa, one for East and Southern Africa, and one for North Africa. These centres would also be training institutions in the area of energy planning so that gradually a permanent unit for energy planning and programming could be created in each African country.

(e) The creation of an African Energy Fund to encourage and support initiatives, whose philosophy is based on African integration (energy co-operative unions, women's associations for the protection of the environment, workshops for manufacturing or assembling NRE equipment, specific scholarships ...). The modalities of contributing to the fund will be defined with precision, while ensuring that it is not dominated by lobbies.

These are the main points of the brief on the African Energy Programme. It is the most important sector development programme to be launched in Africa. It was constituted in the framework of the recommendations of the Lagos Plan of Action and we need to achieve concrete results that could help the continent to move ahead.

Africa should also rethink the problem of integration as being the only way to develop. Energy integration is a major component of economic integration, and the AEP is an attempt to define the conditions of this energy integration.

Africa has world-class experts in all areas and particularly in the field of energy. This has been verified, for we have recruited for all the AEP studies 150 experts. Ninety percent of these experts are from Africa where they are often ignored or marginalised in their own countries.

The energy sources that have been evaluated are considerable, such as the hydro-electric resources of the Inga site. This is one of the most powerful sites in the world and can only be fully equipped in the framework of an interconnection of African electricity networks. Without interconnections, optimal use cannot be made of these resources. Electricity interconnections should be a top priority in order to use the electricity opportunities offered by the hydro-electric potential, and also the coal potential from which South Africa obtains its electricity.

Sub-regional gas and biomass interconnections are solutions to the energy problems of the poorest populations in the sub-regions. It is time that Africa invests in its rural areas, where the majority of its population lives, rather than in the urban centres which will remain poor copies of developed countries.

Rural electrification should be one of the major preoccupations of political leaders. On the one hand, it is a way of achieving development, while on the other hand, it is one of the ways of modernising the countryside.

Supply of energy

Part A: Fossil energy – H Stacey
Part B: Non-fossil energy – M T Davison

Introduction

This paper deals with the various energy sources available in the countries of Southern and East Africa, divided into fossil (Part A) and non-fossil (Part B) energy sources. It endeavours to identify the major problems which face the region in terms of energy supply and to identify the opportunities for development and co-operation in the area of fossil energy in the region. Significant reference is made to the study report on the region prepared under Dr Gata's chairmanship, with major inputs from Professor Dutkiewicz and his team, for the World Energy Council's Commission, *Energy for Tomorrow's World*. Information and views are also drawn from the various papers submitted for this Session of the Forum.

Part A - Fossil energy

*** H STACEY**

Resources

The fossil energy resources of the region have been reviewed under three headings, namely:

Coal
Crude oil and its derivative fuels
Gas

The attached map of the region shows the general location of the coal, oil and natural gas resources of the region.

The major proven coalfields are situated in the more southerly countries of South Africa, Botswana and Zimbabwe, although meaningful deposits have also been identified in Madagascar, Mozambique, Swaziland, Tanzania and Zambia.

Crude oil resources are confined to the coastal areas of Angola and Zaire, and to an inland field in the Sudan.

A natural gas field off the south coast of South Africa is being exploited for synthetic fuels, while other significant natural gas resources are generally located up the eastern side of the continent. The potential of the Kudu field is currently being explored off the coast of Namibia.

Coalbed methane is a potential new gas resource associated with coalfields and is, as yet, an unexploited resource. However, some initial studies are in progress in this regard in South Africa and Zimbabwe.

Table 1 sets out the estimates of proven recoverable fossil fuel resources of the region as quoted in the WEC Commission report.

	Coal	Oil	Gas
	Million Tons	Million Tons	Million m^3
Angola		156	9 000
Botswana	3 500		
Ethiopia	11		24 000
Madagascar	173		
Malawi	2		
Mozambique	240		65 000
Rwanda			40 000
South Africa	55 333		28 000
Somalia			6 000
Sudan		41	83 000
Swaziland	208		
Tanzania	200		163 000
Zaire	54	15	1 000
Zambia	69		
Zimbabwe	734		

Table 1: Estimates of proven recoverable fossil fuel resources

Other fossil-based energy supply sources

Apart from the non-fossil fuel resources which are discussed in Part B of this paper, the countries of the region are all importers of liquid fuels, either in the form of crude oil for refineries or as refined fuels for transportation, heating, lighting, etc. A number of countries have their own refining facilities, but many of these operations are old and inefficient. Minor tonnages of coal and coal derivates, such as metallurgical coke, are imported by countries in the region, primarily in the south.

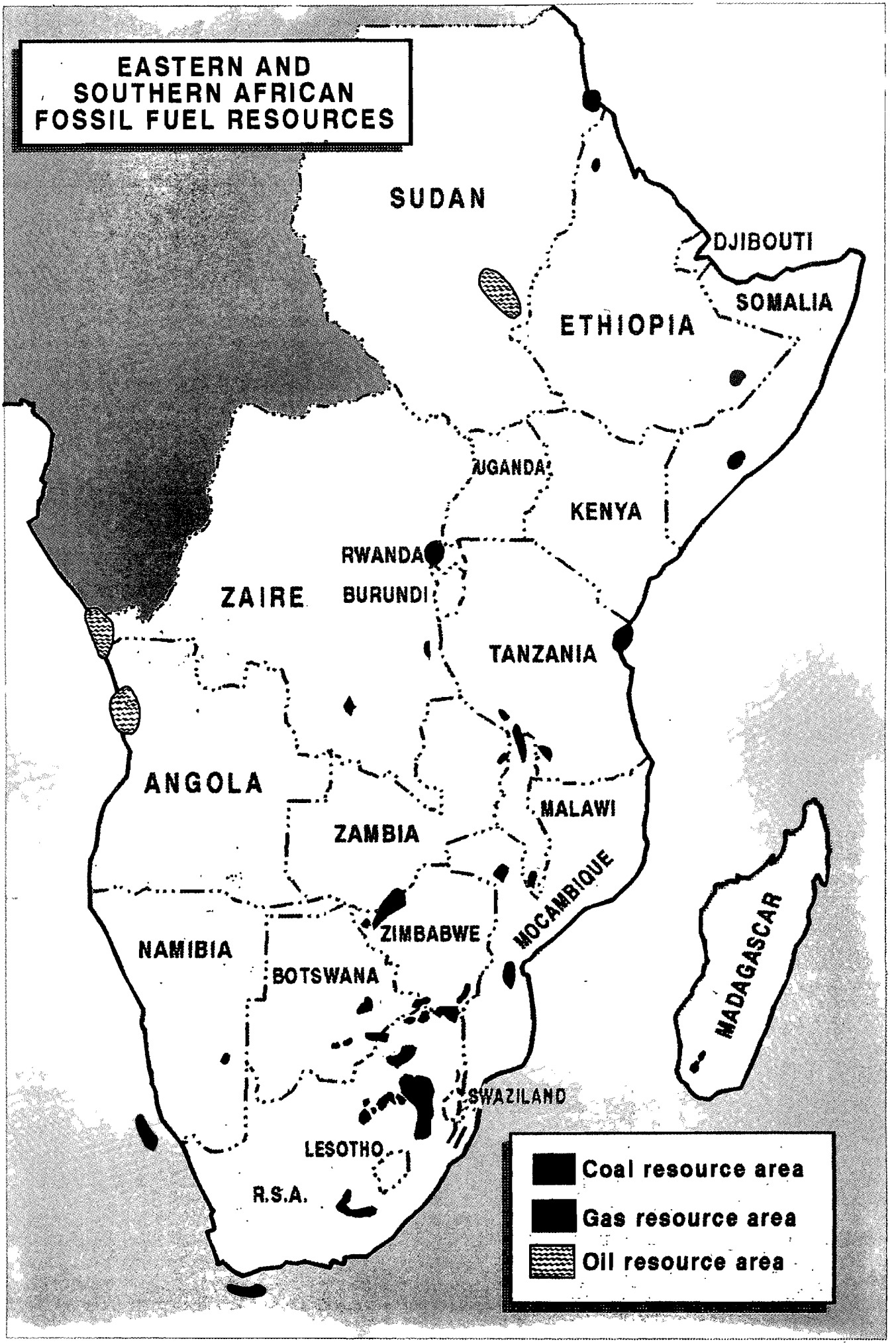
Major problems facing the region

The East and Southern African region is faced with daunting problems in meeting its potentially large energy requirements. To some degree this is being addressed on a regional level on the electricity front and this is dealt with in Part B of this paper. However, in terms of fossil fuels, the following points will need to be addressed urgently if the potential for regional co-operation and advantage is to be progressed in the foreseeable future:

(1) *Political instability*

Civil wars and tribal conflicts have plagued the region. Government instability has militated against the

* Anglo American Coal Corporation, P O Box 261587, Marshalltown 2107, South Africa



efficient functioning and maintenance of energy supply sources, and infrastructure has been allowed to deteriorate.

In his paper on the problems related to the supply of petroleum products to Zaire, Mpitu (1994) graphically describes how these problems have severly affected Zaire. There is a quotation from his paper at the end of this part of the paper.

(2) *Government intervention*

The intervention by governments of the region in the development and exploitation of energy resources has generally been negative and has led to inefficiencies and the imposition of non-economic policies. There are, however, some signs of changes in policy and thinking which could have a positive impact in the future.

(3) *Lack of finance*

Lack of finance is a major impediment to development, but is largely attributable to political instability. World lending institutions have become increasingly reticent about lending to countries where repayment becomes less likely. The ability to generate the funds necessary to promote the development of energy resources has also declined as political instability and government policies have taken their toll of their economies. The development and exploitation of fossil fuel resources requires major financial inputs and these will only be available to stable countries with strong economies.

(4) *Distance and transport infrastructure*

The very significant distances, aggra-vated by difficult terrain and substantially undeveloped or deteriorating transport infrastructure, present a major problem for the interchange of fossil energy resources in the region.

Opportunities

If these problems can adequately be addressed, in particular the creation of an environment in which funding agencies and investors have confidence, there are significant opportunities for co-operation in the development of the fossil energy resources of the region.

South Africa has significant skills in the mining of coal and its utilisation in electricity generation and resources of coal in the countries to the north of South Africa could be developed to fuel power plants. In addition, South Africa is a competitive supplier of coal on world markets and is well situated to supply coal into power plants sited along the coast of the region. Associated with the use of coal in the region, however, attention will have to be given to the environment, and in this regard the utilisation of discard material and the application of clean coal technologies are focused on by Grobbelaar *et al.* in their two papers.

Angolan crude oil production has the potential to supply an estimated 86% of the needs of the region and the use of this crude in the refineries of the region should be investigated. While many refineries are old and inefficient, there is potential for the Kenyan refinery to be modernised and to supply liquid fuels to the countries of East Africa. The South African refineries are modern and have the ability to supply additional quantities of liquid fuels to the countries of the region.

The role of regional organisations in facilitating the supply of oil and petroleum products to importing countries of the region is covered in Dondi-Bungu's (1994) paper and there is no doubt that such organisations will have to be active in developing the climate of regional co-operation that will be required in the future.

A matter which will inevitably have an impact on the countries of the region is the decision of South Africa to move progressively towards the use of unleaded petrol during the 1990s. Burger and Vermeulen (1994) deal with this issue in their paper and, while for South Africa it has been a decision based on economic and technological considerations, it will have implications for countries importing liquid fuels from South Africa.

The natural gas resources of the region have only been subjected to limited exploitation to date. However, the use of natural gas in power generation is growing fast and it provides enhanced efficiency and is more environmentally friendly than coal. In this regard, the resources of the Kudu field off the Namibian coast and the Pande reserve in Mozambique provide opportunities for co-operation in the southern part of the region. The large gas resources of Tanzania could be exploited to serve major projects in East Africa.

Woodman's (1994) comprehensive paper on sub-sea hydrocarbon production technology provides an insight into economical alternatives in this regard for the offshore oil and natural gas resources of the region.

Marcel (1994), in his paper, draws attention to the significant contribution that liquefied petroleum gas (LPG) can make in satisfying domestic energy requirements, while at the same time making a material contribution to reducing the rate of deforestation on the continent.

Conclusion

The following, in conclusion, is an extract from Mpitu's (1994) paper which contains a message for the countries of the region which, if heeded and acted upon, could well lead to the prospect of long-term improvements:

"The picture I have drawn (of the oil industry in Zaire) is very dark, but it shows the situation which prevails in most countries of our continent. Everything has to be done all over again.

The only way out for Africa ... is to promote the integration of African states by adopting common development policies.

In the present state of confusion, we are thus launching an appeal to our politicians to put an end to the fratricidal wars which are tearing our entire continent apart. Our countries will never be able to develop if there is no peace, if there is no increase in the purchasing power of the people who are faced with a lack of productivity, a ruined economy, unemployment and sickness.

In a world environment which is characterised by the development of high technology in Europe, in North America, and now also in Asia, the leaders of Africa should allow the sons of their continent - together with investors from other continents - to shake Africa out of its present state of lethargy".

The opportunities are there, but it is up to us to do what we can to ensure that the region creates the environment in which those opportunities can be developed.

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In addition, significant reference has been made to the WEC Commission's "Energy for Tomorrow's World" and its Sub-Saharan Africa Regional Report.

Part B: Non-fossil energy

* M T DAVISON

Background

In this part of the paper, the papers submitted for Session 3 on Supply of Energy that deal with non-fossil energy forms are summarised and linked through the areas of common focus in a context of regional energy policy and experience. A view on the future of these energy forms is also provided through reference to the papers and also to published information extracted from the WEC book, *Energy for tomorrow's world.*

The papers referenced for the session are listed at the end of this summary, but are also referred to in the text using the standard format (name, year).

The supply forms covered in this summary are solar, wind, bio-energy, hydro energy, uranium, and electricity.

In a later part of the programme there is a complete session dealing with Energy for Development which strongly focuses on renewable energy forms, and other sessions which also cover aspects of electricity. For the sake of completeness these energy carriers are dealt with from the specific perspective of energy supply, and the context of regional energy policy.

The topic of integrated project and performance management of installed transmission and generation equipment is also covered with reference to several of the papers. An interesting perspective is offered in reviewing the insights offered by Thailand's approach to energy supply and experience as a leading industrialised country.

In conclusion, some issues of general concern are highlighted.

Summary of energy supply information for Sub-Saharan Africa

It is convenient to refere to the information summarised in the WEC publication, *Energy for tomorrow's world*, for an overview of the energy supply situation for Sub-Saharan Africa. This region has some 9% of world population, and 2.5% of world economic activity measured by volume. An estimated 2.7% of world commercial primary energy is consumed, as well as a large amount of wood fuel and other biomass energy forms.

As is covered in Part A, fossil fuel reserves comprise 2% of world proven oil, 3% of proven gas, and 6% of proven coal. In addition, there is massive hydro power potential, extensive uranium deposits, and a consistently high level of solar radiation.

The per capita consumption of commercial energy is of the lowest in the world at 16 GJ p.a., and the population growth is one of the fastest at over 3% p.a.

The issues facing the region, in common with the countries of East and Southern Africa, which are the focus of this Forum, are ensuring adequate, reliable, environmentally acceptable and economically sustainable supplies of energy.

	1970	1990	2020*
Population (m)	279	370	1 195
GDP $ per capita	1 116	1 041	1 882
Primary energy MTOE	142	266	690
Primary energy p.cap.	0.51	0.53	0.58
Electricity TWh	74	225	700
Electricity MWh p.cap.	0.27	0.45	0.58

Table 1: Statistics for energy in the Sub-Saharan African region (WEC 1994)

		1990	2020*
Fossil Fuels	- Coal	26	20
	- Oil	14	24
	- Gas	2	4
Nuclear energy		<0.5	1
Renewables	- Hydro.	3	5
	- Traditional	53	43
	- "New"	2	3
Total		100	100

* WEC Scenario Case B - "Reference Case"

Table 2: Shares of fuel mix for Sub-Saharan Africa (%)

For the different WEC scenarios, substantially different primary energy requirements, with consequently differing supply needs, are postulated for the year 2020. Expressed in MTOE of primary energy, for the Sub-Saharan region, these are:

		MTOE
Case A	High Growth esp. in Developing Countries	1 279
Case Bl	Modified Reference (less energy efficiency)	1 053
Case B	Reference	690
Case C	Ecologically Driven (more renewables)	608

* Growth and Development Group, Eskom, P O Box 1091, Johannesburg 2000, South Africa

Geothermal potential	>9 000	MW
Petroleum	59	Bbbl
Natural Gas	285	Tcf
Coal	63	Btons
Hydro-electricity potential	110 000	MW
Biomass potential	Abundant	
Solar potential	Substantial at	>lkW/m^2
Wind potential	some countries	

Table 3: Potential primary energy supply in Sub-Saharan Africa (Karekezi S,1994)

In addition to the sources listed in Table 3, the region has substantial uranium deposits (WEC,1993). These are in Zaire, Namibia and South Africa, and the proven resources are approximately 640 000 tons.

Installed electricity generation capacity is approximately 45 000 MW. However, due to an imbalance of supply and demand, some countries have an over-capacity of generating plant.

Table 4 shows the estimated imbalances from the paper by Corrigal (1994). The opportunity for regional co-operation is being developed and holds great promise for the future.

Zaire	+	1 305	MW
Zambia	+	295	MW
Zimbabwe	-	101	MW
Botswana	-	85	MW
Namibia	+	41	MW
Mozambique	+	1 975	MW
South Africa	+	8 625	MW

Table 4: Electricity capacity balance in Sub-Equatorial Africa in 1993

Energy policy influence on energy supply

The introduction of incentive energy policies and instituional measures that enhance energy efficiency, conservation and environmental protection along with sustained fuelwood supplies through planned and developed rural afforestation programmes, and taking advantage of opportunities for regional co-operation are some of the energy policy-related initiatives that have been highlighted (WEC, 1994).

Amongst the general policy issues which directly and indirectly impact on energy supply policy which should be addressed are those of correcting adverse macro-economic issues, the attraction of private investment in technology and energy supply, and reinforcing restructuring efforts in terms of international trade (WEC, 1994).

These same points are made in several of the papers received for this session (Karekezi, 1994; Luhanga, 1994; and Salisdisdouk, 1994). An important perspective offered is that of an operative domestic energy economy in Zaire, focusing on traditional fuels, i.e. biomass, in pre-colonial times. This was not changed during the colonial period, and remains the same today. Such an energy economy is vitally important to a population dependent to a large extent on firewood and charcoal, and to a lesser extent on paraffin (Sembe, 1994). In Tanzania the introduction of electricity supply was targeted at sectors other than domestic use. Currently less than 4% of the population has access to electricity, and 85% of the population lives in some 8 000 villages. There are 200 000 ha of fuelwood sources in village woodlots, and 10.8 million ha of controlled forest usage, but little reforestation (Luhanga, 1994).

The limitations around effective dissemination of viable renewable energy technologies (RETs), with the emphasis on biomass and solar energy, are seen primarily as the lack of flexible funding mechanisms and innovative dissemination strategies (Karekezi, 1994). These are also aspects of energy policy approaches which need to be addressed where they are particularly applicable.

Penetration of basic, energy efficient devices, such as improved wood-burning stoves and the use of waste biomass in conversion to higher efficiency energy forms, have not received the attention warranted by their economic and environmental benefits.

The experience of Thailand (Salisdisouk, 1994), in which a vigorously pursued energy policy was seen as a priority for development, has led to major investment including private investment in electricity generation, transmission and distribution along with important demand side management interventions to improve effectiveness of investments. The paper proposes that properly integrated policies for energy, industrial modernisation, financial investment, social development and the environment are required for all developing countries. They have been the foundation for the success achieved in Thailand with its rapid economic growth.

Fuel diversification and increasing private investment in the electric power sector have also been an important part of the Thailand national energy and economic policy. The introduction of the policy to enable small power producers (SPPs) to be formed to generate electricity from renewable energy, waste or residual fuels and cogeneration has the potential to change the energy industry in interesting ways. They may produce up to 60 MW, and more under certain circumstances. The first successful example of an SPP is a sugar mill with capacity of 4.8 MW.

Independent power production has also been legislated and invitations will be issued in the 1994/95 period for participants. This is seen as an essential means of reducing the financial burden of the State, and also as a means of improving efficiency and competitiveness in the electricity industry. The evaluation of and public support for nuclear power generation in Thailand is also receiving attention in the overall context of the environment and fuel diversification.

In this same context of diversified energy resources in Africa, and making use of available energy resources over the long term, the use of uranium and access to uranium as an energy form through associated mining for gold and copper is discussed in the paper by Venter *et al.* (1994). The risks associated with mining economics for uranium in South Africa, in particular, are directly influenced by world prices of gold and copper imply that reserves of uranium could become inaccessible. The potential for small-scale mining is suggested as a means of accessing small fragmented deposits through labour-intensive mining methods. There is a progressive change in viewpoint about the nature of nuclear power, due to environmental concerns about fossil fuels, which may fundamentally change the approach toward energy for the 21st century.

Energy supply technology

Developments in the efficiency of conversion of primary to secondary energy forms have progressively

improved the economics of the fossil and the non-fossil energy carriers. In addition, the technology benefits from the energy industry have contributed to economic and industrial development through commercialisation processes (Venter *et al.*, 1994; Salisdisouk, 1994; Karekezi, 1994; Sembe, 1994).

Technology integration is, however, a problem in some countries where systems are not always extended or developed in an integrated manner (Sembe, 1994). The associated problems of training, maintenance, and compatibility of, for example, electrical networks, then lead to inefficiencies and wasted investment in plant to enable interconnection of unmatched systems, or even replacement of unmaintainable plant.

Moreover, since relatively little equipment is made in Africa, and that which is manufactured is done under license, the potential for developing an African energy (in particular, electrical equipment) manufacturing industry is constrained. Proposals are being made to encourage the development of a truly African design, manufacturing and trading industry. This would be done through inter-country co-operation and the inclusion of training for design and manufacturing in contract for imported equipment, i.e. not only installation and maintenance training, setting up of African standards, laboratories and test centres. Promotion of such equipment and exports to countries with similar needs would then be encouraged.

In TANESCO, Tanzania, capacity for in-house research and development, and the design and construction of mini-hydro plant is being progressed (Luhanga, 1994). TANESCO envisages becoming more self-sufficient in distribution, transmission and small power generation by the end of the century.

Managing performance of energy supply equipment

It is recognised that the management of installed plant is essential in ensuring efficient and effective performance. Two approaches in particular are covered. The use of internationally standardised performance statistics like those developed by UNIPEDE is described (Corrigal, 1994). The opportunity to benchmark performance of similar plant around the world is made possible through the use of compatible indicators of performance.

Associated with the management of the committed performance of managers and operating staff is the use of statistically derived performance indicators (Mikali, 1994). The achievement of multiple and interconnected performance measures can be treated in this manner. The relative merit of different power stations' operating results can be derived using a mix of statistically assessed parameters. These methodologies are useful for all forms of energy conversion plant and processes.

Conclusions

The common thread running through these papers on the supply of energy has not been one of physically constrained supply.

Indeed from Table 3 it is suggested that Africa is not supply constrained in energy resources. However, the physical location of the supply sources does not always coincide with the places where they are needed.

At issue is the economics of releasing these resources, and the underlying strategies to extend their availability, in the case of non-renewables and also to exploit the renewables economically.

Part A of the paper highlighted some of the key limitations in accessing, exploiting and transferring energy resources, such as

* Political instability (including war)
* Government intervention
* Lack of finance
* Distance and transport infrastructure.

Regional co-operation, innovative funding and institutional topics will be discussed later.

The conclusions to be derived from this session on energy supply, are that:

Africa can create

- integrated energy policy,
- breakthroughs in macro-economic thinking that empower its people to be entrepreneurial in energy-related industries,
- a climate that invites private investment in energy conversion and transport systems in a responsible manner.

Technological capacity of Africa can be enhanced

- with international investors of competence and goodwill,
- to enable effective design, product development and maintenance to suit the needs of the region.

The debate about Mobilising Energy for Growth from the perspective of supply has value and meaning if the sources and the potential users are at peace with themselves and their neighbours.

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Energy for development in Southern Africa

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This paper presents a brief overview of the development profile of Southern Africa, and the role of energy in meeting the region's development needs. It also puts forward some options for moving towards sustainable development.

Relating to the development profile, the high population growth rate, the low economic growth, widespread poverty, high illiteracy and infant mortality rates, and the prevalence of malnutrition are highlighted. Environmental issues such as deforestation, atmospheric pollution and water depletion pose serious problems for the region. The uneven development of the energy sector is mentioned and the high energy intensities described. The mixes and usage patterns of commercial and traditional fuels within an urban and rural context are also shown.

The role of energy in support of development is stressed. The provision of adequate and affordable energy is central to the overall development prospects of Southern Africa.

A number of options for moving towards sustainable development in Southern Africa are put forward. These options encompass, among others, biomass, biogas, low-smoke fuels, illuminating paraffin, bio-climatic building design, solar water heating, rural electrification, remote area power supply (RAPS) systems and energy efficiency.

It is concluded that regional co-operation in Southern Africa could pave the way for addressing the region's development needs in a way that is sustainable in the long term.

Introduction

For the purpose of this paper, Southern Africa is defined as the countries south of the Equator. According to the World Bank (1994), all these countries are classified as developing economies (ranging from low-income, lower-middle-income to upper-middle-income) with a wide range of development needs. Many of these needs can be met by the provision of affordable, adequate and secure energy.

The aim of this paper is to present a brief overview of the development profile of Southern Africa, the role of energy in meeting the development needs of the region, and finally to offer some options for moving towards sustainable development for the region.

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Southern Africa development profile

Demographics

The region is characterised by population growth rates which are high by world standards. For example, the average annual percentage population growth in Southern Africa for the period 1950-1990 was 2,67%, compared with a world average growth figure of 1,88% per annum for the same period (Spies 1993). According to du Toit (1994), the implications of sustained high population growth for this region are overwhelming in terms of direct energy services, as well as other socio-economic needs, such as housing, health services, education and other infrastructure services.

The high population growth rate (and low life expectancy) has also resulted in a young population in the region. On average, some 65% of the population of countries in the region are under 25-years old (Gielink, 1991) and the age group 15 to 64 years is increasing rapidly. The latter group requires the greatest number of energy services, constitutes the labour force and exhibits the highest mobility.

The level of urbanisation in the region is low (10%-30%) with a few notable exceptions, such as South Africa (60%), Zaire (40%) and Zambia (50%). Due to population pressures on land, the associated degradation of soil and other natural resources and the poor economic prospects in rural areas, many rural residents are migrating to an urban environment where they perceive development prospects to be better. These migratory trends have resulted in the proliferation of peri-urban informal settlements (with related socio-economic problems) and are creating extraordinary demands for housing, services provision, energy and jobs which are far beyond the capacity of most cities in the region (Gielink, 1991). This is further complicated by a system of circular migration between rural and urban areas, adding to the volatile nature of newly formed urban settlements.

Economic development

The economy of Southern Africa is generally dualistic in nature, with formal and informal sectors. The formal sector includes activities such as mining, industry, commerce and agriculture, while the informal sector is characterised by subsistence activity. The lack of employment opportunities in the formal sector has resulted in a fast-growing informal sector.

Economic growth in the region is low by international standards and the average GDP per capita (expressed in real US dollars) for the region as a whole has been declining since the mid-1970s. Poverty (judged by GDP per capita) is widespread throughout the region and it should be noted that women represent the majority of the poor and their numbers are growing both in absolute terms and in relation to poor men.

Widespread poverty, high illiteracy rates and a lack of access to economic opportunities and resources also contribute to the high population growth rates in the region. Infant mortality is still unacceptably high (67 per 1 000 live births) in relation to 12 per 1 000 live births in the

more developed regions (du Toit, 1994). The prevalence of malnutrition is also widespread in the region.

Countries in Southern Africa typically rely on the export of a limited number of commodities whose prices tend to decline when there is a decrease in demand from the developed countries. Consequently, worsening terms of trade, external debts and high inflation, amongst others, have resulted in a serious imbalance of payments for the region.

Environmental aspects

According to Gielink (1991), environment-related priorities in the region differ greatly from those in developed countries, for three main reasons:

(1) "Governments are generally more concerned with economic growth than with environmental protection.

(2) The levels of greenhouse gas emissions are relatively low by international standards (with the exception of isolated areas in South Africa)

(3) The level of affluence is so low in the region that most people are concerned with primary subsistence issues."

Deforestation, atmospheric pollution, the loss of arable land and water depletion are all serious problems and result in poverty, hunger, health problems and general economic decline. This, in turn, places additional pressure on the remaining resources in the Southern African region as a whole.

Energy profile

The uneven development of the energy sector within the region is highlighted in the relevant energy consumption figures. Globally, the African continent uses only 3% of the total energy consumption of the whole world, although it has 13% of the total world population. Sub-Saharan Africa's per capita consumption of commercial primary energy (271 kg of oil equivalent in 1989) is the lowest in the world and grew yearly by less than 1% during the 1980s. The annual per capita consumption of modern energy in Sub-Saharan Africa is less than half the average for all developing countries taken together (Datta, 1993).

Most countries in the region also display high energy intensities which can be ascribed, amongst others, to the heavy reliance on traditional energy (lower end-user efficiency), lack of efficiency strategies and inadequate pricing strategies, and a general dependence on primary production.

Rural people and, to a lesser extent, urban people, use a wide spectrum of fuels for their domestic energy requirements (Nziramasanga (1994); van Horen and Eberhard (1994); Hibajene (1994); du Toit (1994); Olivier *et al* (1994); and Wentzel and Golding (1994)). Throughout Africa and in developing countries in Latin America and Asia, a large section of the population still uses traditional fuelwood as a main energy source, a "free good" traditionally harvested from the natural woodland. Growing scarcities in the availability of this resource, exacerbated by the widespread incidence of intense poverty, result in the use of lower order fuels such as dung and crop wastes.

On the other hand, a large and growing sector, both rural and urban, is switching to higher order commercial fuels, notably coal, illuminating paraffin (IP, or kerosene), liquefied petroleum gas (LPG), candles and charcoal. In some areas even firewood has become a commercial commodity. There is also a growing desire for electricity, the ultimate modern fuel and an essential fuel for certain important services such as lighting, telecommunications (television/radio), and to some extent for refrigeration.

The commercial energy mix within the region varies considerably and is to a large extent dependent on the availability of indigenous resources. A common trend is the reliance of most of the countries on imported oil. This exerts strong pressure on the economy and uses up scarce foreign exchange earnings. Sectoral consumption of commercial energy displays similar trends throughout the region. The transport and industrial sectors are responsible for the greatest demand for commercial energy, while the domestic sector's demand is met mainly by traditional fuels. Overall, the domestic sector is the single largest consumer of energy in the region and traditional fuels, on average, account for 90% of energy consumed by this sector, excluding South Africa (Gielink, 1991).

Electricity is becoming increasingly important as an energy carrier in the region as a whole. The low economic growth in the region has resulted in inadequate resources with restricted opportunities for new investment in energy generation. It has also meant limited human capital, indicating the inability for administering the institutional structures necessary for the efficient energy management in the region. The lack of sound institutional structures in the energy sector has also precluded the implementation of integrated planning in individual countries in support of sustainable development.

> "Taking into account the geographical distribution of energy resources in the Southern African region, the capital intensity of projects, the need for inter-regional trade and the opportunity afforded by energy as a tradable commodity, the countries of the region need to co-ordinate their investments in energy generation on a region-wide scale. The first steps have already been taken in the establishment of a Southern African Power Pool (SAPP) for electricity and the rationalisation of crude oil refining."

The role of energy in development

Because energy affects all aspects of production and all facets of resource use, energy for development is central to the overall development prospects of the subcontinent. Economic growth is dependent on the adequate and cost-effective availability and utilisation of energy. There is a strong correlation between the standard of living as measured by per capita gross national product and per capita energy consumption. However, the importance of energy for development is much more than its direct contribution to the national product. It not only serves as a basic input to all production sectors, but also as a

catalyst to development and growth. It is also an integral component of the final consumption of goods and services.

The provision of cost-effective and adequate energy could encourage increased economic activity and enhance the quality of life of all the people in the region. Some of the benefits of an adequate and cost-effective energy supply are direct and evident. However, many other benefits, such as improved health, greater social cohesion, improved literacy and general education, time saving, and reduced rural-urban migration, are diffuse, indirect, and difficult to quantify. While these benefits may not always be quantifiable using conventional cost-benefit analyses, they are significant.

Access to adequate and affordable energy is necessary for economic development to be effected, though not a sufficient condition in itself. According to the Ms Nawakwi, Minister of Energy in Zambia: "Energy is to an economy what blood is to a human body" (quoted by Hibajene (1994). Economic development requires much more, and govemments should guard against the perception that the mere supply, or even over-supply, of energy would provide the push for development to take place.

Options for moving towards sustainable development in Southern Africa

The region is well endowed with energy sources, particularly for electricity generation, but less so for oil. This applies to conventional fossil fuels (coal and natural gas), as well as to renewable sources (hydro-power, solar energy and, to a lessor extent, wind). Exploitation of coal, for instance, even at double the current rates, will still leave sufficient reserves for at least another century, while the untapped hydro-power potential in the region is more than twice the currently installed generative capacity in Africa as a whole.

The other major requirement is access to oil-based fuels for transportation, the other lifeline of a developing economy.

Exploitation of resources is, however, a capital-intensive undertaking which places a heavy burden on the already fragile economies of the region to provide the necessary infrastructure (including energy, transportation, education and training, telecommunication, health services, etc.). No economy can develop without these. Governments need to strike a delicate balance in the allocation of capital for infrastructure investments in order to ensure sustainability and growth. Taking into account the geographical distribution of energy resources in the Southern African region, the capital intensity of projects, the need for inter-regional trade and the opportunity afforded by energy as a tradable commodity, the countries of the region need to co-ordinate their investments in energy generation on a region-wide scale. The first steps have already been taken in the establishment of a Southern African Power Pool (SAPP) for electricity and the rationalisation of crude oil refining.

Several authors (Engelbrecht 1994; Roucole *et al.,* 1994; Horvei and Dahl, 1994; Nziramasanga, 1994; Fall *et al.*, 1994; and Hibajene, 1994) stress the need for sustainability, demanding that energy utilities be managed on sound commercial principles. There is emphasis on criteria such as the economic and financial viability of energy projects, the adoption of cost-reflective though equitable pricing structures, and the promotion of utilisation efficiency. This is in terms of generation, transmission and distribution technologies, on the one hand, and end-use applications, on the other.

Electricity is of particular importance. It is easy to generate, and it can be transmitted over long distances and distributed geographically to consumers at low cost. It is highly versatile, easily controlled and readily convertible into the required final form. In short, development without electricity does not seem to be possible in today's world. It is therefore axiomatic that energy supply strategies for the future will centre largely on the broadening access to electricity.

Horvei and Dahl (1994) distinguish three main categories of electrification projects:

* Those that are both economically and financially viable and could therefore be self-financing.
* Those that are economically but not financially viable, and would require some form of subsidisation to render them also financially viable, preferably through capital subsidies and mild inter-consumer tariff subsidies. Experience indicates that extensive consumption subsidies are generally unsustainable and tend to promote waste.
* Those that are neither economically nor financially viable and these should be rejected.

However, the last category invariably includes the already marginalised rural communities, a subject of major concern in all developing countries. This is where specific attention is clearly desirable from a socio-economic point of view. It is agreed that the effective use and supply of appropriate forms of energy is a necessary condition for development and the reducing of poverty.

Ways to accelerate extension of the grid is currently being debated in the South African context (Engelbrecht, 1994 and by Roucole *et al.,* 1994). It is, however, becoming clear that, within the economic, financial, institutional and social constraints, millions of people in Southern Africa will still not be connected to the electricity grid over the next two decades. Nziramasanga (1994); Horvei and Dahl (1994); du Toit (1994) and Hihajene (1994); Kouame *et al.,* (1994) discuss in some detail the need for, the impediments on and the potential of electrification and more specifically rural electrification (RE).

Access to affordable, secure and appropriate sources of energy is necessary for sustainable human development, though not sufficient in itself to ensure development. Energy needs have to be prioritised alongside such other basic needs as food, water, housing, sanitation, health and education against the background of household income and affordability. There is a general dearth in the availability of all services in rural areas. Developmental activities in these areas have at best been low-key and executed on an *ad hoc* basis.

The natural fuel switching process, the widespread incidence of poverty, the growing demand for accelerated socio-economic development, and the negative environmental impact of current fuel use patterns (urban as well as rural) necessitates a holistic and well-focused approach to energy provision. This encompasses the entire spectrum of energy sources, and is integrated into a well-planned development programme. Full electrification is seen as the ultimate long-term goal.

This co-ordinated approach is known as integrated energy planning (IEP) and incorporates an end-use focus on the fulfilment of energy services working through the system towards supply. Only such an integrated approach will permit the cost-effective flow of benefits to all sections of the community.

The following are options within an IEP approach for the region:

* **Biomass.** Fuelwood plays a central role and its increasing scarcity places a heavy burden on rural women in

terms of time spent and distances walked in its collection. Environmental damage is the result of deforestation (due to over-exploitation in the form of bush clearing for settlement, agricultural needs, grazing requirements, building materials, etc.) and is often compounded by high population densities. This further suggests that the fuelwood crisis in these areas should be addressed as a matter of urgency.

The elements of biomass provision involved are social forestry (homestead gardening, including tree planting), agroforestry systems, community woodlots, savannah management, the utilisation of industrial forestry wastes and control of invader bush in the commercial farming environment. While such a Biomass Initiative has an energy focus, its main driving force is rural development through small-scale farming. It requires appropriate extension services and funding aimed at the empowerment of rural communities and households towards self-sustenance (Madams (1994)).

* **Biogas.** This is a mixture of methane and carbon dioxide, obtained through the anaerobic digestion of organic material, which offers a domestic and even automotive fuel in rural and urban areas (Mingay and Murphy (1994)).

* **Low-smoke fuels in urban areas (including smokeless stoves and flue-gas cleaning devices).** Severe air pollution is encountered in the PWV region of South Africa, especially in winter, notwithstanding that many of the townships have been electrified. Experience has shown that the use of hydrocarbons (coal, IP and LPG), prevails long after electrification. These fuels are mostly used for high thermal energy requirements such as space- and water-heating and cooking. The result is air pollution that is reaching alarming levels. Three low-smoke coal-based fuels are being evaluated, while the Atomic Energy Corporation recently announced the development of a low-cost electrostatic flue gas cleaning device. Furthermore, low-smoke coal-burning stoves have already been developed some years ago. Implementation of these potential solutions, in conjunction with the electrification of townships, is regarded as extremely urgent.

* **Pricing and accessibility of illuminating paraffin (IP) and liquefied petroleum gas (LPG).** IP is the most ubiquitous fuel used by the developing sector. More than 90% of the product produced by refineries in South Africa is found in the domestic sector. Even though its price is being regulated at the wholesale level and at a maximum retail mark-up prescribed by the Petroleum Act, there is much confusion over what the real price to the consumer should be. Retail prices vary widely from store to store and from area to area, often well above the maximum prescribed. The nature of the IP distribution system, mainly via the informal sector, renders enforcement of regulations difficult, if not impossible. An additional problem is poisoning. Due to ingestion by toddlers, IP is becoming a significant contributor to infant mortality, especially in informal townships. The general utility of this fuel demands that attention be given to these adverse issues.

> "The natural fuel switching process, the widespread incidence of poverty, the growing demand for accelerated socio-economic development, and the negative environmental impact of current fuel use patterns (urban as well as rural) necessitates a holistic and well-focused approach to energy provision. This encompasses the entire spectrum of energy sources, and is integrated into a well-planned development programme. Full electrification is seen as the ultimate long-term goal."

LPG has a penetration of less than 10% in the developing sector in South Africa. It is relatively expensive, completely deregulated, and requires expensive appliances. There is, however, considerable scope for the increased and effective utilisation of this largely neglected but clean fuel.

* **Climate-sensitive (or bio-climatic) dwelling design.** The design, orien-tation and construction of a building impact directly on the energy consumed within its structure for space-heating and cooling, as well as for lighting. This, in turn, impacts on the levels of indoor and outdoor air pollution where hydrocarbon fuels are used, and on the domestic contribution to the peak load demand on the national electricity grid, in the case of electrified dwellings. In each instance, the higher energy requirements increase the expenditure of the home owner. Especially in low-income households, the increased expenditure on energy leaves less disposable income for other life necessities and may contribute to an inability to pay for services. The improved indoor comfort levels also have a positive influence on households' general quality of life.

* **Solar Water Heating (SWH).** With SWH the water is heated by utilising the radiant heat of the sun and this has wide application potential in the region, where there is already a fledgling industry of this kind. Unit costs are, however, high due to the absence of economies of scale. In countries like Israel, the use of domestic SWH systems are enforced by law, while in Australia financial incentives are provided by the Government to promote its use. However, the region can no longer afford not to utilise this natural resource, especially in the area of low-cost housing, clinics and schools, where affordability and the maximisation of disposable income for life necessities is of paramount importance in the combat of poverty.

* **Rural electrification and Remote Area Power Supply (RAPS) Systems.** Grid electricity is generally accepted as the norm for energy provision. However, rural electrification is significantly more capital-intensive than in the urban areas. Consequently, in rural areas, most schools and health clinics are without

electricity, while the domestic use is almost non-existent. Even with an accelerated drive, the electrification of rural areas will be a long-term undertaking. This is further exacerbated by the low uptake of electricity in electrified rural dwellings (about 2 kilowatt hours/day), resulting in the need for heavy cross-subsidisation with little likelihood of breaking even between cost and income, even in the long term.

Certain important energy services require electricity. These include lighting, media access (television, radio), some food preservation (refrigeration) and water pumping.

For remote schools and clinics and many rural households (approximately 5 km or more from the grid), photovoltaics (PV) offer the facility of immediate access to sufficient electricity for essential needs. The envisaged satellite broadcasting of TV from 1995 onward by the SABC will enable the entire rural population to access the electronic media, with potential for distant education.

Southern Africa possesses some of the highest solar energy resources in the world (about 5 kWh per square metre per day). For small supply needs, PV today is cost-effective and requires little maintenance, and there is a a fledgling supply industry. For PV to be instrumental in the enhancement of rural development, it requires the necessary institutional and financial backing. Examples are the ASEAN FINESSE programme in South East Asia and the Zimbabwean SELF/GEF/ UNDP programme. A SADC FINESSE project is also being planned (Hibajene, 1994).

In many areas, there is also significant wind energy potential, especially when employed in conjunction with PV and, where necessary, backed by diesel or petrol-driven generator sets in hybrid configurations. These systems are collectively referred to as Remote Area Power Supplies or RAPS.

An accelerated rural electrification programme, duly supplemented by RAPS to maximise the coverage within the constraints of available capital will constitute a powerful mobilising force for the empowerment of rural communities.

* **Energy efficiency** provides the opportunity of avoiding energy-intensive and environmentally unsound industries. The region is well placed to ensure that future investment in energy- related projects in support of all the economic sectors embodies energy-conservation practices as a central theme, and includes the most appro-priate efficiency technologies. Efficiency is one of the corner-stones of a future energy strategy for the region to ensure sustainable development to its fullest extent.

Conclusion

Focusing on regional co-operation could enable the regional interchange of energy and the utilisation of indigenous energy sources to address the region's development needs in a way that is sustainable in the long term.

There is considerable potential for a sustainable energy economy for Southern Africa and the options contained in this paper could act as some guidelines for ensuring that the ultimate goal of sustainable development for all the peoples of the region is achieved.

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KEYNOTE PAPER

Energy and the environment

* J W HUISMANS

It is timely and appropriate that this important energy forum be held in South Africa for, in the context of human energy, South Africa has been at the forefront of political, economic, social and environmental change in the past nine months.

If energy is the release of force to put ideas into action, the ascent of democracy in South Africa through the election of Nelson Mandela is undoubtedly a positive energy chain vibrating through Africa and the rest of the world.

I am delighed and honoured to address this important gathering on behalf of our Executive Director, Elizabeth Dowdeswell, as the organiser, the World Energy Council (WEC) is widely recognized as one of the most authoritative bodies on energy matters. It is also an extremely reliable source of global data and related information pertaining to energy resources.

Sources of energy and their use

Fossil fuels are the most important source of global commercial energy consumption with oil providing 38%, coal 30% and natural gas 20%. However, fossil fuels are finite, although it has been estimated that there are sufficient coal supplies for at least 200 years. Nuclear and hydro power make important contributions to electricity generation but presently only comprise 5% and 7% respectively, of global commercial energy production. Supplies of uranium will last almost indefinitely, while hydro power is a renewable source of energy.

The most prevalent source of energy is biomass, extensively used by half the world's population in the form of wood, crop residues or animal dung. It has been estimated that, in the developing world, biomass fuels account for, on average, 35% of primary energy. In some countries, in rural areas, this proportion rises to as much as 90%.

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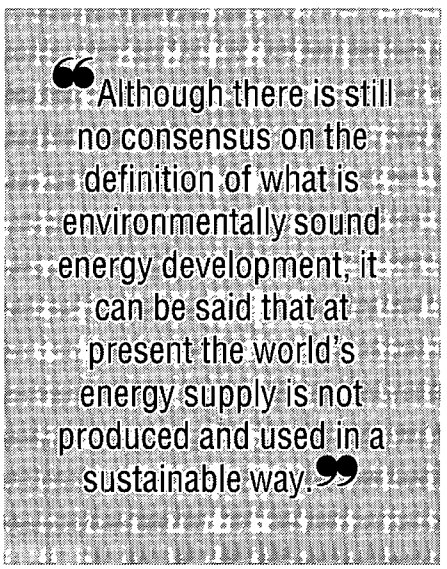
Renewable sources of energy, other than hydro power, such as solar, wind and geothermal sources, currently provide only a small fraction of global energy use.

There is a huge disparity in per capita commercial consumption between industrialised and developing countries: in 1985 OECD countries consumed on average nearly 10 times more energy per capita than developing countries at the same time achieving a 15 times greater per capita gross domestic product.



Despite significant increases in commercial energy consumption in many developing countries over the past decade, biomass fuels undoubtedly will remain the major source of energy for nearly one half of the world's population. According to the World Health Organisation, 90% of the 87 million annual increase in global population occurs in developing countries. As a result, the use of biomass fuels can only be expected to increase dramatically over the coming decades.

Energy-related environmental impacts

All energy systems, including production, conversion and use, have adverse as well as beneficial impacts on the environment. They vary in quality, quantity, in time and in space. Environmentally sound energy management tries to minimise the adverse impacts in an equitable manner between different target groups in the most cost-effective ways. The comparison of the risks posed by different energy systems to human health, the natural environment, and the economy as a whole is extremely difficult. Although there is still no consensus on the definition of what is environmentally sound energy development, it can be said that at present the world's energy supply is not produced and used in a sustainable way.

The most pressing problem in the developing countries relates to the unsustainable and inefficient use of biomass resources. As many as two billion people, particularly women and children, may be exposed to the indoor air pollution resulting from the use of an open fire for cooking and heating, with inadequate ventilation. The most important effects are respiratory, ranging from predisposition to acute infections in children to chronic obstructive pulmonary disease in adults. Over half a billion people in developing countries, again mostly women, may be at serious risk of developing such a disease. In addition, the use of agricultural and animal residues for fuel may compromise the food-producing capabilities of rural communities, and result in malnutrition. The indiscriminate cutting of trees and forests for wood fuels contributes to deforestation and eventually to desertification, siltation of water reservoirs, flooding, and an even greater scarcity of wood fuels. The wood fuel crisis, in particular in Sub-Saharan Africa, is alarming and needs urgent action. Much is already being done but, because of the complexity of the issue, further compounded by periods of drought and a series of other problems of local and international origin, formulation of a policy is difficult, especially because every situation is unique. A

number of options, however, are available. Firstly, the more the urban-industrial demand and supply can be resolved through the substitution or improved supply of biomass, the less the rural areas will be under commercial pressure for tree removal, and thus the less the scarcity will become. Secondly, all general improvements in rural development, and particularly in the state of women, help. There is evidence that people, who have some excess income will buy an improved stove, because it is clean, it looks better and, as a side benefit, it is more fuel-efficient. There is also scope for increasing the availability of wood fuels, without reduction in food production, by introducing appropriate species of vegetation. What is required is increased and continuing emphasis on integrated biomass management based on traditional practices.

There are almost no direct effects on health from the generation of electricity from hydro power. Indirect effects arise following the large-scale uprooting of communities necessitated by dam construction; impaired replenishment of downstream aquifers; and nutrient deprivation of downstream water, as opposed to the benefits from irrigation. In tropical developing countries, impoundment of stagnant water may, in the absence of control measures, result in an increase in vector-borne diseases. In addition, Africa has an additional concern related to hydro power, which can have important environmental implications: the question of climate and levels of precipitation. Recent studies have shown that it is still difficult to predict future levels of precipitation and river-flow rates. There is considerable potential for exploiting hydro power in some energy-short, developing countries, in particular in smaller scale developments, and several African governments are contemplating such developments. However, these problems and uncertainties, particularly as they relate to precipitation, merit serious study before such projects are embarked on.

In the industrialised countries, the major energy-environment problems arise out of the continued use of fossil fuels. However, there is also a significant upward trend in the use of fossil fuel in many developing countries, even though there are pronounced differences amongst, for example, African countries and oil-exporting developing countries. The greatest environmental health hazard from the combustion of fossil fuels is air pollution. Urban air pollution is a worldwide environmental health problem. The contributions of industrial fossil fuel combustion, including power plants, the domestic use of coal, and vehicle emissions, vary in different cities and at different times of the year. World Health Organisation-recommended air quality guidelines are exceeded in a large number of cities, particularly in developing countries. Increased mortality, especially among those with heart and lung disease, decreased lung function and other respiratory effects, and long-term impairment of neuro-physiological development in children, are amongst the several well-documented effects. In addition to potential, direct and local effects on health, air pollution can give rise to transboundary acid deposition, with obvious effects on ecosystems, buildings and other types of structure. Finally, there is the potential of climatic changes, resulting from increased levels of greenhouse gases, nearly half of which is carbon dioxide, produced by the combustion of fossil fuels. The accumulated greenhouse gases trap solar radiation near the ground, warming the globe and consequently changing the climate. Although there is still considerable uncertainty about the results of such a warming, particularly with regard to sea-level rise, the shift of climatic zones and the effects of warmer oceans on marine ecosystems, possible major climatic change is one of the most significant global environmental problems facing humankind today.

> "The most pressing problem in the developing countries relates to the unsustainable and inefficient use of biomass resources."

Renewable energy sources other than hydro power are solar, wind, and geothermal sources. Although currently not in wide use and only of local significance, these are not known to have serious environmental impact. As some African countries are embarking on geothermal energy projects, it should be recognised that there is some evidence that, depending on the type of resource exploited as well as the technology used, geothermal systems can be polluting. Solar energy is, in theory, unlimited, but to use it for major electricity generation, large areas of collector fields are necessary. Solar energy is still expensive because the systems or parts of them need to be imported, but it offers a great potential for small-scale electricity generation in the rural areas of developing countries in the tropics.

With regard to nuclear energy, despite the fact that during the normal operation of nuclear power plants very little radioactive contamination occurs, there is still considerable public anxiety about risks to health, for present and future generations. Until better safety systems have been developed and the problem of the safe disposal of high-level radioactive waste has been solved, the use of nuclear power is unlikely to be extended significantly beyond those countries that already use it. Moreover, most developing countries lack the considerable financial and technical resources required to introduce nuclear power systems.

UNEP's energy policy and programme

The following is a brief outline of the history of UNEP from the Stockholm Conference in 1972 where it all started, to the UN Conference on Environment and Development in Rio de Janeiro, 1992, with particular emphasis on our energy policy and programme as it has developed over the years.

In the climate of the Stockholm gathering, the south was geared for economic development - not environmentally sound projects. Environmental protection and management at that time was however the major preoccupation of the industrialised countries who were discovering the widespread damage to their own as well as the world's environment, resulting from economic development in their countries. In addition, there was the statement at that time of Houari Boumedienne, President of Algeria, which was typical: "If improving the environment means less bread for the Algerians, I am against it."

This was the arena in which UNEP was born. It also had to sell itself to the UN system and its specialised agencies, many of which were unsympathetic to the idea of a new environmental body and thought with extra resources that they could well

handle environmental matters. A small secretariat was established in Nairobi, the first headquarters of a UN body in the developing world. UNEP's birth was both challenging and fraught with difficulties. However, the framework for change was initiated at Stockholm.

Based on a growing knowledge of energy issues as they relate to the environment, the early strategy of UNEP's energy programme in the 1970s was built on a policy to better understand these issues, bearing in mind the production and use of energy. Thus, fundamental information was gathered on the various sources of energy and their impacts on the biosphere, the atmosphere, and human health. Such information was assessed with the assistance of world-wide experts and made available to governments and others as part of UNEP's mandate to report regularly on the state of the environment in relation to human activities.

During the 1980s, there was increasing evidence was that it would be expedient to put greater emphasis on the link between the use of biomass energy sources and depletion of vegetation and soil resources. This problem had surfaced in the global agenda on energy because of the growing appreciation by the global community of the link between desertification and biomass production and use of energy. This led to a considerable shift in focus of UNEP's energy programme, now concentrating on problems of energy production and use in developing countries.

In a more or less parallel process, although there were certainly interlinkages, the problem of possible climate change, resulting from the large-scale combustion, mainly in the North, of fossil fuels became more and more prominent. In 1985, UNEP, WMO, and the International Council of Scientific Unions (ICSU) convened a climate conference in Austria. This laid the foundation for an in-depth exchange of scientific findings. Negotiations for a convention began in early 1991 and led to the formulation of the United Nations Framework Convention on Climate Change which was concluded and signed at the Rio Conference in 1992. In accordance with the Convention, atmospheric emissions of greenhouse and other gases should be controlled. Measures to reduce these emissions will increasingly need to be based on efficiency in energy production, transmission, distribution, and consumption, and on growing reliance on environmentally sound energy systems, in particular new and renewable sources of energy.

The issue of unsustainability of energy use was also raised at UNCED, and, in recognition of the current state of affairs and because of the seriousness and the urgency of the matter, Agenda 21 has identified three issues as priorities for action:

* Co-operation in identifying and developing economically viable and environmentally sound energy sources;
* Promotion of the development of methodologies for making integrated energy and environment and economic policy decisions;
* Promotion of research, development, transfer and use of improved and energy-efficient technologies.

Agenda 21, in its Chapter 38, also identified a number of priority areas for UNEP, and called for its strengthening both at headquarters and in the regions. Apart from UNEP's extensive experience in the "traditional" areas of monitoring and assessment of the state of the world's environment, it is now also moving more actively into other priority areas, such as integration of environmental considerations in the economic and social fields, and more specifically, integration of environmental considerations with national energy policies to achieve sustainable energy development. However, UNEP fully realises that many of the environmental impacts of energy production, conversion and use continue to be externalised both in space and time. Consequently energy systems which can externalise their impacts more easily are favoured, while others remain "too expensive". The lack of full integration of environmental considerations into energy policy and planning is therefore the overriding problem to be resolved.

UNEP is in broad agreement with the conclusions of the WEC Commission on Energy for Tomorrow's World and is, with WEC, convinced that a path must be found to sustainable energy development. The Commission's report, in its Executive Summary, mentions a number of important measures which must be undertaken in this respect.

UNEP is presently reviewing its energy policy in the light of the above developments and findings. It is expected that within the next six months a re-oriented policy will be established for UNEP as part of its renewed and strengthened commitment to provide an effective, proactive and responsive service to governments and the world at large in dealing with the crucial environmental problems that our planet is facing today. UNEP looks forward to working with governments and other partners such as WEC, and to forming strategic alliances in order to concentrate on those aspects of energy development that are most appropriate, given UNEP's overall mandate as the environmental conscience of the United Nations.

Energy and the environment in Southern and East Africa

* S J LENNON and * * J DU TOIT

This paper summarises and interprets the contributions submitted to the Energy and the Environment Session of the WEC Regional Energy Forum for Southern and East African Countries. The role of energy in economic and social development is strongly recognised as is the need to develop energy in an environmentally balanced manner.

In assessing the submissions, local, regional and global environmental issues are discussed. In a local context, the highest priority is given to meeting immediate energy and health needs. Details of environmental management systems and environmental reporting complement local needs. In the region, local issues tend, on the whole, to be given priority over regional and global issues.

Regionally, issues such as deforestation, transmission line routing, mining and regional air and rain pollution are to the fore. Several options for a sustainable regional energy strategy are presented, and the need for regional co-operation is particularly emphasised.

In a global sense, the need for a pragmatic approach is stressed in that global issues should not be addressed at the expense of crucial national and regional development. There are options for future energy strategies which will enable the region to develop while, at the same time, meeting international obligations.

A framework is proposed for optimising the regional energy/environment interface based upon:

* Regional Co-operation
* Integrated Energy Planning
* Integrated Environmental Management
* Research and Development
* Technology Transfer and Adaptation.

In suggesting a road ahead, it is proposed that a mechanism be established whereby nations in the region may network at scientific, industrial and political levels, in order to obtain synergistically common positions.

Introduction

Energy has always played an important role in the economic and social development of nations. In this regard, it has also been responsible for significant environmental impacts, in particular, in the highly developed economies of the OECD nations. In these nations, current environmental concerns revolve around local impacts on waters, soils and resources, regional air and rain impacts and global climate change impacts. In all cases these impacts are due historically to rapid economic growth and high energy consumption rates. This is reflected in the per capita emissions of carbon dioxide of 19,5 tons per annum in the United States and 8,2 in Europe (World Resources Institute, 1994).

The picture in developing nations is, however, different. The norm is energy starvation, with per capita emissions of 2,1 tons per annum in Asia, 2,0 in South America and 1,03 in Africa (World Resources Institute, 1994). This paper focuses on the energy/environment interface in Southern and East Africa. In this regard the submissions to the World Energy Council's Regional Energy Forum are synthesised in a review-type document. Other sources relevant to the environment are referenced as necessary.

It is apparent that a common theme running through the papers is a recognition of the need for an increase in energy use to facilitate national and regional development and the concomitant potential for increasingly negative environmental impacts of such energy use. The means of addressing negative impacts is presented in various ways in a local (community and national), regional and global sense. In this regard, the submissions will be presented in a local, regional and global manner, followed by a consolidated discussion and a framework for the road ahead. It should be stressed that the opinions reflected here are the interpretation of the rapporteurs.

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Local energy/ environment issues (community and national)

There are numerous energy-related issues in the region which directly impact on the well-being of their immediate communities. It is interesting to note the common local problems being faced in the region.

Bauleni (1994) highlights the extremely important role played by biomass combustion in the region. Land degradation due to non-sustainable practices is becoming a significant problem in Malawi. However, it is clear that this problem is not unique to Malawi, but is also being experienced throughout the region. Bauleni outlines the role that must be played by:

* Government in clearly defining energy policy;
* Developed nations in facilitating and undertaking technology transfer;
* Community in adapting to sustainable energy practices.

Dutkiewicz (1994) takes a critical look at the environmental options facing South Africa's energy sector. The use of coal for power generation and current air pollution/acid rain levels due to coal combustion is discussed. It is emphasised that whereas current pollution levels do not give rise to concern, long-term planning should consider alternatives such as imported power, clean coal technologies and improved efficiencies. The growing problem of photochemical smog is also

mentioned. Potential solutions relate to unleaded petrol and the increased use of electric vehicles.

Whilst global warming emissions are not considered to be a priority, Dutkiewicz maintains that the need to conserve coal resources will act towards ameliorating CO_2 emissions.

This paper stresses that the largest energy-related pollution problem in South Africa is due to the domestic combustion of coal. This is a socio-economic problem which can only be solved by increasing the economic well-being of people to enable them to afford electricity in place of coal.

Terblanche (1994) emphasises the potentially severe local impacts of energy usage patterns. She highlights important health issues, stating that approximately 60% of the South African population lives in homes using coal and/or wood. The health of these communities is seriously affected by air pollution caused by the use of these energy carriers. There is need for urgent intervention to supply affordable household services which could be met by a mixture of electricity and other lower-risk fuels, such as gas and low-smoke coal.

The latter fuel source is strongly supported by Tait (1994) who argues for the necessity of providing low-smoke coal to supply the energy needs of developing communities. It is, however, stressed that implementation and financial support are required to persuade communities to accept these fuels.

It is interesting to note that the Environment and End-Use Working Group of South Africa's National Electrification Forum also strongly supports the concept of a well-balanced energy mix in various communities. The use of integrated energy planning on a local and national basis is recommended (Basson, 1994).

Fedorsky and Statham (1994) underline how a power utility may manage its environmental responsibilities in the context of a developing nation. The paper details Eskom's environmental management system and emphasises how this can be integrated with the requirements of South Africa's Reconstruction and Development Programme (RDP). The necessity to balance developmental needs and environmental considerations without compromise is stressed, together with the need to consult locally and internationally in making management decisions.

At a greater level of detail, Doppegieter (1994) reviews the environmental reporting practices of organisations involved in the South African energy economy. Disappointment at the level and quality of reporting is expressed and the need for improved performance is stressed. The author feels that environmental reporting is becoming increasingly important as national and international environmental regulation and legislation are toughened.

It should be noted that the papers submitted do not reflect the full spectrum of local energy/environment issues and that little mention is given to factors such as:

* Liquid fuels - In particular for transport and the impact of leaded petrol and domestic use of paraffin;
* Gaseous fuels - In particular, household usage of LPG;
* Alternative energies - In particular, solar water heating.

However, the papers strongly reflect local developmental needs, and it is felt that the emphasis on meeting immediate local energy requirements whilst solving local health issues is a common national priority in the region. Additional work that clearly reflects this position and proposes pragmatic solutions has been widely undertaken in the region. In particular, the studies effected by AFREPREN deserve mention.

Regional energy/environment issues

Energy and environmental challenges facing the SADC region are well presented by Matize and Dale (1994). Their paper details the objectives of the SADC Energy Sector Programme which focus on optimising existing energy sources and on creating a solid foundation for energy developments.

After a summary of current energy strategies and an evaluation of the region's energy industry, the paper highlights the major energy-related environmental issues in Southern Africa. These are detailed as:

* Deforestation caused by domestic fuelwood needs;
* Transmission line routing and construction;
* Open cast mining of coals;
* Valley flooding causing loss of biodiversity and wilderness areas;
* Atmospheric pollution, caused by coal burning and domestic and bush fires;
* Global warming.

The paper argues the case for:

* Clean energy production technologies or retrofits for coal-fired stations;
* Energy conservation and efficiency;
* Biomass fuel development;
* Rural electrification;
* Promotion of renewable energy sources;
* Southern African energy co-operation.

This paper is complemented by Berkovski (1994) who summarises the World Solar Summit Process. In particular, the application of renewable energy sources (especially solar) in the region is strongly promoted. This holistic approach to renewable energy covers:

* The role to be played by renewable energy sources;
* Training, research and technology transfer;
* Demonstration projects;
* Funding mechanisms;
* National and regional development issues.

The paper by Sakrini (1994) presents a history of energy development in Africa and highlights the wide disparity in energy intensities between the various nations of the continent. In assessing the impacts of energy utilisation, the following major problems are identified:

* Deforestation;
* Air and soil pollution.

Sakrini proposes detailed options for reducing the environmental impacts due to energy on the continent. In this regard, the following points need to be considered:

* Energy choices based upon available resources;
* Appropriate technologies for sustainable development;
* Pricing policies;
* Inter-African co-operation.

In particular, the lessons learnt in applying "free" redundant or obsolete technologies are mentioned, along with the need to modify selectively non-sustainable, traditional practices. A potential solution to the energy needs of the region, namely the exploration of Central African hydro resources, is detailed.

It is felt that all the papers give a broad appreciation of the energy challenges

facing the region. However, the regional influences of South Africa's energy impacts are not sufficiently addressed. Similarly, the balance between natural regional phenomena, such as trans-border air and rain pollution, are not adequately represented. In this regard, the work of Lennon *et al.* (1992) should be mentioned. This work, presented at the last WEC Forum in Harare, clearly details the power generation contribution to air and rain pollution in the region and addresses common misconceptions relating to the use of flue gas cleaning technologies.

Other work of interest in this field relates to the contributions made to regional air and rain pollution by biomass burning. In particular, the international Southern African Fire Atmosphere Research Initiative could contribute significantly to knowledge in this area (Held and de Beer, 1994).

Global energy/environment issues

As mentioned in the Introduction, in global energy terms, Africa's historical and current contribution is particularly small. As such, global environment issues should be relatively low on national energy agendas - especially in the allocation of scarce resources. This position is presented in Lennon's (1994) paper in which he outlines South Africa's contribution to the enhanced greenhouse effect. He argues that developing nations should adopt a pragmatic approach to this issue by entertaining initiatives which would be beneficial, whether or not significant impacts are realised. Examples which would be of national and global benefit, such as South Africa's electrification programme, are presented. An assessment of short-, medium- and long-term options open to the South African power industry is included.

One of those options is covered in detail by Stumpf and King (1994). After detailing a background to global warming, they discuss future energy mixes in the light of international pressures to curb CO_2 emissions. The role which nuclear power has played in the past, and its potential impact on future energy supply scenarios, is highlighted.

An energy mix for the year 2030 for South Africa is proposed which includes coal and gas 73%, nuclear 10%, hydro 12% and renewables 5%. A 15% growth savings via energy conservation is also proposed.

In essence, this paper argues for a national and international long-term generation mix strategy which balances the risks and benefits of all available forms of energy production to achieve the least vulnerable future position.

Lindsay (1994) outlines a total view of global climate change and the energy sector. In presenting the WEC report, *Energy for tomorrow's world,* a quantified framework with a time horizon of 2020 is shown. He maintains that CO_2 levels in the atmosphere cannot be stabilised at 1990 levels by the year 2020, due to international developmental and economic constraints. Lindsay then advocates increased resource allocation to research into global climate change, improved energy efficiency, controlling CO_2 emissions where this can be done most efficiently (and not specifically at the source of origin) and encouraging a shift to non-fossil fuels. In this regard, public awareness of the need for change is imperative.

It is considered that the papers submitted relating to global climate change largely address the issue. Papers which address issues unique to Africa were, however, not specifically submitted. This clearly reflects the need in Africa to address local and regional environmental issues and emphasises the relatively low priority attached to global issues. This is not say that nothing has been done to prepare African nations for the implementation of their commitments to the Framework Convention on Climate Chance (United Nations, 1992). In preparing to meet these commitments, the responsibilities of developed nations to reduce emissions and to supply finance and technology to developing nations must be emphasised. Africa cannot afford to sacrifice developmental prerogatives in order to address climate change issues. As such, the need for developed nations to meet the full incremental costs of implementing the Convention in developing nations is stressed.

In preparing to meet the commitments, several African nations have prepared detailed response strategies. The Zimbabwe Greenhouse Gas Abatement Studies (Maya *et al.*, 1992, Maya *et al.*, 1993) are particularly good examples of these. These extremely comprehensive studies clearly detail the options available to Zimbabwe and provide a menu of greenhouse gas abatement options for potential funding. In this way, the maximum leverage of funds may be achieved in optimising emission reductions without compromising essential development.

Discussion

As stated in the introduction to this paper, a common theme in the papers submitted is recognition of the need for increased energy use to facilitate national and regional development. It is further encouraging to note that this may be achieved whilst reducing local environmental impacts via improved socio-economic conditions.

It must be stressed that a critical balance needs to be achieved in realising national development and meeting environmental constraints. In this regard, environmental and developmental issues need to be prioritised in order to attract the relevant attention. The South African RDP is considered to be a good example of a structured and prioritised national development framework.

There are, however, numerous potential pitfalls facing the regional energy sector in meeting development needs without compromising long-term environmental considerations. As a means of optimising this process, the energy sector could consider operating within the following framework:

Regional Co-operation

Several of the papers refer directly to the necessity for regional co-operation via the creation of a regional transmission system and the optimisation of electricity supply options. Regional co-operation could well be extended to cover the broad range of energy supply and demand side options.

Integrated Energy Planning (IEP)

A holistic approach to the supply, transport and end-use of energy is considered essential, not only from an environmental viewpoint but also in order to ensure a least-cost approach. IEP can result in the use of balanced energy packages in a variety of environments ranging from the rural domestic household to heavy industry.

Integrated Environmental Management (IEM)

The application of an integrated approach to the environment throughout the life-cycle of an energy project can go a long way towards avoiding long-term environmental costs and reducing operational costs. The IEM process is described in

detail by South Africa's Department of Environment Affairs and Tourism Guidelines on the topic (DEA, 1994). The application of this process is described in the work of the National Electrification Forum (Basson, 1994).

Research and Development

It is essential that ongoing R&D into aspects unique to the African environment needs to be undertaken. This is particularly the case in the area of energy supply, end-use and environmental impacts.

Technology Transfer and Adoption

In parallel with local R&D, the access to technology developed elsewhere and its adaptation to suit local conditions is considered essential to optimise development. Due to the provisions of the Framework Convention on Climate Change, there is a unique opportunity for the region to accelerate development through technology application. Caution should, however, be exercised in avoiding "technology dumping" and in ensuring that a long-term holistic approach is adopted to technology transfer, adoption and application.

It should be noted that numerous other environmental issues, such as demand side management, energy conservation, tariff design, future technologies, fuel usage, etc. are not covered in this document. These are, however, well represented in other sessions in this forum and, as such, their critical role in optimising the energy environment interface is recognised.

The road ahead

In meeting the energy challenges facing the region, it is suggested that all nations would benefit from shared experiences and the synergism of varied histories. As such, it is proposed that a mechanism be established whereby nations in the region may network at a scientific, industrial and political level in the energy/environment field. In particular, common positions on international obligations, such as the Framework Convention on Climate Change, may be established through this mechanism. The implementation of co-operative projects could also be facilitated using this process.

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Financial and institutional structures

* R VEDAVALLI

Introduction

This is a time of unprecedented global change, political, economic and technological. Africa too is in the midst of change, political as well as economic. Here in South Africa the historical political change was witnessed, making development possible for all her people. In the 20 years of work on development, two fundamental lessons have been learned: firstly, that real development can only come from within; and, secondly, that humility and patience are prerequisites in the development business. No individual nor institution has all the answers on development. People need to listen to each other and to continue to learn and build on mutual experiences.

Context

It is now universally agreed that energy demand in developing countries, including Africa, will grow rapidly. The challenge is how to equate energy demand with consumption to ensure environmentally sustainable economic growth and development in Africa. It is in this context of persisting challenge that the role of financial and institutional structures is presented as the key for tackling the energy issues relevant to Southern Africa.

Why the need for financial and institutional structures?

The need for financial and institutional structures is driven mainly by the need to mobilise both domestic and external financial resources to equate energy demand with consumption. Primary energy consumption in 1993 in Africa was 221 million tons of oil equivalent of which South Africa's share was 41%. As already stated, despite the current low level of per capita energy consumption, even modest levels of economic growth, regardless of how efficiently energy is produced and used, will require per capita consumption levels that will be multiples of today's levels.

"The challenge is how to equate energy demand with consumption to ensure environmentally sustainable economic growth and development in Africa. It is in this context of persisting challenge that the role of financial and institutional structures is presented as the key for tackling the energy issues relevant to Southern Africa."

If African economies are to achieve the 4% to 5% GDP growth rates, commercial energy supplies need to increase sixfold by the year 2020, with a total investment in the range of $8-15 billion per year equivalent to 2% to 4% of GDP. Although this may represent less than 5% of GNP, the crucial issue is to put in place the appropriate institutional and financial structure to mobilise the required domestic and external financial resources. Cumulative World Bank lending for the whole of Africa, as of June 30 1993, totalled $4.2 billion; averaging about $173 million per year during 1984-1993. Assuming that this level will continue in future, adding all the co-financing and other bilateral/multilateral financing could increase the external financing to about $1.0 billion per year. This would still leave a wide gap in financing to meet the 4% to 5% targeted increase in energy demand. With international institutional financing looking increasingly constrained, mobilising alternative sources of financing, from both domestic and foreign private sources, is crucial if energy demand ultimately is to equate with consumption.

Mobilisation of domestic and foreign private financial resources to energy investment operations is a function of the soundness of macro-economic structure and performance of enterprises in the energy sector. Macro-economic reforms which promote stability and growth are the first steps. They should be underpinned by appropriate financial and institutional structures to tackle the sector performance issues and to mobilise domestic and external financial resources.

Sector performance

Africa, as a whole, is a net energy exporter and a number of African countries are striving towards furthering their energy sector performance by improving access to service and better organisation. However, there have also been shortcomings. The institutional capacity often did not keep pace with demands made on the sector. Also, in the 1980s, the institutional and financial performance deteriorated further due to inappropriate macro policies and enterprise-related factors.

At the macro-level, inappropriate policies on pricing, investments, institutional development and methods of government have led to inefficiencies and the high cost of energy. At the sector level, enterprise-related factors, including conflicting objectives and lack of management-accountability, have resulted in technical,

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operational and financial problems. The technical and operational problems include:

* marked inefficiencies in the procurement, refining and distribution of petroleum products,
* high petroleum refinery losses,
* inefficient fuel use,
* high transmission and distribution losses.

The combined effects of pricing distortions, poor sector performance and the problems of debt have affected the sector's ability to finance urgently needed maintenance and provide working capital for new investments. As a result, service has been poor for users and unreliable energy supplies have, consequently, had an adverse impact on economic growth. It appears that energy infrastructure is not sufficient to ensure adequate service, even to current users. To realise a sustainable least-cost expansion in supplies to provide for economic growth, Africa needs an energy strategy focusing on development effectiveness in order to improve the service to users. Such a strategy would also assist in dealing with some of the traditional problems, such as limited domestic markets, inadequate maintenance, low-cost recovery of electricity tariffs and reduction of high cost of petroleum products.

Energy development strategy

The elements of energy development strategy to equate demand with consumption should include:

(1) Developing long-term national strategies for the energy sector, based on implementing the least-cost mix of domestic, imported, and inter-country energy resources. Key elements of such strategies are the ranking of investments, with an improved balance between expenditure on maintenance and rehabilitation and investment in new capacity; efficient use of local resources and facilities; conservation of costly sources of energy (including petroleum and woodfuels), sound pricing policies and maintenance of existing installed capacity.

(2) Promoting strong inter-country co-operation for optimum exploitation and delivery of energy to create larger markets that permit economic investments and optimum utilisation of hydro-electricty, gas and other primary energy resources. These reduce administration barriers to joint procurement, processing and distribution of petroleum products, and eliminate barriers to inter-country trade. Jointly, they promote the exploration and development of geological basins underlying several countries by establishing favourable investment conditions.

(3) Creating an environment that will attract high levels of investment. The key element involves creating a contractual and regulatory framework that provides an investment environment while protecting the interests of the country.

> "If African economies are to achieve the 4% to 5% GDP growth rates, commercial energy supplies need to increase sixfold by the year 2020 . . ."

(4) Encouraging improved end-use efficiency and development of energy efficient technologies; promoting commercial pricing of electricity and petroleum products to ensure economic and financial viability of energy enterprises.

(5) Introducing concerted efforts to tackle the woodfuel crisis. The management of forest cover needs to be improved. In order to encourage conservation and inter-fuel substitution, wood fuels should be priced economically, as is being attempted in Malawi and Niger. The use of more energy efficient charcoal and wood stoves should be encouraged. Reliable, economically accessible and appropriately priced alternative energy supplies, such as kerosene and liquefied petroleum gas, need to be developed. Finally, institutional development should be upgraded through planning, management and training to enable the public sector to formulate, monitor, evaluate and adjust effective fuelwood strategies.

Where do we go from here?

Setting up the required financial and institutional structures is crucial for the successful implementation of energy development strategy. In the traditional approach pursued in the 1970s and 1980s, almost 90% of electric power financing and other energy infrastructure financing, other than oil upstream activities for exports in the developing countries, was provided by the government. In the process, utilities incurred huge debts that governments are obliged to pay. With budgetary constraints drastically reducing the availability of government financing, there will be no business-as-usual in the 1990s and beyond. Nor can external aid provide the assistance. The World Bank, for example, has been heavily involved in the power sector to an extent of approximately 15% of total lending over the years (or about $100 billion worth of investments in 1994 prices). This is only a small fraction of the total financing required in the future. Clearly, energy investments in future need to come from domestic and foreign private sources. Attracting such investments requires a move towards *"commercial approach"*, which requires financial viability and autonomy, with revenue linked to the satisfaction of users who determine the market. In the evolving approach, the government must redefine its role from that of provider to that of regulator. Government involvement in regulating energy operations is and will continue to be essential to facilitate channelling of domestic and external private capital to the energy sector.

In a number of areas, such as petroleum upstream and downstream activities, power generation, transmission and distribution, attracting private ownership is feasible and this brings equity, technical innovation and managerial skills. However, regardless of ownership arrangements, services must run commercially and efficiently. There is already a trend towards a more commercial approach to energy operations throughout the developing world including Africa. Zambia, meanwhile, is advancing towards privatisation and commercialisation and the power utility is determined to commercialise its operations. This typifies the service-focused commercially oriented

"revolution" that is gradually taking place. Many governments are opting for two-track strategies: by promoting private sector participation to meet pressing capacity requirements; at the same time devising regulatory arrangements to commercialise sector-wide operational improvements, to create incentives for better management, and to mobilise alternative financial resources. Consequently, private financing in developing countries has experienced a resurgence in recent years. In 1992 and 1993, private financing constituted over 60% of all capital flows to developing countries, compared with 43% in 1990.

Macro-fundamentals and micro-reform of institutional and financial structures work together to develop domestic capital markets and to encourage private investors. Sustainable macro-economic adjustment programmes in many developing countries, such as India and Egypt, have encouraged the repatriation of flight capital and increased the flow of foreign exchange. Investors view emerging markets as attractive investment opportunities for diversifying investor portfolios. It is, therefore, important to set up the required institutional and financial structures to facilitate transparency and openness of the regulatory structure, professional management, institutional independence and commercial pricing to ensure financial viability and credit worthiness of energy operations. Establishing a reasonable track record of commercialisation is crucial to mobilise financing resources both from local capital markets and foreign private investors.

Local capital market development overtime will be necessary to sustain private investment in energy infrastructure. Once a reasonable track record of financial viability is established, an approach to the local capital market can be considered through stock exchange listing. To some extent progress has already been made. For example, in Malaysia funding for two independent power projects was raised from the domestic market pension funds. The International Finance Corporation (IFC) Emerging Markets Database shows that the total capitalisation of stock markets in developing countries grew from US$599 billion in 1989 to US$1 399 billion in 1993. Africa's stock markets have been growing rapidly in recent years, attracting investors despite the political uncertainty in some nations. In 1994, the combined annual market capitalisation in Africa was about US$2.5 billion.

Financial structure to attract private investment in energy can be in many forms: privatisation (change of ownership; Build Own Operate (BOO) schemes and Independent Private Power (IPPS); operations and maintenance contracts, and the leasing of pieces of equipment or whole plants.

Energy projects with BOO and IPP schemes are usually undertaken by project financing, and are financed by sponsors, buyer's credits, and loans from export import (EXIM) and commercial banks.

Project finance refers to a range of financing structures whereby lenders fundamentally depend on the performance of the project itself, rather than on the credit of the sponsor. It is also sometimes referred to as non-recourse financing. These terms indicate that lenders have limited or no recourse to the sponsors for repayment of loans. Project finance normally involves one or more of the following elements:

* Lenders' reliance on the cash flow from the project for repayment without full recourse to the sponsor.
* Technical and financial evaluation of the project by lenders, including the source of revenue stream, construction contractors, operating arrangements and other project features that are esssential for maintaining an adequate cash flow for debt service.
* Complex loan and security documentation often involving several lenders and investors.
* Detailed process of risk allocation among project participants, including sponsors, lenders' equipment suppliers, contractors, operators, purchasers, input suppliers, and insurers, among others.

Project finance structures are attractive primarily because they allow sponsors to make investments that would not otherwise be possible on the strength of their own balance sheet. In this way, it allows them leverage to their resources and expertise in pursuing profitable investment opportunities. Another important reason is risk sharing which is achieved through project finance structures, where lenders share project risk with sponsors. If the project fails, lenders absorb any losses suffered along with the sponsors.

Attracting domestic and external financing leads to the commercial approach by setting up the required institutional and financial structures, recognising the three special characteristics of financing energy projects: long-term, large-scale and domestic currency revenues. This is where the World Bank can play a crucial role: through policy dialogues to improve the business environment; through strengthening financial intermediation, capital market development and public sector restructuring; and through new co-financing instruments such as the Expanded Co-financing Operations (ECO) to catalyse private financial flow into projects in developing countries. Examples of bank operations, such as the Argentina Capital Market Development Project and ECO operations in the Philippines, Pakistan and Jordan, are focusing on facilitating access to both domestic and overseas markets. In addition, the Joint-UNDP/Bank's Energy Sector Management Assistance Programme (ESMAP) is concentrating on providing technical assistance to countries enabling them to design institutional frameworks, including pricing mechanisms, regulatory arrangements and contracting out-of-key energy services.

Conclusion

The changes affecting energy investments entail a fundamental rethinking of the institutional and financial structures' arrangements. It is recognised that there is no uniform solution: each country must find the institutional and financial structures most suited to its situation and capacity. At the same time, experience of commercial approach world-wide, including Africa, is encouraging and has proved effective.

The greatest challenge in mobilising energy for growth is building financial and institutional structures. It extends beyond this decade into the 21st century. The message delivered by President Mandela on completion of his government's first 100 days is clear: "... at the end of the day, the yardstick we shall all be judged by is... are we through our endeavours, creating the basis to better the lives of all South Africans?" Only through working together and by mobilising all our energies will there be a convergence between Africa's energy demand and consumption to improve tomorrow's world.

Financial and institutional structures relating to energy

* J H de V BOTHA

Introduction

South Africa's joining the Southern African Development Community (SADC) at the end of August this year signifies a renewed commitment to workable regionalism.

Driven by mutually beneficial partnerships, this regionalism will build on Southern Africa's noticeable interconnections in areas such as transportation, energy and human resources for their effective regional utilisation. Closer regional policy co-ordination between members of the community is now on the SADC agenda. This will be accompanied by the institutional reform required to meet the region's needs adequately.

Energy is vital for development and the provision of adequate, affordable and reliable energy is central to the overall development prospects for Sub-Saharan Africa. For the energy sector to realise its full potential against a wide spectrum of development needs and opportunities, the establishment of a sound financial and institutional framework is of paramount importance.

Mamburg (1994) also highlights the importance of information on detailed studies in other countries of the sub-region, or the continent as a whole, with regard to the possibilities of financing specific types of projects. However, information on institutional matters should also be shared, and this approach would, furthermore, lead to savings in human and financial resources. Such a databank could combine the various national energy databanks, such as the one which is being set up by the National Energy Commission of Zaire. Such an initiative could possibly be facilitated by the World Energy Council.

The objective of this paper is therefore to highlight briefly those issues which are pertinent to the financial and institutional framework within the Sub-Saharan energy context.

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Energy financing

Development framework

The development environment prevailing in Sub-Saharan Africa at present and in the foreseeable future will have a fundamental impact on energy financing and investment decisions. The rate of population growth, urbanisation, growing energy needs, domestic investment, influx of capital levels of government expenditure, rate of economic growth, and many other aspects will impact directly on the availability of finance for energy projects in both the public and private sectors.

> "It should be recognised that energy is important but not sufficient to be a pre-condition for development. Energy provision alone does not promote growth or ensure that inputs, other than energy, required for enhancing economic activity, are mobilised on their own."

Stassen and Botha (1994) argue that it is imperative to locate the financing considerations of energy projects within a broader development context, and this requires an integrated approach to the planning and financing of energy projects in general. It is being accepted increasingly that only through a comprehensive, integrated approach, which is end-consumer focused and not supply-driven, can energy projects be effectively appraised in support of sound investment decisions. The meeting of basic needs, developing human resources and building the economy of countries are central to future energy planning and financing.

Internationally, the following policy imperatives, among others, are coming to the fore and these are directly related to future energy provision and financing considerations within a broader development context (Pickering 1994):

* "*equity:* as a social concept relating mainly to questions of access to energy services and the fulfilment of basic needs;
* *economic competitiveness:* which recognises the need for economic efficiency as a necessary condition for sustainable economic growth and competitiveness, particularly in the context of the global market; and
* *sustainability:* which is conceived in the dimensions of both environmental sustainability and the financial sustainability of policy options, particularly in terms of the financial viability of delivery institutions."

However, it should be recognised that, while this region has abundant energy resources, energy is not the most basic need nor the highest priority. It will have to compete with many other demands on the other natural resources of the region in meeting needs such as water provision and housing.

Energy projects in Sub-Saharan Africa need to be approached, *inter alia*, in the context of overall services provision, economic development impact within the region (Mamburg and Loku, 1994) and fiscal impact at the local sub-regional and national levels. Moreover, due to the limited financial resources in the overall Sub-Saharan financial system (particu-

larly in respect of the mobilisation of concessionary funding), future energy projects need to be considered in the context of opportunity cost.

One of the key elements of financial management policy for the region should be to ensure financial sustainability of the wide range of energy projects currently under consideration or to be implemented in future. Energy pricing policies should also endeavour to reflect the true cost (economic, social and environmental) incurred in the production, distribution and utilisation of energy. According to Arnail (1994), the setting of energy prices, especially when transmission and distribution networks are being monopolised, is an important economic lever for both energy consumers and the producers of alternative forms of energy.

It appears that the financing challenge facing the energy sector in Sub-Saharan Africa is huge. Schloss (1990) estimates that electric power investments in this region will require approximately US$11 billion in foreign resources to finance some 4 300 MW of additional capacity. Public borrowings on behalf of the energy sector account for more than 20% of the external debt across the region. It is also estimated that, in the most optimistic scenarios, external aid flows can finance only half of the required total investments for this region.

The mobilisation of capital markets (private savings) and direct private sector financing could be increasingly important sources of finance for the energy sector in Sub-Saharan Africa for the future (Potgieter, 1994; Huff, 1994). These options could facilitate the shifting of the debt from government to the private sector.

It is, therefore, important to locate the financing considerations of energy projects in a broader development context. This requires an integrated approach to the planning and financing of energy projects in general. It is increasingly being accepted that only through a comprehensive, integrated approach can energy projects be effectively appraised, with the emphasis on certain underlying assessment principles, *viz.:*

* Overall linkages with the economy. This includes assessing the economic, social, technological, environmental, institutional, political and resource linkages to energy projects under consideration. The analysis of the first level assures that a project will be consistent with other priorities and will support the many interrelated, though often conflicting, national/ regional/local objectives as effectively as possible;
* An end-use focus (not supply-driven). This level deals with the fulfilment of services working through the energy system towards supply and addresses issues such as diversification of supply, demand analysis, substitution and consumption by energy type, etc.;
* The management of a project dealing with issues, such as pricing, end-use, financial viability, and capacity building.

"Although energy is highly desirable to support development, it is not the most basic need nor the highest priority. It will, therefore, have to compete with many other demands in the socio-economic realm, such as housing, education, water provision and health services."

It should be recognised that energy is important but not sufficient to be a pre-condition for development. Energy provision alone does not promote growth or ensure that inputs, other than energy, required for enhancing economic activity, are mobilised on their own. From a development viewpoint, it is important that energy should not be considered an end in itself but as a means to reach development goals and priorities. Less effort should thus be placed on accelerating the implementation of energy projects *per se* and more on ensuring that it effectively supports and promotes development in its broadest sense. Although energy is highly desirable to support development, it is not the most basic need nor the highest priority. It will, therefore, have to compete with many other demands in the socio-economic realm, such as housing, education, water provision and health services.

Institutional framework

A sound institutional framework is an absolute pre-requisite for the successful planning and implementation of energy projects within Sub-Saharan Africa. In this regard Schloss (1990) argues that:

"The real challenge for Africa lies not so much in building more power plants, more transmissions lines, or pipelines, but in building the institutional capacity and creating the type of environment that will get the job done".

Failure to implement energy policies, programmes and projects is widely recognised to be a problem, if not the major institutional problem in developing countries. As pointed out by Munasinghe (1985): "A properly functional institutional framework is a vital precondition for the success of any planning process. The greatest challenge to implementing integrated national energy plans comes from the institutional, rather than the methodological side".

According to Mbewe (1994), the institutional framework required in Sub-Saharan Africa is country-specific and therefore a universally acceptable and efficient framework that would meet all the individual requirements of the countries within the region is unattainable.

A sound institutional framework within which capable institutions can provide energy reliably and cost-effectively denotes the following (Mbewe, 1994; Stassen and Botha, 1994 and Arnail, 1994):

(1) For governments it means, *inter alia:*
   - The formulation of energy policy and the preparation of short- and longer-term energy plans/programmes and supervising the activities of the entire energy sector;
   - Ensuring availability of energy at affordable prices for economic and social development;
   - Monitoring, regulating, directing and co-ordinating the system;
   - Directing, co-ordinating and promoting research on the exploration, exploitation and utilisation of all forms of energy;
   - Reviewing energy legislation continuously and updating it with developments in the energy sector.

(2) For energy delivery institutions it means, *inter alia:*

- Clearly defined responsibilities;
- A sound legal basis;
- Autonomous control of finances and human resources (no political interference in operational activities);
- Financial viability, capable of contributing substantially to new investment;
- The existence of levels of skills required for the development, construction, operation and management of energy projects.

(3) For communities it means, *inter alia*

- That energy delivery institutions have a formal, legitimate and credible status;
- That the key importance of people participation in decision-making is recognised and adhered to throughout all stages of the project cycle;
- An inclusive process representing all user groups (women, poor households, etc.);
- A clear articulation of their identified needs, ability and willingness to pay and social preferences;
- Scope for the training and utilisation of local human resources in energy projects.

(4) Finally, regional cohesion can only be achieved by widening the scope of energy policies (Arnail, 1994). The motivation for expanding transmission and distribution networks, the pooling of resources for security of supply and the interconnection of networks are possible avenues requiring investments the cost-effectiveness of which will only become apparent in the long term. States have a role to play in identifying networks of regional importance and in motivating utilities of the sector to invest in such projects.

It should be highlighted that, in creating a sound institutional framework, the public sector, civil society and the private sector each have a supporting and complementary role to play.

Conclusion

A number of dimensions have been identified from a development point of view (*viz.* economic, institutional and financial) which are pertinent to an energy development programme in Sub-Saharan Africa. It is equally important that attention should be paid to policy, technical and environmental issues. Establishing an integrated approach in addressing each of these dimensions will enable future energy projects to support sustainable development effectively.

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Regional co-operation in energy: The driving force for sustained growth and development

* B MUTHARIKA

Common Market for Eastern and Southern Africa (COMESA)

This is a general overview of regional integration in Eastern and Southern Africa within which co-operation in the development, utilisation and trade in energy is being envisaged. It should be stressed that energy is the motivation for sustained economic growth and development.

I am aware that regional economic integration exists in several parts of Eastern and Southern Africa. However, my knowledge is restricted to the PTA/COMESA and for that reason, this analysis is based on that Organisation. However, COMESA is ready to co-operate with these organisations in the field of energy.

COMESA has learned in Eastern and Southern Africa that economic growth and development essentially take place when the following three critical factors are blended in such a way that they complement and reinforce one another. These are:

(1) The ability of a country to attract and sustain large flows of investments, which can be achieved only if the field is large enough to appeal to foreign investors, as well as local and cross-border investors as a viable economic space;

(2) The ability of the private sector to increase productivity in industry, manufacturing and energy, using the economies of scale and the "competitive edge". These economies of large-scale operation can reduce production costs, increase efficiency and thereby increase the profitability of the business venture;

(3) The ability to access or penetrate a wide and diversified market which is provided by countries agreeing to remove tariffs, non-tariff barriers and other economic impediments that restrict the smooth flow of goods and services across national frontiers.

These three elements need to be assured if growth is to take place. It is in recognition of this that the Preferential Trade Area for Eastern and Southern African States (PTA) was established by a treaty in December 1981. The PTA was a deliberate and conscious effort of free and independent states in Eastern and Southern Africa to create a viable market for investment, production and trade. The PTA set as its main objective:

"To promote co-operation and development in all fields of economic activity particularly in the fields of trade, customs, industry, transport, communications, agriculture, natural resources and monetary and financial matters, with the aim of raising the standard of living of its peoples, of fostering closer relations among its Member States and to contribute to the progress and development of the African Continent".

It is important, at the outset, to underscore that the PTA co-operation framework was a step-by-step approach to integration. From the beginning, the realisation of the full integration of Eastern and Southern African countries was to be done in stages, starting with the preferential trading arrangement, followed by the Common Market and finally the Economic Community. Each programme of activity was designed to consolidate integration while providing the foundation for the next stage. Article 29 of the PTA Treaty provided that ten years after the definitive entry into force, the member states should consider measures to transform the PTA into a Common Market for Eastern and Southern Africa. It was on that basis that COMESA was established.

Criticism has sometimes been levelled against the PTA to the extent that it has not achieved much by way of promoting trade and regional integration. A brief digression may disprove this. In order to enhance investment, production and trade, several institutions were created. These institutions also served to strengthen the capacity of individual member states to implement agreed regional integration programmes by improving the production capacity, standardisation, quality control and joint exploitation of resources.

In the area of trade expansion, the PTA promotion and facilitation programmes have resulted in considerable trade among the member states. For instance, intra-PTA trade has been growing at an annual rate of 10.1% (compared with 7.2% for trade with the rest of the world). In 1982, total intra-PTA trade stood at less than US$1.0 billion. In 1993, this rose to more than US$1.8 billion and it is expected to be around US$2.0 billion in 1994. In order to provide a competitive edge for commodities produced and traded in the sub-region, member states are implementing a timetable for the gradual reduction of customs duties and other charges of equivalent effect. Some PTA/COMESA countries have now reduced tariffs, in some cases by as much as 60%, and are determined to achieve a zero tariff by the year 2000. Similarly, member states have agreed to abolish all non-tariff barriers.

Another success story has been the PTA/COMESA trade fairs. To date, four general trade fairs were organised in 1986, 1988, 1990 and 1992 respectively. The fifth PTA general trade fair was held together with the Maputo International Fair from 26-31 August 1994. The first four fairs generated a combined import-export business of US$530 million. The two specialised fairs on leather and leather products and on textiles were organised by the PTA and generated business worth US$29 million. Other

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areas of trade promotion of interest are the buyer/seller contact promotion meetings which have also been organised with great success during the past four years. These meetings generated additional trade of about US$90 million.

Later this statement will clearly indicate that regional integration in Eastern and Southern Africa is not a dream but a reality. For the moment, however, it should be mentioned that the PTA has indeed a proven track record of achievements. It is on this basis that member states decided to move towards regional co-operation and integration. The PTA has now been transformed into the Common Market for Eastern and Southern Africa (COMESA). The treaty establishing COMESA was signed in Kampala, Uganda in November 1993 by 16 member states of the PTA. COMESA aims to attain sustainable growth of the member states by promoting a more balanced development of its production and marketing structures. It also aims to promote joint development in all fields of economic activity and the joint adoption of macro-economic policies and programmes to raise the standard of living of its peoples, and to foster closer relations among its member states.

COMESA has been designed to assist the member states to overcome the following development constraints:

* Structural weaknesses in industry and manufacturing, the slow rate of accumulating capital, insufficient availability of goods and services produced locally, and the under-development nature of agriculture, especially food security;
* The inability to diversify the economies from primary commodity dependence;
* Inadequate capital inflows and even capital flight;
* Lack of complementarity between production, trade and consumption, both at national and regional levels;
* Secular decline in real terms of export earnings from principal primary commodity exports;
* The mounting in external debt burdens
* Rapid increases in the prices of imported manufactured goods which has contributed to chronic balance of payment deficits;
* Restricted access to markets of industrialised countries.

Regional capacity building

An important issue in regional integration relates to capacity building, especially involving different countries. It should be mentioned that in Eastern and Southern Africa, a measure of success has been achieved, as illustrated by the following institutions:

(1) *Road Customs Transit Declaration Documents (RCTD)*

Recognising the importance of the haulage and trucking industry, the PTA introduced the RCTD, which is a single customs document for movement of goods in transit by road within the PTA sub-region. Hitherto, countries were required to fill in more than a dozen documents. The RCTD has facilitated cross-border transit by road and to some extent has reduced the turn-round time of trucks by more than 50%. The use of the RCTD, coupled with the "PTA Licence for Carriers" has greatly liberalised the commercial trucking industry through free access to the market by road hauliers and this has contributed to the reduction of transport costs.

(2) *PTA Regional Customs Bond Guarantee*

The PTA Regional Customs Bond Guarantee scheme is a system designed to enable all road transport hauliers to make only one deposit payment for customs that will be applicable in all PTA/COMESA member states. The scheme will eliminate the need to enter a bond guarantee for transit movement of goods at each border. It will eventually enable the huge funds, which were immobilised as the guarantee for intra-PTA exchange, to be released, thus reducing the transport costs of commodities.

(3) *Trade Information Network (TINET)*

The PTA also fully recognised the need for information and therefore created a computerised Trade Information Network (TINET) for the exchange of data related to trade and production development in the PTA. Under the PTA's strategy to promote trade, increase production, improve physical infrastructure and achieve market integration, TINET is part of a project on PTA Trade Development and Promotion Programme executed by the International Trade Centre UNCTAD/GATT (ITC) and funded by the United Nations Development Programme (UNDP), with the assistance of other bilateral donors.

The Central Unit of TINET is based at the PTA Secretariat in Lusaka, Zambia, while TINET focal points are established in each PTA member state. The National Focal Point is the contact and co-ordinating centre for all TINET activities. TINET is being extended to more business users through chambers of commerce as co-operating agencies.

(4) *Automated System of Customs Data (ASYCUDA)*

The ASYCUDA programme provides up-to-date information on customs administration and procedures in the member states. It is a computerised customs management system funded by the European Union. It handles manifests and customs declarations, accounting procedures, warehousing and import and export licences and operates on micro- or mini-computers for use within local area networks and functions on UNIX and PROLOGUE operating systems. ASYCUDA generates reliable and timely trade statistics and can be configured to suit national characteristics of individual customs regimes.

(5) *PTA Clearing House*

A successful institutional framework for regional integration is the PTA Clearing House. This is a useful tool for promoting exports. The complementarity between trade, monetary and payments arrangements necessitated the setting up of an appropriate payments scheme in order to facilitate intra-PTA trade liberalisation and expansion within the Eastern and Southern Africa subregion. It is an autonomous institution which makes possible the settlement of day-to-day payments to be made in national currencies. In the ten years since it was established, total transactions of about UAPTA 615 million (US$800 million) have passed through it. In 1993, the rate of utilisation stood at over 70% which implied the volume of trade transacted in local currencies.

(6) *UAPTA Travellers Cheques*

The UAPTA Travellers Cheques (Unit of Account PTA) came about as a response to the shortage of foreign exchange which, in the 1980s, led many countries in the PTA region to impose restrictions on

external travel so as to conserve their limited foreign exchange earnings. A distinct feature of this mechanism is that 1 UAPTA = 1 SDR of the IMF and the par value is maintained. The use of the PTA Travellers Cheques saves the member states much needed foreign exchange and enables them to be liberal in permitting travel within the PTA. Trade is also promoted through business contacts and tourism within the region.

(7) *Eastern and Southern African Trade and Development Bank (PTA Bank)*
The Eastern and Southern African Trade and Development Bank (PTA Bank) was established by the PTA in November 1985 to mobilise financial resources for the promotion of regional and national projects. It finances trade and assists the private sector in sourcing funds to finance their businesses. The PTA Bank operates as an autonomous institution and, over the years, it has recorded commendable achievements in project and trade financing. Projects in the pipeline amount to more than US$100 million. In order to meet the increasing trade financing needs of its member states and business community, the PTA Bank has created structured finance products which will enable it to raise resources externally without having to rely too heavily on its balance sheet. This has increased the Bank's role as a fund-raising intermediary in the international financial markets.

(8) *PTA Association of Commercial Banks (PTA Bankers' Association)*
The Association of Commercial Banks of the Preferential Trade Area (BAPTA) was formed by the commercial banks in the region. Its secretariat is in Harare, Zimbabwe. Although the Association has existed for a number of years, it only became active in 1993. So far it has played an important role in promoting the use of the region's currencies in intra-PTA trade and in providing the business community with information about commercial banks' development and trade financing schemes. The Association is collaborating with the PTA Clearing House and the PTA Bank to publicise the institutions to bankers and economic operators in the PTA region.

(9) *Federation of National Associations of Women in Business (FEMCOM)*
FEMCOM was established in recognition of the important role which women in business play in the development of the region. Its aim is to promote programmes, in Eastern and Southern Africa, that integrate women, in particular, in industry, trade and services, agriculture, fishing, energy, transport and communications, natural resources and mining. The objective is to improve the economic conditions of women in the sub-region. FEMCOM undertakes to serve as a representative body and a link between members and the PTA Secretariat, the PTA Policy Organs, and other sub-regional, regional and international organisations. The aim of these organisations is to promote trade and development, and to promote, in the member states, the establishment of enterprises owned by women, either wholly or in joint ventures with partners, from within or outside the sub-region. This includes the expansion of existing enterprises owned by women.

> "COMESA aims to attain sustainable growth of the member states by promoting a more balanced development of its production and marketing structures. It also aims to promote joint development in all fields of economic activity and the joint adoption of macro-economic policies and programmes to raise the standard of living of its peoples, and to foster closer relations among its member states."

(10) *PTA Third Party Motor Vehicle Insurance Scheme (The Yellow Card)*
The PTA Yellow Card scheme is a regional programme designed to facilitate road traffic movement. It certifies that the visiting motorist and yellow card holder has a regionally valid and recognised third-party motor vehicle insurance in compliance with the law of the member state concerned. The premium is paid in local currency and once purchased, there is no need to purchase any other insurance on crossing the borders. In the event of an accident, the motorist can lodge the claim with the national bureau of the country in which the accident has occurred. This saves foreign exchange and eliminates delays in claims. The scheme has facilitated the cross-border movement of vehicles and persons and contributed to the increase in intra-PTA trade.

(11) *PTA Re-Insurance Company (ZEP-RE)*
ZEP-RE was created to provide a new framework for insurance companies in the region to obtain re-insurance services without diverting foreign exchange to overseas re-insurers. The retention capacity developed with ZEP-RE will allow for greater investment in PTA in the developmental programme countries. ZEP-RE started its operations on 1 September 1992 at its headquarters in Nairobi. The authorised share capital of the company is UAPTA 20 000 000. Apart from some member state governments, a number of companies within the PTA region are shareholders of ZEP-RE. During two years of operations, ZEP-RE has gained considerable confidence in the insurance market and has successfully sourced business in 16 countries in Eastern and Southern Africa, as well as in West Africa.

Co-operation in energy

As regards energy, it has always been said that "trade is the engine for growth". It can equally be said that without energy nothing can actually move. Energy is, therefore, the real engine for growth. History has taught us that, in drawing up strategies for growth and development in

Eastern and Southern Africa, many countries made a wrong assumption - that energy for development did not require conscious and deliberate planning. This was a tragic and costly error. Energy is a highly critical factor in national and regional planning.

The COMESA strategy in energy encourages co-operation and joint exploitation of resources of wood fuel, oil, hydro power, coal, geothermal, biomass and solar energy in the sub-region. In addition, a regional energy policy has been adopted to ensure balanced economic growth of this region. The strategy aims to optimise intra-sub-regional production and trade in commercial energy products. Special attention will be given to the fuelwood crisis in COMESA because of its economic and physical effects on rural development.

The following figures illustrate the importance of energy and prospects for trade and co-operation in this field: Eastern and Southern Africa, including South Africa and Botswana, occupies an area of about 8.3 million square kilometres of which nearly 60% is endowed with rivers and lakes. This area could be jointly exploited for irrigation, hydro power, and the development of fisheries and water transport. Only 4% of available water is used for irrigation purposes.

The COMESA region also has a large share of other forms of energy. The aggregate sustained annual supply of wood and biomass is estimated at 800 million cubic metres, while hydro potential is estimated at 150 000 MW. Africa's total coal deposits are estimated at 150 billion tons, a major share of which is located in Southern Africa. The consumption of oil in Africa represents only 3% of the world market, whereas Africa's oil-producing countries provide 9% of the world's output. The PTA/COMESA region has the potential to produce 8 billion tons of oil, but only Angola, with an estimated reserve of 2 billion barrels, is currently producing oil.

Renewable energy resources available in the region include wind, solar, mini- and micro-hydro, geothermal and some biomass. However, it should be stressed that solar energy is a new area which COMESA can profitably exploit. The average solar radiation is of the order of five to eight kilowatts per hour per square metre and is evenly distributed. This form of energy has the potential to support all energy needs in our rural communities for the foreseeable future.

Exploitation and utilisation of energy

One major constraint for the African economies in general, which should be emphasised is they are almost totally dependent on non-commercial, traditional fuels to meet their energy needs. Stocks of trees within and outside the forest, shrubs and other biomass have rapidly dwindled. Around cities and other resettlements, the concentrated demand for biomass fuel is increasing faster than re-growth rates. Fuels like wood, charcoal and animal dung meet 70% to 90% of energy needs and their continued use has contributed to serious environmental degradation. In COMESA, all countries import petroleum and petroleum products. Although petroleum contributes 6% to total energy demand, the import of fossil fuels absorbs large and increasing proportions of foreign earnings.

"The COMESA strategy in energy encourages co-operation and joint exploitation of resources of wood fuel, oil, hydro power, coal, geothermal, biomass and solar energy in the sub-region. In addition, a regional energy policy has been adopted to ensure balanced economic growth of this region. The strategy aims to optimise intra-sub-regional production and trade in commercial energy products. Special attention will be given to the fuelwood crisis in COMESA because of its economic and physical effects on rural development."

It should also pointed out that the use of traditional forms of energy has limited impacts on the economic development of rural areas where most people are located. The attendant destruction of forestry resources creates desertification, poverty and large-scale population migration to urban centres. The deforestation of the African countryside is among the current critical ecological problems of the world.

It should be recognised, therefore, that the provision of safe, alternative energy resources will enable regeneration of forest and will introduce new ways of life to the depressed rural areas of Africa. Co-operation in energy is important in ensuring sustained economic development, based on characteristics of energy supply in Africa. It is clear that the prevailing patterns and trends in energy supply and utilisation in individual countries are not sustainable economically, environmentally and socially. Therefore, these countries should jointly conceive policies and strategies to enhance co-operation and trade in energy as the foundation of regional integration.

In the COMESA treaty, member states agreed to co-operate in the joint exploitation and utilisation of hydro potential, fossil fuels and biomass in order to speed up development and distribution of adequate energy resources for sustained economic development. They have also recognised the need to reduce high energy import bills by undertaking joint procurement and distribution of petroleum resources within the sub-region. In order to reduce the cost of energy to the consumers, the treaty calls for the involvement of both private and public entrepreneurs in the development, distribution and marketing of energy. We hope to co-operate with SADC in this important development.

Eastern and Southern African countries have regularly participated in the Africa energy programme, which aims to develop and integrate energy information systems and encourage energy trade so as to ensure the establishment of appropriate regional energy institutions. The Africa energy programme has assessed energy supply and demand balances in most African countries and has recommended data management systems for all African countries. These programmes, when

implemented, will enable countries readily to access each other's data and exchange information on technology and research programmes. This type of co-operation is possible, given the similarities in energy use patterns in most African countries.

Another important issue relates to grid interconnectivity and trade in energy. The Electricity Supply Commission of South Africa (ESKOM) stated a wish to create a multilateral agreement with neighbouring power utilities to interconnect the grid systems. ESKOM envisaged the grid interconnections to include Botswana, Mozambique, Zambia, Zaire and Zimbabwe, in the medium term, and to extend to East African countries such as Kenya, Tanzania and Uganda in the long term.

This is a dream shared by COMESA. This proposal is most welcome as it has the potential to supply electricity to some 200 million people in countries south of the equator where today only 10% enjoy the benefits of electricity. Moreover, the ESKOM grid concept also envisages the possibility of building two hydro-electric power stations on the Congo River, which could, in the long run, provide the largest part of Africa with electric power at a fraction of thermally generated or nuclear power.

In the past, countries in this region recognised the importance of developing energy resources to meet growing needs. For instance, the Kariba Dam and Cahora Bassa were conceived as frameworks for co-operation in energy. It was always realised that some countries lacked adequate resources of energy and they agreed to initiate trade in energy systems and energy resources, such as coal and electricity. Several countries have already embarked on grid interconnections. Major studies are also underway to identify the possibilities of joint development of hydro resources in the East African region. The COMESA member states have further agreed jointly to develop technologies that will exploit indigenous energy resources. In this regard, COMESA countries are improving mechanisms to effect exchange of information on the development of renewable energy systems. They have jointly undertaken training programmes to exploit resources that will provide power for the rural areas of the region. As stated in the COMESA Treaty, priority will now be given to programmes that will enhance rural electrification activities and planned management of forest resources. Co-operation in these areas will be strengthened by the establishment of financial and technical institutions that will support joint energy development programmes.

In conclusion, South Africa's critical role in inter-State co-operation in the production, management and utilisation of energy resources should be emphasised. For instance, during the recent drought experienced by some of the Southern African states, South Africa co-operated in sharing power with her neighbours. This type of co-operation helped those countries overcome the drought crisis, and COMESA plans to further such co-operation.

This meeting on energy is, therefore, an opportunity for participants to lay the foundation of future co-operation in energy and to design optimal regional strategies that will encourage development of energy resources and, at the same time, ensure conservation of the environment.

RAPPORTEUR'S REPORT

Regional co-operation

* J K KONCZ

This is a summary of the contributions submitted to the Regional Co-operation Session and is intended to persuade both the listener and the reader to consult the original submissions. Per force, reference to key points which emerged in the preceding sessions will need to be re-emphasised for contextual completeness. However, as far as circumstances have permitted, repetition has been avoided.

The emphasis on co-operation in the power sub-sector is a significant indicator of visible progress/achievements to date in the region.

Socio-economically, the region in characterised by considerable differences in levels of welfare and development, as well as a variety of energy demand levels and patterns. Approximately one third of the population is reasonably wealthy, measured in terms of the availability and relatively heavy use of energy. In contrast are the low-income rural areas where 99% of households use mainly wood. In the peri-urban and poorer urban areas, a varying mix of energy carriers is used.

All these factors influence the energy policies adopted by individual countries.

The energy resource bases of the individual countries also differ considerably. This diversity makes inter-statal co-operation in energy matters potentially advantageous to the whole region. Some the countries have large hydro-electricity potential (Zaire, Zambia, Zimbabwe and Mozambique), while others have sizeable coal reserves (Zimbabwe, Botswana and Swaziland). The potential for gas in Mozambique and Namibia is promising, and the Cabinda off-shore region of Angola has been described as having some of the best prospects for oil in the world.

Generally, energy resources are in areas far from the present load centres/markets. Often, they are in countries with poor economic conditions and inadequate infrastructure. Lack of reliable access to sustainable and adequate supplies of the various forms of energy would pose a serious threat to prospects of survival and development in any setting. Preceded only by water and food, achieving and maintaining energy security needs to be given top priority.

Energy services that are accessible to the population of Southern Africa, as indicated by levels of commercial energy per capita, will have to increase at rates far higher than population growth if there is to be improvement in the low development indicators. The demand for commercial energy grows more or less in step with GDP - possibly a little faster in the low-income countries. Without assured energy supplies, particularly electricity, Southern Africa's economies will not grow.

Energy must be a component of overall planning. Regional co-operation in energy development cannot be divorced from the broader context of social and industrial development. To meet the many interrelated and frequently conflicting national objectives as effectively as possible, the region's long-term policy options need to be integrated with overall economic and other policy considerations. Despite the different responses to energy issues, the energy policies of sub-equatorial African countries have common characteristics which are likely to determine the region's policy in the future:

(1) The most important economic factor for every country is the provision of an adequate energy supply, at reasonable cost, because it is essential for economic development and prosperity (Akapelwa and Sakala: 1994; Dutkiewicz: 1993, 1994; Nyembo: 1994; Sikasote and Kalyalya: 1994).

(2) Each country strives to minimise its dependence on others. As a result, domestic energy production and efficiency have become important goals. The strategic importance of this is illustrated by Zambia's decision to declare *force majeur* and cut back electricity supplies to Zimbabwe during the 1992 drought (Sikasote and Kalyalya: 1994).

These requirements could be satisfied by sourcing through a power pool. Such a pool would overcome existing reservations, since availability is secured from several sources, and price competitiveness is a basic factor. In expanding power systems, export markets for surplus energy are also readily accessible (Rode *et al.* 1994; Akapelwa and Sakala: 1994; Dutkiewicz: 1993, 1994; Nyembo: 1994; Sikasote and Kalyalya: 1994).

Since energy constitutes a significant portion of input costs, it is vital for the region's business sector to encourage governments and utilities to establish the power pool as soon as possible (Rode *et al.* 1994).

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Introduction

The emergence of major trading blocks, notably Europe, North America and the Pacific Rim, has given rise to fears that the countries of Southern Africa will be marginalised internationally unless they, too, merge into an operational economic grouping.

Clustering in the region is driven by the need for economies of scale: enhanced efficiency through competition and specialisation, improved terms of trade *vis-à-vis* the rest of the world, increased capital inflow and rapid technological advance, as well as greater distributional and administrative efficiency. A specific incentive is the added pressure from international agencies, such as the World Bank, who readily support a regional approach.

Political considerations

Within the limitations of its institutional framework, the Southern African Development Community's (SADC) achievements in forging a regional identity should not be underestimated. Particularly in the international context, this is a regional asset.

Regionally, and to some extent internationally, it is assumed that present areas of regional co-operation will expand with confidence and a "community" will emerge. Certainly, "interdependence" is increasingly seen to be a desirable state where a mutually acceptable balance exists between dependence and self-sufficiency, and where the economic, political or social costs of dissociation outweigh the disadvantages of association.

However, there are economic forces pulling the region together, and political forces which often divide, and any plans to expand present regional interaction must take this into account. Above all, there are widely divergent conceptions of "dependence" and "interdependence". Dependence is still generally perceived as a major obstacle to national economic development.

The political capacity is still inadequate to implement and sustain significant regional sectoral responsibilities, whether for planning or operation.

Economic interdependence

There are many bilateral economic relationships between countries in the region which embody significant, if varied, degrees of interdependence. Visible and invisible trade relations, flows of labour and the development of common political and economic institutions and infrastructures are increasingly drawing the region closer.

Trade relations in the region are continuing to be shaped largely by market forces. While it could be argued that the underlying patterns are unlikely to be disturbed, "in the last twelve years or so a wave of 'new trade theories' has emerged, which pose a formidable challenge to the orthodoxy" (Sikasote and Kalyalya: 1994). When contrasting these with the various orthodox approaches, it may be concluded that "the focus of these new theories is intra-industry trade as opposed to inter-industry à la orthodoxy. ... Moreover, granted that there is at present little or no intra-industry trade among Southern African countries, if one considers that one motivation for establishing economic integration among these countries is the desire to alter the existing production and trading patterns, then that may not be a misplaced objective" (Sikasote and Kalyalya: 1994).

Most states in the region suffer from budget deficits, rampant inflation and over-valuation resulting in shortages of convertible currencies. Reliance on donor aid not only highlights the inadequacy of the states' total buying power, but also tends to direct trade towards the sources of finance.

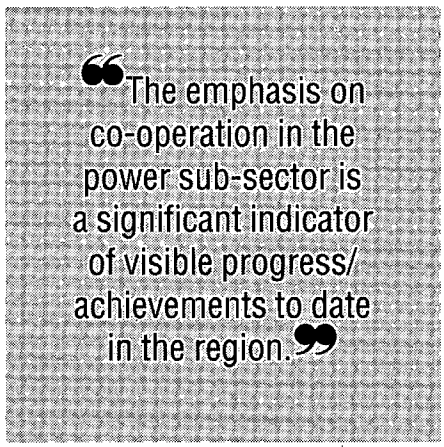
There is strong dissension about the correct strategy to pursue. In cases where it is necessary to maintain an alliance of countries in implementing any strategy, this has profound implications.

There are deep-seated reasons, both for the divergence of interest between some of the regional states and for their limited interaction:

* In structural terms, their economies are more competitive than complementary
* Their economic development is fundamentally export-led and all their major exports are primary commodities, the majority of which they can not easily sell to each other.

There is thus continual tension between the integrative impulses in the regional economy and the external orientation of most of the regional states to world commodity markets.

Furthermore, there is the matter of established interests and inertia. There is a natural temptation for existing interests to retain most, if not all, of the existing regional structures, for example, SADC and PTA (Preferential Trade Area). Given the political will, a more efficient structure may be devised.



To restructure the region's economies, an important package of market-oriented policies has been introduced by the World Bank/IMF. These include programmes of privatisation, financial reforms, liberalisation of foreign-trade laws, and price reforms, allowing prices to be dictated by market forces. Most are also underpinned by the devaluation of local currencies.

In tandem, institutional changes are shifting towards decentralisation. This should provide increasing economic autonomy for all sectors in the region. The move towards joint ventures and similar involvement is also intended to allow for more autonomy. This will provide easier access to foreign capital and management expertise.

Nyembo (1994), however, disagrees with this view, and refers to " ... the ineffectiveness of actions taken by international bodies such as the IMF or the World Bank, in prescribing inefficient programmes to developing countries", and emphasises that "development had become increasingly prescriptive and coercive, instead of being positive in its approach - with an international police sanctioning the behaviour and controlling the development of nations in every regard".

Finance and investment

The role of central banks and finance ministries has a crucial impact on the energy sector. In most countries they control all access to financing and regulate the flow of foreign exchange. By restricting access to money markets, central banking policy severely impairs the ability of energy producers to raise development capital.

Where government policy has been to provide energy as a free resource, energy producers cannot cover recurrent operating costs. The imposition of ideologically motivated tariff controls is regarded by many regional utilities as an extremely serious shortcoming.

In the case of energy project financing with foreign capital, the division of responsibilities between various ministries causes communication and integration problems, and results in costly delays.

Much of the region's economic development should continue to be financed by international capital. Indications are that the growing economic integration of the region will attract outside investors, provided that governments implement the necessary structural changes.

A number of problems which hamper activity in the investment environment were outlined by Kakou and Ahoussou (1994), Dutkiewicz (1993, 1994) and Nyembo (1994).

(a) *Investors*
- Seldom focus on the capital needs of the sector, preferring to sell technical and managerial services
- Often fail to take a longer and more realistic view of their investment prospects
- Seek gain in the short term at the expense of recipients/local society
- Link loans to ideology or political interest.

(b) *Recipients*
- Have little choice but to accept the judgement of the market
- Do not always understand
  - what is required to attract foreign investment

- competition
- contracts: rights and obligations
- foreign exchange risks

- See foreign capital as a means of acquiring "modern" technology (engineering rather than management)
- See foreign capital as 'expensive aid'.

Nyembo (1994) states: "The electricity sub-sector requires major capital investments to finance power generation, transmission and distribution capacities. Recourse to foreign capital, which can be justified in the case of needy developing countries, has become quasi-automatic to acquire the product of Western know-how".

Technology transfer

Reliance on foreign assistance to augment expertise frequently results in the use of inappropriate and expensive technologies. Nyembo (1994) cites examples.

Kakou and Ahoussou (1994) provide an insight into the partial failure of technology transfer from the developed economies ("the North") to Africa in general. They identified the reasons (listed below) which, in many respects, correlate with the investment and financing problems outlined elsewhere in this paper:

- Lack of motivation by the North
- Loan linkages
- Commercial strategy
- Private interests of decision-makers
- Fledgling industrial structure
- Inadequate human resources
- Inadequate political and institutional framework.

Kakou and Ahoussou (1994) view Africa simply as a market; (a view shared by Dutkiewicz (1993), and a simple market at that. Given the developed world's vast investment into developing leading edge technology, the North's reluctance to share freely is acknowledged.

The authors also propose prerequisites for successful technology transfer:

- Choice of technology
- Transfer of know-how
- Partnership
- New sources of funding
- Political will
- Training.

Dutkiewicz (1993, 1994) believes that standards are over-regulated. He proposes that there is much scope to exchange experience in appropriate technology developed in the region, and refers to applications in South Africa's domestic electrification schemes and standardisation of equipment which would help to alleviate skills shortages.

Dutkiewicz maintains that managing technology transfer is the process of managing change, and Africa has potential advantage to short-circuit the rapid changes now occurring globally. However, there is a need for skills which understand "what such change involves and what it means in terms of adaptation for local conditions and requirements" (Dutkiewicz: 1993, 1994). Kakou and Ahoussou (1994) suggest that South Africa has had some success in "cross over" in technology transfer and could lead the region in this respect.

> "Since energy constitutes a significant portion of input costs, it is vital for the region's business sector to encourage governments and utilities to establish the power pool as soon as possible"

Kakou and Ahoussou (1994) also propose a greater emphasis on local manufacture for the regional market, and they are looking closely at the Ivory Coast as potential for manufacturing, joint ventures and other investment to support the region's energy sector. Dutkiewicz supports the view that local manufacture would be preferred, but notes that availability of finance, particularly foreign exchange, poses constraints to such ambitions.

Human resources

Dutkiewicz (1993, 1994) and Kakou and Ahoussou (1994) express concern that most of the region is over-dependent on external sources of expertise and technologies for both the development and the efficient use of commercial energy supplies. This has been a pervasive constraint to all aspects of energy supply and utilisation, with a particularly negative impact on technology transfer. One of the most negative aspects of Southern Africa's economic crisis has been the dramatic brain drain involving middle- and high-level manpower.

Human resource development, as a critical component of technology transfer, is emphasised by Kakou and Ahoussou (1994) and Dutkiewicz (1993, 1994). Kakou and Ahoussou advocate the use of existing regional training facilities, specifically those located in the Ivory Coast. Dutkiewicz proposes greater participation in training available from exporters/manufacturers of equipment.

Information

In many cases, the existing institutional structures lack adequate organisation to collect reliable data on the status of resources and the consumption of energy by locality and sector. This is essential for planning.

In contrast, the case-study submitted by Nawezi (1994) provides insight into a practical approach to the collection and capture of production and consumption data for a sub-regional, multinational energy databank. "The statistical data are used to determine trends pertaining to supply and demand and to make projections for the future. These data are used to direct investments in the production or distribution sector. As knowledge has become available on peak consumption and high energy consumption periods, it has become easier to target economic sectors with a high energy demand. This information serves to improve the management of the production equipment and to use energy more rationally: ... Data on all forms of energy are converted into tons of oil equivalent, which makes it easier to evaluate the energy supply and the energy demand ... The energy databank is a valuable tool for planning and carrying out studies in the field of energy" (Nawezi: 1994), and he recommends its extension to other Southern and East African countries.

Electricity sector

The region has abundant and potential hydro and thermal resources. Yet, despite the excess capacity, the bulk of the

region's inhabitants rely on wood fuels to meet their energy needs. However, increasingly, national energy planners and producers are embarking on schemes to close the gap between the "haves" and "have nots". Pooling will help to reduce the cost and therefore the end-user price, and thereby improve affordability of electricity to a larger percentage of the population (Sikasote and Kalyalya: 1994; Nyembo: 1994; Dutkiewicz: 1993, 1994).

An overall plan of energy interchange is already growing. Such exchange is to the advantage of both exporting and importing countries, and even third parties can benefit from such arrangements through wheeling (Akapelwa and Sakala: 1994).

International power exchanges have existed in the region since at least the early 1950s. In recent years, interconnections and associated power exchange agreements have multiplied noticeably. Reduced water flows into the region's major hydro-electric reservoirs have highlighted the benefits of interconnecting Southern Africa's hydro-electric resources with South Africa's approximately 9 000 MW existing surplus of thermal generation (Akapelwa and Sakala: 1994; Dutkiewicz: 1993, 1994).

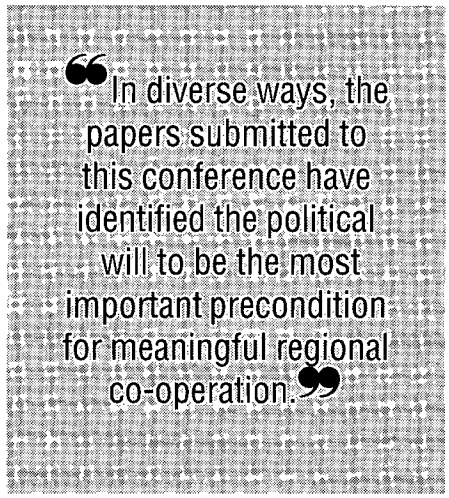
The growth rate in the level of international annual electricity exchange in the region is approximately 15% per annum, and is likely to be 1 000 MW (or 7 500 GW/a) in 1995/96, and worth approximately US$125 million per annum.

In spite of their low rating, the interconnections in the region have already served the utilities well in helping to overcome shortages of energy. These interconnections have been most useful when linking countries with complementary characteristics: for example, a predominantly coal-fired system with a hydro system (Namibia-South Africa) or two hydro systems with different rainfall patterns (Zaire-Zambia).

It is clear that a lower risk is associated with the import of energy. It is less costly to pay for what is actually received than to produce locally. High fixed costs are avoided when the plant does not perform. In an environment where skilled manpower is scarce, operating constraints are also reduced. Utilities are able to improve the performance of existing power stations, rather than allocate scarce resources to the construction of new power stations. "The SADC Electricity Sub-Committee (ESC) estimates that the Southern African region, including Zaire, has a surplus generating capacity of nearly 12 000 MW or 36% (SADC ESC, 1994). ESC adds that although most of this plant would require refurbishing, these expenses would, however, be relatively small compared with establishing new power stations" (Sikasote and Kalyalya : 1994).

Towards the power pool

A large portion of the over-capacity is represented by coal-based generation which, in the longer term, could be replaced by cheaper and environmentally more acceptable hydro options. Zaire, alone, could provide the electricity demand of the whole region (Dutkiewicz: 1993, 1994).



Primarily, pooling is concerned with optimising costs of operation and planning, and to improve the quality of supply to the system. Benefits accrue to the consumers and, therefore, the region.

Rode *et al.* (1994), Sikasote and Kalyalya (1994), Akapelwa and Sakala (1994) and Dutkiewicz (1993, 1994) all point out that, since the various networks combined in a power pool can be as one system, potential savings and other benefits of pooling are, for example:

- Delayed investments in future generation (economies of scale, more economic projects);
- More economic use of primary energy sources;
- Hydro-thermal balance/co-ordination;
- Lower operating reserves;
- Peak load diversity;
- Lower unit commitment costs;
- More flexible maintenance scheduling;
- Improved reliability and frequency stability (translates directly into economic gains);
- Spinning reserves: emergency support (for example, 1992 regional drought emergency);
- Energy production efficiency (positive environmental impact implications);
- Channel savings to other development needs, for example, electrification, refurbishment.

Because the size of one generator, compared with the size of the whole system, will be less than when the various systems are isolated, frequency will also be more steady.

The higher the diversity between the systems, their primary energy sources, their load profiles and their sizes, the higher are the incentives for pooling. On this basis, the incentives to create a power pool among utilities in Southern Africa are very high.

Until recently, the electricity utilities of Botswana (BPC), South Africa (ESKOM), Zambia (ZESCO), and Zimbabwe (ZESA) have been buying and selling power to each other along the lines of a "loose pool". There has been no obligation on any of them to co-operate, or even to trade.

Rode *et al.* (1994) report that an Intergovernmental Memorandum of Understanding (MOU), an Interutility MOU, the Operating Agreement and the Operating Guidelines are currently being drafted by the eleven SADC utilities plus the Zairean utility SNEL. The target date for the interconnection of the four systems (being those of the initial Pool members), is the end of 1994 or early 1995 "pending implementation of all the minimum operating requirements by each of the utilities".

"The findings and conclusion of the Energy Sector Management Assistance Program (ESMAP) study on independent versus integrated electricity development are also noteworthy. Using four different plans ... the study shows that the cost of independent development is a lot higher than any regional scheme. Whereas the cost of independent development was estimated to be US$5 300 million (in constant dollars) that of the least-cost regional scheme (Plan D) came to US$4 364 million, a saving of US$936 million" (UNDP/Word Bank: 1993:1-40; Sikasote and Kalyalya: 1994).

However, as utilities reduce their costs, they also lose some of their independence. At some stage, they need to

decide where the best compromise between these two conflicting objectives lies (Rode *et al.* 1994). In the final analysis, it will be the degree of integration in planning and operations that will determine the amounts of money saved.

"The sharing of knowledge and expertise between the utilities will help develop local expertise and decrease the dependence of the region on foreign consultants who do not always have the best interest of the local utilities at heart" (Rode *et al.* 1994).

Wheeling

Zambian exports to Botswana, through Zimbabwe's system, set the scene, and the concept of power wheeling between "supplier" and "consumers" through intermediate networks is now fully accepted in the region.

An examination of the region's energy balance illustrates the vast opportunities for wheeling. For example, "the Zambian power system is centrally located to actively facilitate bulk power transfers in the Southern African region. There are opportunities for moving electrical power from Inga, and other facilities in Zaire, to other countries in the region, which will require the participation of Zambia" (Akapelwa and Sakala: 1994).

Akapelwa and Sakala also point out that "because of the significant impact that wheeling charges can have on the final price to the buyer, it is imperative that all charges for such a service should transparently reflect true cost". To ensure commensurate compensation to the wheeling party, wheeling transaction should be computed accurately. "It is clear that the utilities will require to invest significantly in computational facilities to generate all the necessary information to cover each wheeling transaction. A common IT strategy may be necessary to address this requirement. In addition the region must harness all necessary technical capacity to be able to deal with these obviously complex issues."

Conclusion

"Interdependence in the world economy today has reached such a stage that the question that confronts countries is no longer of whether or not to cooperate with others, rather it is of how to improve cooperation" (Sikasote and Kalyalya, 1994).

As evidenced, much progress as been made since the first Regional Forum was held in Harare. In large measure, the progress has been possible because the political will was there to open the way and to facilitate the process.

In diverse ways, the papers submitted to this conference have identified the political will to be the most important precondition for meaningful regional co-operation.

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Summary and proposals

* R K DUTKIEWICZ

Background

The Regional Forum is being held against a backdrop of a world energy demand which is rapidly swinging to overall dominance by the developing countries. In 1990, 75% of the world's population lived in the developing world and consumed 33% of total energy. By 2020 the developing countries will represent 85% of the population and 60% of energy demand - a daunting proposition taking into account the problems facing the developing countries.

This meeting takes place against a background of improving regional political stability and a refocusing of attention on economic growth, which, if successful, could lead to a greatly increased energy demand.

Political changes mean that it is now possible to start on a programme of integration and co-ordination, a topic which has been much to the fore in the Forum. In this connection, the various groupings in the region, such as SADC and PTA, will have an increasingly important role to play in the future.

The region in question, and indeed the whole of the African continent, is characterised by poverty - poverty in terms of per capita income - but rich in resources, both in energy and mineral resources. It is also rich in human resources, and it is knowledge and will-power that are the keys that are needed to unlock the potential bounty.

Supply

The region is well endowed with all the main energy resources, with the possible exception of oil. Coal is found mainly in the southern part of the region, with the main deposits in South Africa, Botswana, and Zimbabwe, with meaningful deposits being found in Madagascar, Mozambique, Swaziland, Tanzania and Zambia. Gas is found in Ethiopia, Mozambique, Rwanda, South Africa, Sudan and Tanzania. Oil is the only fossil energy source which is in short supply - only Angola has any significant resources.

The region has significant skills in the mining of coal and in its processing and transport. For export purposes, most of the coal is of poor quality and has to be beneficiated, but the technology of coal washing does exist in the region. South African coal suppliers are well situated to export coal to other countries in the region, especially those along the coast.

Hydro potential in the region is vast with significant capacity in the Zambezi Valley, in Mozambique, Angola and Namibia. The potential of the Inga development is around 40 000 MW but the cost is such that it will have to be constructed in large blocks. The development of this scheme will have to wait until the growth in the total demand of energy in Africa (and possibly further afield through links with Europe) will allow such a large incremental addition.

As the region has large resources of most commercial fuels, it is ironic that there are power shortages in many parts of the region. Work done by SADC and others has shown that there is a significant cost saving to be made in the region by the interconnection of the electricity grids of various countries. These conclusions have been agreed to and the concept of the Southern African Power Pool (SAPP) is now a reality.

Angola oil production has the potential to supply an estimated 86% of the needs of the region. However, the refinery situation in the region should be investigated. Many of the refineries are old and often incapable of handling the type of crude that is now available. There is obviously room for rationalisation of the refinery capacity in the region and for trade in finished products. The Kenya refinery needs to be modernised to supply liquid fuels to the countries of East Africa. The South African refineries, however, are modern and have the ability to supply additional quantities of liquid fuels to the countries of the region, both by inland transport and by sea. South Africa's decision to move progressively towards the use of unleaded gasoline will inevitably have an impact on the region. It is encouraging to note that SAC are doing good work in investigating liquid fuel and gas supply and demand.

Demand

Of the regional commercial energy demand, South Africa accounts for 53% and therefore any aggregation of energy demand in the region is dangerous. There is also a significant difference in the sectorial energy use between South Africa and the rest of the region. For instance, in South Africa, only 20% of energy is used in the domestic sector while in the previous SADC countries it is 68%. South Africa has a decreasing energy intensity while most of the other countries presently have a constant, and high, energy intensity.

The increase in demand for energy in the region varies from 1% p.a. (Malawi) to 3.1% (Botswana) whilst the population growth rate varies from 2.6% p.a. to 3.4% p.a.

One of the shortcomings of the energy situation in the region is the lack of adequate statistics and an insufficient understanding of the energy-economics relationships In the region. This is slowly being addressed and the work of SADC on country demand profiles is welcome. The secrecy surrounding the demand and supply of liquid fuels in South Africa has recently been lifted and improvements in the statistics in that country are now expected.

Little work has been carried out on the establishment and analysis of time series data on prices and taxes in the region, in terms of the different economic sectors and energy carriers. Work on improvement in the efficiency of energy utilisation has started, thanks to the excellent work of SADC, much of it sponsored by CIDA, but the effort needs to be accelerated and expanded in order to take advantage of the financial benefits of the main effort being of an effective demand side management programme. The concept of integrated energy planning in the region has also not been addressed sufficiently.

Training opportunities in the region for planners and energy practitioners are inadequate and there is much scope for the pooling of training facilities and infrastructure in the region.

Many of the papers stress the necessity for more co-operation on energy demand matters in the region.

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Development

The region is characterised by a high population growth rate, a young population composition, a high rate of urbanisation in certain countries, low economic growth and high levels of illiteracy and infant mortality. This has resulted in a high level of traditional fuel utilisation and a low level of availability of electricity. It is accepted by all the authors that there is a need to decrease the reliance on traditional energy forms and increase the access to affordable commercial energy. However, it has been stressed in a number of papers that the supply of energy is necessary but not a prerequisite for economic growth and that those who preach energy for development must realise that provision is only one component of a much broader picture. In the area of development the following options should be noted:-

* Planning for energy supply in developing areas must form part of an integrated plan.
* Biomass is a large component of most of the energy used in the region and will continue to play an important role in the foreseeable future. Plans must therefore be made to provide sustainable and affordable energy in many areas.
* Electrification is an important component of regional planning. However, grid electricity is not always available and the use of alternative energy sources, such as solar and wind, should be considered for electricity production and for heat and hot water.
* The improvement of energy utilisation efficiency is an important part of the overall energy for development picture.

Finance

Many developing countries have looked to the developed countries for financial assistance in energy projects but there is now a growing awareness that the developing countries, and especially those in Africa, are not to the fore for international funding and that funding will only be found for profitable ventures. It has been stressed that real development can only come from within and that humility and perseverance are prerequisites in the development business. World Bank estimates show that, in order to achieve the 4%-5% GDP growth rates required in the region, commercial energy will have to increase sixfold by the year 2020, with a total investment requirement in the range $8-15 billion. This must be compared with the cumulative funding for Africa by the Bank at $4.2 billion up to June 1993. Thus the required external financing in Africa will need to be around $1 billion per annum. It is estimated that, in the most optimistic of scenarios, aid flows can finance only about one half of the required total investments in the region. The mobilisation of capital markets (private savings) and direct private sector financing will be an increasingly important source of funds for the energy sector.

Mobilisation of domestic and foreign private financial resources for energy operation are a function of the soundness of macro-economic structure and performance of enterprises in the energy sector.

Institutional

One of the main stumbling blocks to the provision of an efficient and cost-effective energy industry is the inadequate institutional framework within which many organisations operate. This is characterised by over-control, lack of responsibility, decisions taken for political rather than economical reasons, and the problems of foreign exchange. A number of countries are taking steps to reduce control but there is still some way to go before there is an adequate structure in the region. It has been pointed out, however, that the characteristics of each country in the region are so different that there is no one single institutional model that will suit the region as a whole.

Environmental

A common theme running through the papers is a recognition of the need to increase energy consumption through economic growth, but that this is associated with a negative environmental effect. While developed countries are increasingly concerned with global warming and acid rain, the problems of the developing countries relate mainly to the unsustainable and inefficient use of biomass resources. In the region there are specific environmental issues, mainly in South Africa, where the concerns are with the use of coal for domestic purposes and with the adverse effects of the large block of electricity generation in the Eastern Transvaal.

Whilst global warming is becoming a major international concern, it should be noted that in the developed world the emission of carbon dioxide varies from 19.5 tons per capita (USA) to 8.2 tons per capita (Europe). In the African countries the figure is around 1.0 tons.

It should be stressed that a critical balance has to be achieved in realising national development and meeting environmental constraints. It is recognised that the environmental issue has to be approached as a joint project between integrated energy planning, integrated environmental management, and a sound research and development programme. Regional co-operation is vital in order for all the countries of the region to benefit from shared experiences.

Regional cooperation

The need for regional co-operation is evident in most of the papers. It is recognised that there is a fund of knowledge, gathered from the particular conditions of the region. This could be exploited for the benefit of all the countries. While recognising that countries will continue to depend highly on the developed countries for the supply of equipment, it is felt that technology transfer is less than adequate because of

Lack of motivation
Loan linkages
Private interests of decision-makers
Inadequate human resources
Inadequate political and institutional framework.

Most of the region is over-dependent on external sources of expertise and technologies for both development and the efficient use of energy supplies. Human resource development is also seen as a regional factor.

We need to emerge from the parochial concept that we are part of Southern Africa. In the energy sector we must consider Africa as our region.

There are possibilities for strong interaction between Africa and both the developed and developing world. For instance, the concept of Cahora Bassa being financed and managed internationally is an example of Africa-developed world co-operation. We can also learn from countries, such as Thailand, who are carrying out useful work on efficient wood stoves.

Proposals

(1) In view of the highly useful interchange of information that has taken place in Harare and here in Cape

Town, plans should be made for the holding of a further Forum in three years time. It is proposed that the various Regional Forums in Africa be merged into an Africa Forum.

(2) It is proposed that specialised work-group meetings be set up more frequently to capitalise on the networks already created.

(3) In view of the shortage of information on energy in the region, it is proposed that a central repository of data be set up, together with a system of country reporting on energy statistics for the whole of Africa. International aid agencies are urged to assist in the promotion of a structure to facilitate the interchange of such statistics and information.

(4) The WEC is an ideal vehicle for aiding regional co-operation and attempts should be made to urge non-member countries to join WEC.

(5) The WEC and its national committees should indicate to governments that political, institutional and economic changes may be required in order for adequate financing to be made available.

(6) The countries of the region are strongly urged to devote more time to solving the problems in using traditional forms of energy.

(7) Countries are urged to pool information on the low-cost electrification of underdeveloped areas.

(8) Institutions in the region should be encouraged to undertake research into the relationship between energy utilisation and economics in each of the countries of the region. There must be an interaction between such work and the development of economics in each country.

(9) The WEC should act as a central integrator for the interchange of information between all the countries of Africa.

Cahora Bassa should be considered as a pilot study for the Framework Convention on Climate Change Joint Implementation Programme - in consultation with UNEP and the developed nations, This concept should be presented to the Conference of Parties in Berlin in April 1995.

A plan for action

*** I C McRAE**

A brief plan of action for the future was discussed at the conclusion of the Regional Forum. This is as follows:

(1) A recommendation will be made to the World Energy Council (WEC) that the focus in future be on Africa as a whole continent and not on two separate regions in Africa.

(2) A recommendation will be made to the WEC that a WEC regional structure for Africa be established made up of members from the National Committees.

(3) Through this structure the WEC links with African, Regional and National political structures, e.g. OAU, SADC, COMESA, etc. to provide an advisory body on energy matters to these political organisations and governments.

(4) Through this body the WEC facilitates identification of energy-related issues, possible projects essential for building the energy infrastructures.

(5) Through this body the WEC creates a sense of urgency in Africa to provide the energy base for the creation of economic growth.

(6) Through this body the WEC facilitates interaction and co-operation between member committees in Africa and provides a conduit through which support may be obtained from all member committees and countries around the world.

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COMPARATIVE ENERGY COSTS IN SOUTH AFRICAN CITIES RELATED TO HEATING VALUE

FEBRUARY 1995											
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)	259,35	68,40	R/Ton	0,93	0,24	0,59	3,41	1,00	2,40	28,0	MJ/Kg
Elect.	20,01	21,92	c/kWh	5,56	6,09	5,68	22,75	24,92	23,26	3,6	MJ/kWh
Heavy Furnace Oil	53,06	73,96	c/litre	1,42	1,80	1,42	5,80	7,38	5,80	41,0	MJ/litre
Illum. Paraffin	90,63	102,53	c/litre	2,45	2,77	2,45	10,03	11,34	10,03	37,0	MJ/litre
Petrol (Premium)	163,00	173,00	c/litre	4,70	4,99	4,70	19,23	20,41	19,23	34,7	MJ/litre
Diesel	143,90	153,90	c/litre	4,02	4,28	4,02	16,46	17,51	16,46	38,8	MJ/litre
Power Paraffin	90,00	102,30	c/litre	2,40	2,73	2,40	9,82	11,17	9,82	37,5	MJ/litre
LPG	102,00	115,80	c/litre	3,72	4,23	3,72	15,24	17,30	15,24	27,4	MJ/litre
Gas											
Cape Gas	45,60	–	R/GJ	4,56	–	–	18,67	–	–	–	–
Gaskor	–	17,16	R/GJ	–	1,72	–	–	7,02	–	–	–

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 Saaiwater to Cape Town and from Saaiwater 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. 32, February 1995)

Energy news in Africa

Electricity

Congo

The privatisation of the Congolese utility, Société Nationale d'Electricité (SNE), is not expected to take place until the end of 1996 or early 1997 unless the timetable for the project is moved forward. The government has so far failed to approve the terms of reference that had been worked out with the donors to implement the privatisation.

Meanwhile, SNE has been given a Ffr14 million loan from the Caisse Francaise de Developpement (CFD) to enable it to launch a series of much needed works projects and studies. These will include keeping a network between Brazzaville and Pointe Noire in working order with the restoration of a transformer and a medium-voltage station, as well as a renovation of the Djoué power station and back-up for maintenance.

(Source: African Energy & Mining, 21 December 1994)

Eritrea

The World Bank has called for the privatisation of the energy sector in Eritrea, starting with electricity but including oil. The Eritrean Electricity Authority (EEA) intends putting a new diesel-powered station into service at Beleza. However, other generators have had to be stopped for urgent maintenance work, or because they were using heavy fuel. Power shedding has remained the rule, especially to level off peak demand, and as a result, industry has suffered. However, the Reconstruction and Recovery Programme (RRP) is expected to boost energy demand by 10%/year.

The World Bank suggests that privatisation of the electricity industry starts with maintenance contracts tied to invitations to tender for new units, and then with contracts for existing units, including the supply of spare parts.

The EEA has also claimed that they intend reducing electricity rates, and the World Bank has agreed that cuts were necessary if the industry was to be competitive. However, prices should not be lowered before the EEA has the necessary production capacity. It is suggested that the EEA could introduce "lifeline rates" in the domestic sector. However, to stop this from raising peak consumption unduly, the EEA should at the same time introduce a double rate (basic and peak) for industrial consumers who can be equipped with special meters.

(Source: Africa Energy & Mining, 21 December 1994)

Ghana

The rise in the level of Lake Volta behind the Akosombo Dam in November 1994 enabled the Volta River Authority (VRA) to call for a provisional halt to power shedding on its network. At present the VRA hopes to be able to maintain this freeze on power shedding until at least July 1995.

Supplies of power to the Communauté Electrique du Benin (CEB) and covering around 80% of the needs of Benin and Togo, the two companies that make up the community. The Yeripao Dam that is currently being built in Benin will have only limited capacity as it will only provide 270 GWh/year, or half the needs of the two countries.

(Source: Africa Energy & Mining, 11 January 1995)

Mozambique

Two Portuguese companies have jointly won a $25 million contract for 4 500 km of lines destined for the restoration of the high voltage line to South Africa from the Cahora Bassa Dam. Sweden has offered a $8,5 million loan to build a station at the starting point of the line and for another at Songo for the line to Zimbabwe.

Electricidade de Mozambique (EDM) has just issued an invitation to tender prepared by Swedpower for contracts covering two projects at Maputo and Beira within the framework of the Electricite I project. The latter is being financed by the African Development Fund (ADF).

(Source: Africa Energy & Mining, 11 January 1995)

Morocco

The Office National de l'Electricité will launch the first phase of a new section of renovation and extension work on its transmission-distribution network. The project is known as Electricité VIII and the first invitations to tender are expected for July 1995. Work is expected to begin early in 1996 and to be completed towards the end of 1998. Part of the $120 million cost is expected to come from the African Development Bank.

The Jorf Lasfar thermal power station and its third and fourth units are being programmed to enter service by 1999. Between 1994-97, Morocco's installed capacity will increase by nearly 1 300 MW. Other projects already endorsed are expected to add a further 1 960 MW between 1998-2000. The start up of Jorf Lasfar three and four in late 1999 will coincide with that of one of two combined cycle power stations to be built under private ownership.

(Source: Africa Energy & Mining, 7 December 1994, 21 December 1994)

SADC

The Opec Fund for International Development has approved a small grant of $185 000 for a project between the SADC countries and a programme that promotes electrification named Financing Energy Services for Small-Scale Energy Users (FINESSE).

The FINESSE-SADC project calls for a three-year market survey in the SADC countries and for the preparation of business plans for establishing alternative energy companies. An international forum will be set up to facilitate co-operation among development, financial and policy-making bodies.

(Source: Africa Energy & Mining, 11 January 1995)

Senegal

Senegal is still not willing to bow to pressure from donor countries to privatise its electricity company, Sénélec. It has even rejected handing over management of the company to outside firms.

Senegal is not regarded as the worst off in Africa. However, out of energy consumption that barely reaches 1,5 MTOE, electricity accounts for less than 5%. Sénélec has managed to drum up minimum investments, mainly through export credits provided by construction companies. It is also preparing a demand side management programme based on the use of low consumption lights and an effort to curb household demand at peak periods. With regard to street lighting, an annual saving of 51 GWh is deemed possible in 1998 and 76 GWh around the year 2005. Reductions in consumption of household appliances will reach 19 GWh in 1998 and 32 GWh in 2005.

(Source: Africa Energy & Mining, 7 December 1994)

Tanzania

Tanzania is expected to experience increased power cuts this year. There is no lack of major projects, but the short- and medium-term picture is marred by institutional and management problems as well as immediate shortages that call for and hamper sweeping reforms. the European Investment Bank will provide funds for the lower Kihansi hydro-electric project. The 3 x 60 MW power station will only come on stream at the end of the decade.

The start-up of the Songo Songo project is also unlikely to take place before the end of the decade. With regard to the interconnection with Zambia, an agreement was signed between the Tanzania Electric Supply Co. (TANESCO) and ZESCO, under which the latter will supply 200 MW. This is twice as much as Tanzania needs at the moment. This will form part of the Southern and East African electricity pool that Eskom is promoting. Thus Tanzania will receive power via Zambia, but not before 1997 at the earliest.

(Source: Africa Energy & Mining, 11 January 1995)

Hydro-electricity

Ghana is to push ahead with the construction of a hydro-electric power station at Bui. If this becomes a reality, it could enable the country to remain a surplus producer and a major electricity exporter well into the 21st century.

The Bui power station is located near the Ivory Coast on the Black Volta. A feasibility study was undertaken and the estimated cost of a 400 MW station has been put at $450 million. It is hoped that work could begin in 1998 and that it will be completed by the year 2002.

(Source: Africa Energy & Mining, 11 January 1995)

Ethiopia and Uganda are planning to develop their hydro-electricity potential based on the Nile River basin. It is likely that Sudan will join them. Preliminary studies have indicated that there is a potential of 1 400 MW in the Uganda part of the Nile.

In Ethiopia, a study is to be started shortly concerning an "integrated development" of the Abbay valley, including a survey of its hydro-electric potential.

(Source: Africa Energy & Mining, 21 December 1994)

Based on a pre-feasibility study on the interconnection between the Inga project in Zaire and Egypt, the planning director for the Société Nationale d'Electricité (SNEL) claims that there is the possibility that Zaire will one day boast a "Great Inga" project with new dams totalling 39 000 MW of installed capacity or 80% of the Inga site's estimated hydro potential. This project would be carried out in stages and leave Zaire with more than enough capacity to serve Egypt and be brought into a future integrated Southern African network.

Such a project is expected to cost $13,3 billion, while another $15,6 billion would be needed to build the line to Aswan. The dam system would involve 13 sections of 3 000 MW (4 x 750 MW each). The first phase would cover two sections, or 6 000 MW, but sales of electricity to Egypt would only start in the year 2010. The price would be highly competitive and would work out to be roughly four times less than the current cost of electricity in Egypt.

(Source: Africa Energy & Mining, 8 February 1995)

Natural Gas

The World Bank is expected to approve the extension of an existing gas pipeline in Nigeria between Escravossa and the Egbin power station near Lagos extended to Ghana via Benin and Togo. The World Bank has scheduled its last evaluation mission for March 1996. Funding of $260 million is to be split between the Bank and the International Development Association. This will account for no less than 72% of the total estimated cost of the scheme which will be carried out by an international company that is to be set up under the name West Africa Pipeline Company (WAPC). The WAPC will seek private investors but the Bank will also increase its contribution through the International Finance Corporation (IFC).

The IFC will co-finance the remainder of the total cost in the form of loans but the gas and/or electricity companies in the four countries in question will also take stakes. A pre-feasibility study is underway. The scheme aims to ensure that gas which Nigeria presently burns off is put to use in high-efficiency power stations. In Ghana, a final decision is expected soon on a project for a 300 MW combined cycle power station at Takoradi that will eventually run on Nigerian gas.

(Source: Africa Energy & Mining, 7 December 1994)

Nigeria's project to export liquefied natural gas (LNG) has got underway. A memorandum has been drawn up between Nigerian LNG (NLNG) and the constructors, TSKJ (Technip, Snamprogetti, Kellogg, JGC) to build the liquefaction plant and auxiliary facilities at Finima on the island of Bonny.

An initial agreement signed in 1991 with ENEL for the sale of 3,5 billion m^3/year of gas, or 59% of the plant's capacity is to be confirmed. Italy will also ensure that a re-gasification terminal able to receive the Nigerian gas would be built on schedule, that is, by 1999 when Nigerian exports are to begin.

The LNG plant will be privatised, with the government share at 49% and IFC at 2%. Shell Gas BV will take a 24% share, Elf 15% and Agip 10%.

(Source: Africa Energy & Mining, 7 December 1994)

The Nigerian oil minister signed an agreement in early January with the oil ministers of Benin, Togo and Ghana to carry through a project to build a regional gas pipeline. It will be an extension of the Escravos Egbin (Lagos) pipeline and will run to Takoradi, supplying gas to the electricity networks in the three countries.

The signing of the agreement ensured that Ghana will use Nigerian gas for its future 300 MW combined cycle power station near Aboadse on the Ghanaian coast.

The World Bank will provide funding totalling $260 million towards the project, which is expected to cost a total of $360 million.

Initial studies showed that there would be an estimated market of 1,8 billion m^3 of gas in the three countries served by the line when it comes into service in 1998.

(Source: Africa Energy & Mining, 11 January 1995)

Oil

Saudi Arabia has had talks with the South African government on a proposal to lease storage capacity at Saldanha Bay to the Saudis. In mid-1994, the South African government decided to step up the reduction in the country's strategic oil stocks and lease part of the underground tank farm to foreign producers.

Iran is also pursuing negotiations with South Africa. Iran has boosted oil deliveries to South African refineries and to the Strategic Fuels Fund from 100 000 bpd to 200 000 bpd.

(Source: Africa Energy & Mining, 25 January 1995)

Waste

The Tanzanian division of Denmark's Carl Bros hopes that a project for a power station that will generate 9 MW running on methane from household and other garbage can be set up as a private sector operation. The Tanzanian electric utility (TANESCO) has agreed to buy the power station's electricity "at market prices" and distribute it, while Carl Bros will be free to also sell power directly to industrial customers.

(Source: Africa Energy & Mining, 21 December 1994)

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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 the End-use of Energy and the Environment.

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

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Mr Botha graduated as a civil engineer in 1970, and spent a year in the construction industry. Thereafter he was a consulting civil engineer for three years before being appointed as the City Engineer of Welkom, a position which he held for 13 years.

He joined the Development Bank of Southern Africa (DBSA) in 1988, first as a Divisional Manager to External Human Resources and Urban Development. He became Group Manager in 1991 of the Urban Development Group, and after the restructuring of the DBSA in 1993 was appointed as General Manager. Mr Botha is presently Executive Manager responsible for DBSA relations with Italy, Spain, Portugal, Cyprus and Central and South America, and is the Policy Programme Manager for Infrastructure at the Bank.

Mr Botha has served on various councils and committees, and was Director of the South African Institute of Civil Engineers between 1985 and 1988. He also has various business interests in Randburg and Klerksdorp.

He is married, and has three children. Mr Botha is a keen sportsman - golf, jogging and gym.

BOTHA R K

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Mr Botha graduated with a law degree from the University of Pretoria, after which he joined the South African Foreign Service and was given several overseas postings. When he returned to Pretoria he served in the Africa Division. He became law adviser to the Department of Foreign Affairs, and finally as Under-Secretary, was responsible for South West Africa and the United Nations.

He was a six-time member of the South African delegation to the United Nations General Assembly, and has been South African Ambassador to the United Nations and the United States respectively.

In 1970 he was admitted to the Bar as an advocate of the South African Supreme Court and elected Member of Parliament. As a Member of Parliament for 25 years, 17 of which he served as South Africa's Foreign Minister, Pik Botha was appointed as South Africa's Minister of Mineral and Energy Affairs in May 1994.

DAVISON M T

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Marie Davison is Corporate Strategy Consultant in the Growth and Development Group of Eskom. She is particularly involved in Eskom's interests in natural gas, scenario planning, and energy and electricity policy development.

Marie joined Eskom in 1969 after graduating from the University of Natal, and she has worked in various fields of electrical engineering. Her initial interest was in telecommunications, and she was instrumental in implementing the computer-based Natal Telecontrol system, NATELE, in the late 1970s. From the 1980s her spectrum of work broadened into project engineering for substations and later, project management for national telecommunications systems.

From 1986-1987, Marie was Assistant Regional Manager of the Eastern Transvaal Region, Witbank and Western Transvaal Region, Johannesburg. She moved to Marketing late in 1987 and was National Marketing Strategy Manager from 1991 to 1993.

Marie has continued to meet new challenges through further study. In the 1970s she completed a diploma at the Philips International Institute of Technological Studies in Eindhoven in the Netherlands. She also completed the Graduate Diploma in Engineering at the University of the Witwatersrand. In 1985, UNISA awarded her their Gold Medal for the Management Development Programme she had developed at Eskom. She is presently registered for an M.Sc. (Eng.) degree at the University of the Witwatersrand.

The ECSA has on several occasions invited Marie to participate in and lately, to lead the electrical team for university accreditation visits. She has also been invited to participate in the IEEE accreditation visits to South Africa. She has promoted engineering in career guidance work and particularly recommended it as a desirable career for women.

Apart from her engineering interests, Marie has been President of the Soroptimist International Club, Johannesburg, and has served on the Executive Committee of the Executive Women's Club of South Africa.

Marie is married, with two stepsons and daughters-in-law, and three grandchildren. She enjoys relaxing in the Pilanesberg for game and bird watching. She also enjoys the theatre, music and reading.

DE VILLIERS M G

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Following his undergraduate studies Mark de Villiers worked initially as a water treatment engineer. He joined the Energy Research Institute in April 1992 after completing a Master's programme at the Institute. His half-thesis was on energy management in industry, and included a case-study on the brewing industry. He is currently working on energy and environmental research projects. Major projects include a study of the brown haze in Cape Town, development of an industrial energy efficiency strategy for South Africa, energy efficiency collaboration with countries in the region, and energy audits in industry.

DU TOIT J

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Fax.: (021) 808 2409

Joan du Toit works as an energy researcher on a project entitled "Environmental scanning and scenario development for long-term energy planning in South Africa". She co-produces an annual compendium, *Energy Futures*, and a quarterly scanning document, *Energy-Scan*. She is responsible for liaising with a wide variety of persons active in the energy field, and for organising an energy discussion group.

DUTKIEWICZ R K

B.Sc.(Eng.)(Wits), M.Sc.(Eng.)(Wits), Ph.D.(Cambridge), Pr.Eng., FIMechE, Hon.F(SA)IMechE, MBIM, FInstE, C.Eng.
Professor of Applied Energy and Director, Energy Research Institute, University of Cape Town, P O Box 207, Plumstead 7800, South Africa
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Fax.: (021) 705 6266

Professor Dutkiewicz was born in Poland and obtained his schooling in the United Kingdom and South Africa. He received his B.Sc. and M.Sc. 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 within 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.

HUISMANS J W

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Dr Jan Huismans was trained as a biologist at the State University Utrecht (Netherlands). He worked as a toxicologist and as toxicological adviser for the Dutch Organisation for Applied Scientific Research (TNO) and the Dutch Health Council respectively. From 1977 to April 1993, he was Director of the International Register of Potentially Toxic Chemicals (IRPTC) which is a Programme Activity Centre of the United Nations Environment Programme (UNEP) based in Geneva. He is now Assistant Executive Director, Office of the Environment Programme, at UNEP Headquarters in Nairobi.

KONCZ J K

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Judi Koncz is currently the General Manager (Planning) of SAD-ELEC, a non-governmental organisation which facilitates the implementation of power sector expansion initiatives in Southern Africa.

A business strategist, she was formerly with Eskom's International and Corporate Strategy divisions, and the Sheri-Lynn group in the U.K.

She is a graduate of the University of the Witwatersrand and UNISA.

KOTZÉ I A

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Dr Izak ("Sakkie") Kotzé obtained a Masters degree in Physics from the University of Pretoria in 1965 and subsequently joined the then newly established University of Port Elizabeth as a lecturer in Physics. During the period 1966 to 1968 he accepted a Research Assistantship at the University of Virginia, U.S.A., where he obtained a D.Sc. degree in Materials Science with a dissertation entitled, "Melting and the structure of Liquids", focusing on a dislocation model of the melting process of metals. He subsequently taught at the Universities of Pretoria and Port Elizabeth, and joined what was then known as the Uranium Enrichment Corporation of South Africa in 1974 as a Materials Scientist, progressing to the position of Assistant Manager: Materials Science.

After spending a year as Chief Techno-economist in the Directorate Technology Promotions of the Department of Trade and Industry, he joined what was then the National Energy Council in 1989. He currently holds the position of Director: Energy for Development in the Chief Directorate: Energy, Department of Mineral and Energy Affairs. In this capacity, his work entails policy development with regard to the energy issues of the developing sector of South Africa, as well as the promotion of those renewable energy sources available to the country, particularly solar, wind and biomass energy.

LENNON S J

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Manager: Scientific Services, Technology Research and Investigations, Eskom, Private Bag 40175, Cleveland 2022, South Africa
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Steve Lennon spent one year with the CSIR's Division of Materials Science and Technology before joining Eskom's Technology Research and Investigations' (TRI) Metallic Corrosion Group in 1986. He was appointed Head of the Corrosion and Non-Metallic Group in 1987. In 1989, he was appointed Scientific Investigations Manager, which meant that he was responsible for chemical, materials and environmental tests, investigations and research at Eskom. He became Scientific Services Manager in 1991.

His interest in environmental matters is reflected further in some of the other offices he holds. These include President of the S A Corrosion Institute, Chairman of the S A Electrolytic Corrosion Committee, and Chairman of the Energy Use Task Group of the Interdepartmental Co-ordinating Committee for Global Climate Change.

LINDSAY I D

Secretary-General, World Energy Council, 34 St. James's Street, London SW1A 1HD, United Kingdom
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Fax.: (0944) (71) 925 0452

Ian Lindsay graduated from Oxford University with a Masters degree in law. In 1969 he attended the Harvard University Programme for Management Development in the U.S.A.

Between 1959-1986 he worked for the British Petroleum Company in various countries and capacities, ending as Director for Africa.

From 1987 to the present he has been the World Energy Council's Secretary-General based in London. His policy can be described as "expansionist" in that he has attempted to establish the WEC world-wide as *the* prime multi-energy non-governmental organisation.

MBUENDE K M

BD, B.A.(Hons.) (Lund), Ph.D. (Lund)
Executive Secretary, SADC Secretariat, Private Bag 0095, Gaborone, Botswana

Dr Kaire Mbuende's career consisted of two main interests: academic and politics. Most of his academic studies were pursued in Scandinavia, specifically Sweden and Denmark. His main areas of interest were economic history and economic sociology in which he received his Ph.D. in 1986. In 1981, he was Assistant Lecturer at the University of Aarhus in Denmark. Between 1984-1987 he lectured at the University of Lund, Sweden.

Dr Mbuende's political interests began in 1972 when he became a member of the SWAPO Executive Committee. In 1989 he was the Regional Head of the SWAPO Election Directorate in Gobabis, Namibia, and later became a member of the Constituent Assembly. Thereafter he served on several committees related to development and land reform, becoming in 1991 a member of the Presidential Committee on Parastatals.

He was elected to the Namibian Parliament in 1990 and was given the portfolio of Deputy Minister of Agriculture, Water and Rural Development.

In 1994 he became Executive Secretary of the Southern African Development Community (SADC).

He has published several books, such as, *Namibia, the broken shield: Anatomy of imperialism and revolution* (1986), *Church and liberation in Namibia* (1989), and *Social movements and the demise of apartheid colonialism in Namibia* (soon to be published).

Dr Mbuende is married and has three children.

MCRAE I C

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Chairman, National Electricity Regulator, P O Box 785080, Sandton 2146, South Africa
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Nowadays the name of Ian McRae is synonymous with Eskom. Ian Campbell McRae started with Eskom as an apprentice fitter in 1947 where his obvious ability resulted in him being sent to the University of the Witwatersrand where he obtained his B.Sc.(Eng.) degree in Mechanical Engineering. He was then allocated to the generation side of Eskom's activities. Promotion saw him transferred to Eskom's Head Office. In 1980 he became General Manager of Operations, and in 1984 he was promoted to General Manager of Engineering. In 1985 Dr McRae was designated Chief Executive Officer and Chairman of the Management Board, positions which he held until 1994.

His success in Eskom has also been recognised outside the organisation. He has been awarded an Honorary Doctorate in Engineering by his Alma Mater - the University of the Witwatersrand - in recognition of his efforts in the economic upliftment of South Africa and her neighbouring states, and for his attempts to improve the quality of life for the developing sector of the country. Other awards include Honorary Fellowship of the South African Institute of Measurement and Control, Fellowship of the College of Engineers of the Society of Professional Engineers, Honorary Fellowship of the Institution of Nuclear Engineers, Gold Medal Award - Mechanical Engineer (1991) from the S.A. Institution of Mechanical Engineers, and the Engineer of the Year award (1992). In 1993 he received the Order for Meritorious Service - Gold from the State President. On 1 March 1995, Dr McRae takes on the position of Chairman of the National Electricity Regulator.

Dr McRae is married to Jessie and they have two children, Heather and Donald, neither of whom have followed in their father's footsteps. Ian McRae also enjoys a keen and regular game of bowls, and he also jogs. Other interests include gardening, the theatre and watching sport.

MUTHARIKA B

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Dr Bingu Wa Mutharika is presently the Secretary-General of the Common Market for Eastern and Southern Africa (COMESA). He has extensive experience in regional integration, development finance, monetary economics and trade.

In his Masters degree, which he obtained from Delhi University, he specialised in banking, monetary economics, mercantile law and trade. He obtained his Ph.D. in Economics from the Pacific Western University, California, U.S.A. He also attended short courses in business practices and financial management at the George Washington University, Georgetown University and the American University, Washington, D.C., U.S.A. Dr Mutharika has accumulated more than 30 years experience at different management levels.

He is a citizen of Malawi, and has held the positions of Administrative Officer in Malawi's Ministry of Finance, and Principal Administrative Officer in Zambia's Ministry of Finance. In this position, he was responsible for policies in banking, currency, foreign exchange and insurance and liaised with the Reserve Bank of Malawi and the Bank of Zambia.

Between 1975-1978, Dr Mutharika worked at the World Bank where he gained experience in development financing and project management, and was responsible for channelling finance to rural agricultural and industrial development posts, harbours, highway and road projects; rural credit and development finance institutions. He also held top management positions in international relations in the Division of Trade and Finance, specialising in African regional economic integration, trade development, as well as co-operation between Europe and Africa.

Dr Mutharika has also published several books, such as *Towards multinational economic co-operation in Africa; Regionalism in Africa and the new international economic order*; *Transnational corporations and technical co-operation among developing countries; Multinational co-operation in regional integration: The African experience; One Africa, One destiny* (in press).

OTT G

Chairman of the Executive Assembly, World Energy Council, 34 St. James's Street, London SW1A 1HD, United Kingdom
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In 1951 Gerhard Ott graduated from the University of Munich Law School. In 1957 he went on to complete postgraduate studies at the University of Michigan Law School, Ann Arbor, U.S.A. In 1958 he was at the Bayerische Hypotheken- und Wechselbank, Munich.

Some of the other highlights of Dr Ott's career are that in 1968 he was the

Managing Director of the Gas-Unie GmbH, Frankfurt, Germany. In 1970 he was appointed as Member of the Board of the West German National Coal Association, and in 1980 he became the Managing Director.

His involvement with the WEC began in 1977 when he was appointed as Executive Director of the Organising Committee of the 11th World Energy Conference which was held in Munich in 1980. In 1989, he was appointed as Chairman of the Executive Assembly of the WEC in London.

SALL K

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Mr Khalilou Sall is presently a consultant for the African Development Bank (ADB) in Abidjan, Ivory Coast, and he is also the Co-ordinator of the ADB's African Energy Programme.

STACEY H

C.A.(Zimbabwe)
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Hugh Stacey is a Marketing Director for Anglo American Coal Corporation.

He also has a keen interest in sport, particularly bowls.

STASSEN G

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Infrastructure Policy Programme Co-ordinator, Centre for Policy Analysis, Development Bank of Southern Africa, P O Box 1234, Halfway House 1685, South Africa
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Deon Stassen obtained a B.Sc. degree at the Rand Afrikaans University (RAU) in 1978, and in 1982 received a B.Sc.(Hons.) degree from RAU's Institute for Energy Studies. In 1986 he was awarded a M.Phil. in Energy Studies from the Institute for Energy Studies.

He worked as a Professional Research Officer at the Chamber of Mines' Research Laboratories, and thereafter joined the then Energy Branch of the Department of Mineral and Energy Affairs as Assistant Director: Renewable Energy Sources. In 1986 he joined the Development Bank of Southern Africa. His present position at the Bank is Infrastructure Policy Programme Co-ordinator in the Centre for Policy Analysis.

He has also been chairman of the Photovoltaic Industries Association and the Solar Energy Society of Southern Africa. He is currently active in the Working Groups of the National Electrification Forum.

VEDAVALLI R

Ph.D. (Delhi)
Principal Economist, Industry and Energy Department, World Bank, 1818 H Street, NW, Washington, D.C. 20433, United States of America
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Dr Rangaswamy Vedavalli obtained her Ph.D. from the School of Economics, Delhi University, India. She was awarded the Prof. Chablani Memorial Prize for the best Ph.D. dissertation from Delhi University. Her thesis was entitled, "Private foreign investment and economic development: A case study of the Indian Petroleum Industry", which was later published by Cambridge University in the U.K. Dr Vedavalli also received a post-doctorate distinction in economics from the London School of Economics.

Prior to joining the World Bank, Dr Vedavalli was the Economic Adviser to the government of Venezuela and a member of the Venezuela Energy Board. She also prepared a series of lectures on private investment in energy and economic development in Venezuela for the Minister of Planning and Finance. These lectures were delivered at the Tuft University, Boston, U.S.A. and later published by the Cambridge University Press, Boston, U.S.A. She was also consultant to OPEC and UNIDO and wrote on economics and private investment opportunities for alternative energy sources, and private investment and industrialisation in developing countries.

Since joining the World Bank, Dr Vedavalli has had eighteen years of experience in operations, sector work, policy, research and advisory functions in the energy sector. She has been Mission Leader for complex, multi-disciplinary sector adjustment and project missions addressing pricing, sector reform, restructuring, privatisation, energy efficiency, demand side management, and pollution control issues in over 30 countries world-wide.

Some of the specific activities Dr Vedavalli has undertaken include the preparation of Bank policy papers on petroleum exploration promotion, power and efficiency and regional energy strategies; petroleum exploration promotion projects to private investors in Nepal, North and South Yemen, Thailand, Jordan and the Philippines; energy sector adjustment loan and power projects in Colombia, Egypt, Tanzania and Jordan; environment and industrial pollution control projects in Egypt and Jordan; energy sector work in countries such as Egypt, Jordan, Madagascar and Zambia, Energy Sector Management Programme (ESMAP) technical assistance in Egypt and Zambia.

Forthcoming energy and energy-related conferences: 1995/1996

1995

APRIL 1995

3-4

DOMESTIC USE OF ELECTRICAL ENERGY Cape Town, South Africa

Enquiries: The Domestic Use of Electrical Energy Secretariat, Attention: Anna le Roux, P O Box 652, Cape Town 8000, South Africa

Tel.: (021) 460 3151
Fax.: (021) 460 3217
Email: nbeute@maxwell.ctech.ac.za

19-21

INDUSTRIAL UTILITY EFFICIENCY Johannesburg, South Africa

Enquiries: Attention: Conference Administrator, International Executive Communications Ltd, P O Box 91052, Auckland Park 2006, South Africa

Tel.: (011) 726 6003
Fax.: (011) 726 1304

24-26

GLOBAL ENVIRONMENTAL CHANGE : IMPLICATIONS FOR SOUTHERN AFRICA : REGIONAL CONFERENCE Pretoria, South Africa

Enquiries: Mrs Louise Botten, The SA IGBP Secretariat, Foundation for Research Development, P O Box 2600, Pretoria 0001, South Africa

Tel.: +27 (12) 841 4429 (Mrs L Botten)
+27 (12) 841 3887 (Mrs B de Beer)
Fax.: +27 (12) 841 3791
Email: louise@frd.ac.za
bettie@frd.ac.za

JUNE 1995

26-30

FIFTEENTH ANNUAL TRANSPORTATION CONVENTION (ATC 95) Pretoria, South Africa

Theme: Transport: A catalyst for development

Enquiries: Conference Planners, P O Box 36782, Menlo Park 0102, South Africa

Tel./Fax.: (012) 46 0170 (Ammie Wissing)

JULY 1995

18-21

HOUSEHOLD ENERGY FOR DEVELOPING COMMUNITIES Midrand, South Africa

Enquiries: The Conference Organiser, P O Box 2862, Randburg 2125, South Africa

Tel.: (011) 886 8313 (Estelle Lotter)
Fax.: (011) 886 9916 (Estelle Lotter)

SEPTEMBER 1995

9-16

ISES 1995 : IN SEARCH OF THE SUN Harare, Zimbabwe

Enquiries: In Search of the Sun, P O Box 2851, Harare, Zimbabwe

Tel.: (263)(4) 730 707
Fax.: (263)(4) 730 700
Email:XCARELSE@ZIMBIX.UZ.ZW

18-20

PV CON '95: A CONFERENCE ON PHOTOVOLTAIC TECHNOLOGY Kruger National Park, South Africa

Enquiries: Conference Secretariat, Thereza Botha, Techno Scene, P O Box 70251, The Willows 0041, South Africa

Tel: (012) 807 0869
Fax.: (012) 807 1699

OCTOBER 1995

26-27

TWELFTH ANNUAL CONFERENCE ON ATMOSPHERIC SCIENCES Pretoria, South Africa

Enquiries: Chairman of the Organising Committee, Mr S O'Beirne, S A Society for Atmospheric Sciences, c/o Ematek, CSIR, P O Box 395
Pretoria 0001, South Africa

1996

APRIL 1996

14-17

ELEVENTH INTERNATIONAL SYMPOSIUM OF ALCOHOL FUELS (ISAF XI) Sun City, South Africa

Enquiries: ISAF XI, P O Box 207, Plumstead, South Africa

Tel.: (021) 705 0120
Fax.: (021) 705 6266

Recent energy publications

ANNECKE W

An in-depth investigation of fuel use by urban women. Dec-1994. 128p. + appendices.
Report No. EO9117

The report focuses on the use of energy by women living in the informal settlements of Canaan and Clermont, in conditions of poverty. These are compared with the conditions of women living in KwaMashu in formal dwellings and relatively better surroundings. The study attempts to interrogate and define factors which influence energy selection and consumption. In terms of the former, the primary influence of the means of income generation is confirmed. In terms of the latter, the study begins to elucidate the influence of household, and particularly power relations (who performs the tasks of heating water and cooking, and therefore energy use patterns). The report flags the importance of changing gender roles, and also looks at the role of children.

COOPER C J

Proposals for a national energy database and information system. Aug-1994. 53p. + appendices.
Report No. EG9403

Discusses the main issues surrounding the development of a national energy database and information system. The main issues are that there should be a single, comprehensive national energy database, which is compiled in a standardised manner. This would require state involvement and thus legislation. The need for the funding of such a project will need to be discussed and debated between the state and the energy industry. Recommendations are made for the creation and operation of a national energy information system. The appendices contain examples of energy questionnaires to the various industries in other overseas countries.

COWAN W D

Proposed planning framework for solar electrification in South Africa. Nov-1994. 24p.
Report No. EO9415

The purpose of this document is to propose a planning framework for solar electrification activities in South Africa. Contains proposals for establishing an interim co-ordinating committee and a suggested process for establishing appropriate longer-term planning and implementation structures. Outlines the requirements for successful expanded solar electrification in South Africa. Currently planned projects and programmes which will help to meet these requirements are tabled.

COWAN W D

Electricity for rural institutions: Guidelines from the IDT clinics electrification programme, 1993. Mar-1994. 43p. + appendices.
Report No. EO9305

The aims of the study were to, (1) monitor, document and evaluate the progress of the IDT clinics electrification programme during 1993, focusing on the RAPS electrification component; (2) to provide a concise overview of programme developments; (3) to identify success factors and constraints, particularly related to RAPS electricity; (4) to record any guidelines, identified in the programme experience during 1993, which may contribute to the successful extension of this programme.

DAVIS M and HORVEI T

Handbook for the economic analysis of energy projects. Oct-1994. 1V.(various pagings)
Report No. EO9401

This handbook describes and illustrates the application of economic analysis tools to energy projects at the micro-level. Discusses the concept of economic analysis and the methodology. Also looks at multiplier effects, intangibles and externalities; practical issues relating to the cost-benefit analysis of energy projects; resources; and two case-studies, one relating to electrification in the former Transkei.

DYER S T

Identification and wood properties of 300 fuelwood samples. Nov-1994. 103p.
Report No. EO9412

The main objective of this study, which forms part of the Biomass Initiative, was to collect information relating to the use and preferences by rural communities of tree species. Fuelwood species were collected from the former Bophuthatswana, Ciskei, Gazankulu, KaNgwane, KwaNdebele, Lebowa, Transkei and Venda. The ratios of indigenous to exotic species used for fuelwood varied from region to region, with the highest percentage of indigenous species used in Gazankulu and KaNgwane and the highest percentage of exotic species used in the Transkei.

HOFMEYER I *et al.*

Assessment of Masizakhe Energy Information Centre. Apr-1994. 56p.
Report No. EO9313

This describes the assessment of the Masizakhe Energy Information Centre at Khayelitsha, Cape, in South Africa. The goals of the Centre were to establish an energy centre through which to inform and educate the community in the efficient and safe use of all energy sources. The report evaluates the present operation of the Centre and provides guidelines for its improvement, and also for the establishment of other urban energy centres. The kind of energy information required covers health and safety; general energy information; career counselling; training; appliance sales; fuel sales; energy efficiency; and environmental concerns.

HURLIN D C R

The role of national energy research, development and technology in South Africa. Jan-1994. 55p.
Report No. EG9305; NEPS11

This study is a synthesis of the policies, activities and priorities of the energy sector in South Africa, including policy-related studies and activities that have taken place from 1986. It also identifies policy constraints and gaps, and arrives at and analyses policy options, identifying their future priorities. The study addresses both the urban and rural situations where appropriate.

NAUDE C M

A study of the relationship between energy policy and the demand for fuel in transportation: A historical perspective since the 1985 draft White Paper on energy policy. Jan-1995. 1V.(various pagings)
Report No. VE9302

Examines energy policy in South Africa and liquid fuel demand prior to the 1986 White Paper on energy policy, and to a greater extent, the period following the White Paper. The report examines the

principal tenets of energy policy up to 1986, as well as the main demand issues and influences during the period. Thereafter the major part of the document outlines in some detail the contents and implications of the White Paper, as well as views on energy policy which emanated from various stakeholders. Finally, issues important to demand analysis are discussed to indicate the amount and direction of work funded by the Department of Mineral and Energy Affairs in this area.

PRETORIUS P H

Power frequency electric and magnetic fields. Mar-1993. 91p.
Report No. EL9103

Reports on a three-part study on the electric and magnetic fields in transmission line and substation environments based on Eskom experiences. Part I considers the effect of variation in system parameters on the electric and magnetic fields at ground level and focuses specifically on a 400 kV line. The application of existing models to predict electric and magnetic field intensities close to power lines is covered in Part II. Part III deals with field data obtained from transmission line and substation environments. Considers both field simulations and measurements.

ROGERS D E C and PIETERS C J

Laboratory tests of emissions of particulates and gases in smoke from 3 low smoke fuels and one domestic coal. Dec-1994. 37p.
Report No. EO9304

Laboratory tests have been carried out in three low smoke test fuels produced in Southern Africa and one coal sample taken from a coal merchant in Evaton. Testing was carried out at the CSIR laboratories. The main pollutants measured were particulates, SO_2, NO_x and CO. TOG was also measured. Combustion was carried out in a low smoke stove following the requirements of SABS 1111. It was found that the low smoke fuel reduced emissions by 2 to 6 times.

ROUSSEAU P G *et al.*

Practical viability of a compact evaporative cooling system. Nov-1994. 30p. + appendices.

Report No. ED9203

The primary objectives of the project were to (1) evaluate the practical viability of this closed loop, plastics plate, parallel flow, indirect air cooler as an office-type unit, (2) to make recommendations for further improvements to the system based on the results of the study. An optimisation study was conducted on the heat exchanger itself. Several new ideas were also implemented to improve the efficiency of the system as a whole. Despite technical innovations made to the system, an effective thermal efficiency of only around 55% was obtained. It was therefore not seen as a viable option for office air conditioning.

TROLLIP H L

National domestic energy use database system. Nov-1994. 78p.
Report No. EO9301

Describes a computerised database containing information on household energy use studies and key quantitative data from the studies. The database attempts to provide a comprehensive collection of all research on low-income household energy usage that has been done in South Africa in a consistent format and to provide quick access to key quantitative data from this work. The main objective of this report is to make the database accessible for use as a research and planning tool and to contextualise the database. The database is programmed in the Microsoft access system. The report is not a user manual. Rather, it contains a description of the motivation for the work, the approach used, the database structure and examples of information in the database.

TROLLIP H L

National domestic energy use database system: Appendices. Nov-1994. 1V.(various pagings).
Report No. EO9301

Appendix 1 is an author listing of bibliographic and selected review information of all studies in the database. Appendix 2 is an author listing of studies which include surveys. Appendix 3 is a brief list, by locality, of studies in the database. Appendix 4 contains numerical data for rural localities on the percentage of households using fuels. Appendix 5 shows the detailed structure of the database, including a list of all database fields. Appendix 6 is a keyword index for studies in the database.

VILJOEN R

Analysis of backlogs in energy provision in the developing areas and scenarios for their reduction by the year 2004. Dec-1994. 52p.
Report No. EO9314

Looks at the range of fuels used in the developing areas of South Africa, and analyses the consumption and expenditure patterns of these fuels. Also considers the potential of new fuels. Analyses the growth and change in energy consumption patterns of the developing areas. The major requirement is to establish the total financial requirements, and the potential impact on the economy of various programmes to reduce socio-economic backlogs. The purpose of the report is to test the implications of various energy provision scenarios for the developing areas on future central government budgets.

WEBBER D J and NORTHROP P A

An overview of the establishment and running of the Masizakhe Energy Information Centre in Khayelitsha. May-1994. 35p. + appendices.
Report No. EO9002

The aims of the project were to establish an energy marketing and information centre in Khayelitsha, in order to advise, educate and inform the entire community of Khayelitsha, Cape Town, South Africa on the safe and efficient use of energy - particularly domestic energy usage. Includes a feasibility study, the opening and marketing of the Centre.

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The publications can be ordered from: The Librarian, Chief Directorate: Energy, Department of Mineral and Energy Affairs, Private Bag X59, Pretoria 0001, South Africa. Prices are available on request from the Department of Mineral and Energy Affairs.

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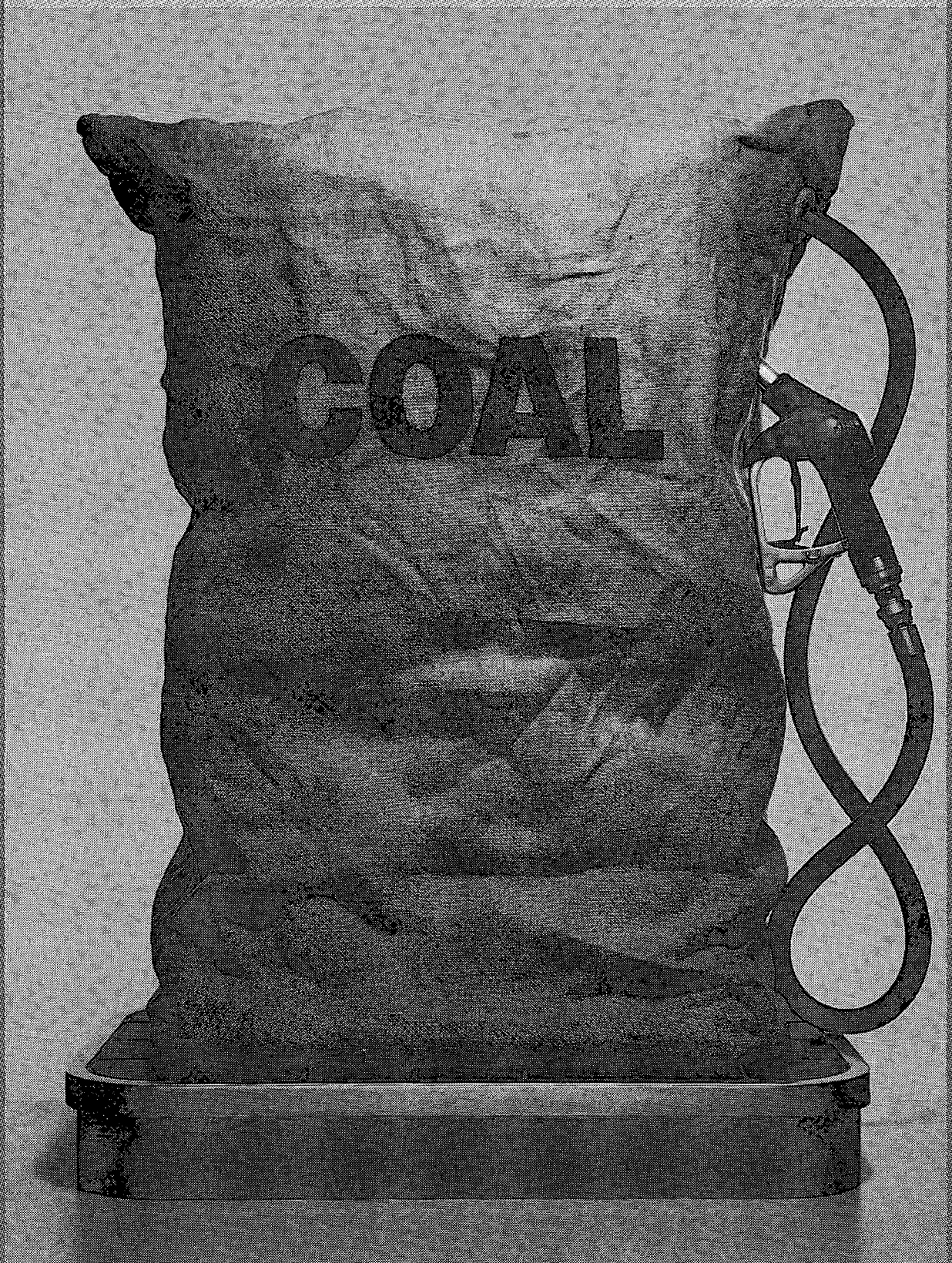

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