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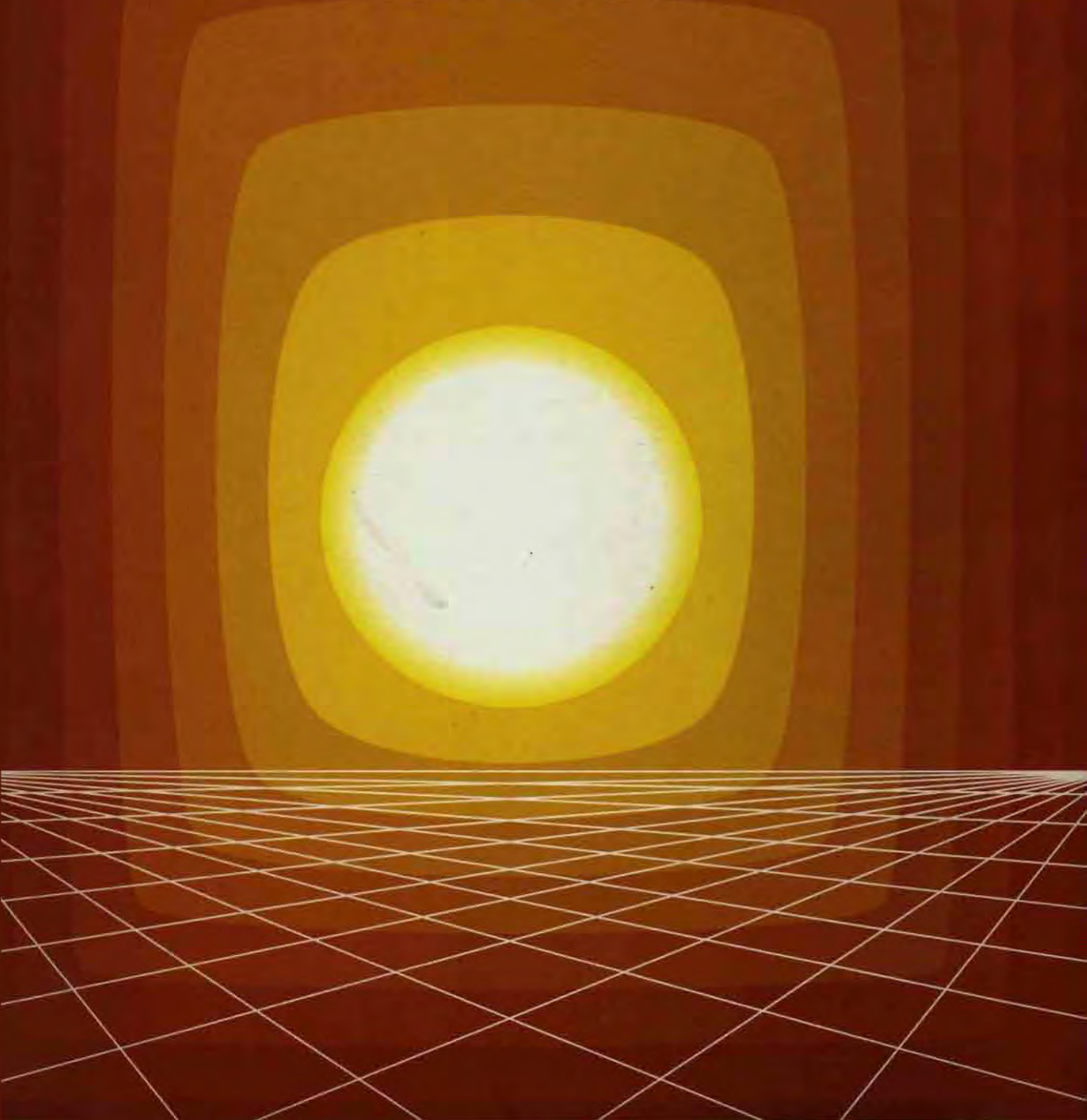


LEADERSHIP IS ACTION
NOT POSITION
"Traditionally business has measured market leadership in volumes and sales and the bottom line. No longer good enough. Right now in South Africa the success of a business will also be gauged by how it values people. Creating opportunities for those they employ. Empowering the lives of those they don't. It makes good sense. Morally. Economically. Business must lead by example. Create an environment in which all people can reach for better things. And grasp them. This is the lead Caltex has taken. For without action, position means nothing."
Mike Rademeyer
Chairman and Managing Director
Caltex Oil South Africa
CALTEX
PROUD SPONSOR OF THE SOUTH AFRICAN TEAM TO THE 1996 OLYMPIC GAMES IN ATLANTA
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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, and of general interest to Africa. Only previously unpublished work will be accepted. However, conference papers delivered but not published elsewhere are also welcomed. Short discussions, not exceeding 500 words, on articles published in the Journal are also invited. Items of general interest, news, technical notes, reviews and research results will also be included. Announcements of relevant publications, reviews, conferences, seminars and meetings will be included.

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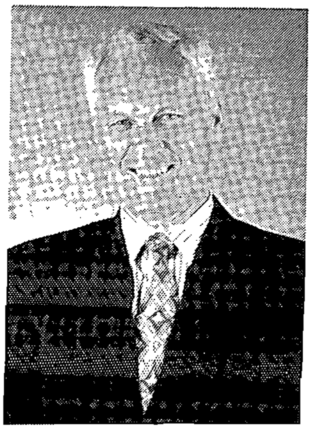
Robert John (Rob) Angel

Chief Executive and managing director, Engen Limited



Rob Angel was born in Adelaide, South Australia. He completed his schooling at Prince Alfred College, Adelaide, and went on to study at the University of Adelaide, where he was later awarded his Bachelor of Chemical Engineering (Honours) degree.

He started his career as a chemical engineer at Mobil's Adelaide Refinery in 1967. After several management appointments he was transferred to the Altona Refinery, Melbourne in [illegible]3, and in 1975 to the Jurong Refinery, Singapore.

In 1978 Rob Angel took up an assignment in New York, at the Mobil Corporation's headquarters, as area co-ordinator for Australasia. Thereafter he moved to Cyprus where he held the positions of chairman and managing director for Mobil. In 1981, he was appointed refinery manager at Mobil's Coryton Refinery in the U.K. and then manufacturing director of Mobil Oil Company Limited. On completion of this assignment in 1984, he returned to New York as the international division planning manager in the marketing and refining division of the Mobil Oil Corporation, where he was responsible for all marketing and refining planning activities outside the United States.

Rob Angel was sent to Cape Town in February 1986 as deputy managing director. In March 1987 he was appointed chairman and managing director of Mobil Oil Southern Africa (Pty) Ltd, where he was responsible for Mobil's operations throughout Southern Africa.

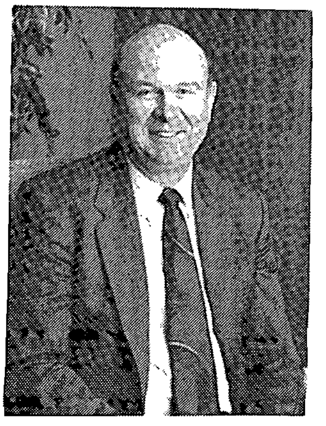
In 1989 the Mobil Corporation disinvested from South Africa, selling Mobil Southern Africa to Gencor, this country's second largest mining house. Rob Angel decided to stay on in South Africa and was duly appointed managing director and Chief Executive of Engen Limited, the newly-created energy arm of Gencor. Engen Limited was floated on the Johannesburg Stock Exchange in May 1990.

Rob Angel is also the chairman of Engen's key group holdings, which include Engen Marketing (Engen, Trek and Sonap) and the group's oil refining complex in Durban. During March 1993 he was appointed to Gencor's board of directors.

Profile:

John Barnard Drake

Chief Executive and chairman, Shell South Africa (Pty) Ltd



John Drake was appointed Chief Executive and chairman of Shell South Africa (Pty) Ltd in November 1993. He joined Shell and BP Service Company Ltd as company secretary in 1969, having previously been a partner in a firm of attorneys, Findlay & Tait. He is a qualified attorney, conveyancer and notary public.

Some of his other notable achievements are that he was president of the Cape Town Chamber of Commerce between 1975 and 1978, and one of the "Four Most Outstanding Young South Africans of the Year" in 1975.

A few of his other previous appointments within the oil company were

* area co-ordinator for Brunei, Malaysia, Indonesia, Thailand, Mynanmar, Cambodia, Laos and Vietnam (EA/2);
* managing director, oil division;
* managing director, coal division;
* retail marketing director;
* company secretary.

John Drake was born in Nairobi, Kenya, and was educated at St. George's Grammar School, the University of South Africa and the University of Cape Town. He is married, with two sons. His main sporting activity is golf.

Profile:

Paul Kruger

Managing director, Sasol Ltd

Paul Kruger has been involved in the oil-from-coal business for nearly 30 years. Since qualifying as a mining engineer in 1959 from the University of the Witwatersrand, and with brief spells in gold and asbestos mining, he has devoted himself to a career with Sasol. In 1973 he obtained an M.B.L. degree from Unisa's School of Business Leadership, for which he received the Old Mutual Merit Award. In 1986, Paul Kruger attended the Stanford Executive Program at the Graduate School of Business in California in the U.S.A. In April 1993, he was awarded the degree of Doctor Scientiae, Honoris Causa, by the University of Port Elizabeth.

Paul Kruger's career with Sasol began in 1964 when he started working at the Sigma Colliery, Sasolburg, where he later became mine manager. After the announcement of the development of Sasol Two in 1974, Paul Kruger was made responsible for the coal exploration and coal mining project phases. He was responsible for the commissioning of Sasol Two and the development of Secunda, and later for all three of Sasol's oil-from-coal operations. In March 1987 Paul Kruger was appointed managing director of Sasol, with executive responsibility for the group. In May 1996, Mr Kruger was appointed as Executive Chairman of Sasol, and from 1 January 1997, he will become Non-Executive Chairman.

He is also chairman of the Rand Afrikaans University, a trustee of the Afrikaanse Handelsinstituut, and a member of the S A Akademie vir Wetenskap en Kuns.

In order to keep fit, Paul Kruger jogs. He also has a keen interest in nature, and whenever possible, spends time in the bush with his camera, enjoying the wildlife, particularly the bird life.

He is married to Gina (neé Claassen) and they have two daughters, Greta and Ciska.

Profile:

Frederik (Fred) Phaswana

Chairman and Chief Executive, BP Southern Africa (Pty) Ltd

Fred Phaswana was appointed chairman and Chief Executive of BP Southern Africa, and head of BP's Africa division as from 1 December 1995. He is the first person, born on the African continent, to hold this position, succeeding Tony Deakin, who held the position since 1990.

Prior to this appointment, Mr Phaswana was president of BP Nederland and BP Belgium, based in Amsterdam and Brussels respectively, and oil director for BP's Benelux companies.

Mr Phaswana joined BP Southern Africa in 1965 and held series of support and line positions before becoming general manager of information systems, services, new ventures, purchasing and procurement in 1988. In 1989 he was appointed to the board of BP Southern Africa, on which he continues to serve. Before leaving for Europe in 1992, Mr Phaswana was also involved in manufacturing and supply, solar, distribution and commercial and industrial marketing.

Mr Phaswana studied at the University of the North and has a Master's degree in Literary Criticism and a B.Com.(Hons.) in Energy Economics. In 1992 he completed the Executive Development Programme at the Massachusetts Institute of Technology in the U.S.A.

Profile:

Sydney Dennis Poole

Managing director and Chief Executive Officer, Total South Africa (Pty) Ltd

Born in Manchester in the U.K., Dennis Poole attended the William Hulme Grammar School in the city, thereafter graduating in Economics from the University of Liverpool. He studied further in the U.S.A., graduating from the Harvard Business School.

After completing his studies, Dennis Poole started working for the United Africa Company Division of Unilever Ltd, where he stayed for four years. He then spent two years with the Cummins Engine Company in Darlington, England.

In 1969 he joined Total Oil Great Britain Ltd as depot supply officer (distribution). He subsequently joined retail marketing and was promoted to regional manager for both the North-Western and Eastern Regions.

In 1978 Dennis Poole was appointed general manager and director of Petropolis Ltd, a subsidiary, running a large chain of high volume retail locations. In 1987 he became director of retail marketing for Total throughout the U.K. He was appointed managing director and Chief Executive Officer for Total South Africa in 1994.

Dennis Poole is married to Lyn and has three children - two daughters and a son.

Profile:

Mike Rademeyer

Chairman and managing director, Caltex Oil (SA) (Pty) Limited

After matriculating from St. John's College, Johannesburg, Mike Rademeyer spent a year working in the mining industry before enrolling at the University of the Witwatersrand to do a B.Sc.(Chem. Eng.). On completion of his studies, Mr Rademeyer spent two years with AECI. He joined Caltex Oil in 1967 where he held positions in the operations division in both Cape Town and Johannesburg. In 1970 he studied for his M.B.A. at the University of Cape Town.

Mr Rademeyer was then appointed to the position of assistant division manager (operations), before being transferred to the Caltex Petroleum Corporation's headquarters in New York as a member of a marketing operations study team. This assignment involved extensive travel and contact with a large number of subsidiaries within the group. Subsequent to his return in 1975 and another stint in the operations division, he was appointed regional manager in the Bloemfontein office.

In 1977 he again travelled to New York where he became the deputy regional director for Southern Africa. An appointment to the position of marketing director of Honam Oil, a Caltex joint venture with the Lucky Gold Star Company of South Korea followed in 1979. Mr Rademeyer then took up the position of managing director of Caltex Thailand before returning to Korea in 1983 as senior vice-president of Honam Oil. In 1983, the King of Thailand bestowed upon him the Royal Order of the White Elephant for services rendered to that country.

Mr Rademeyer returned to South Africa in 1987 as senior general manager of Caltex Oil South Africa. In April 1994, he assumed the position of managing director, to which was added the chairmanship of Caltex Oil South Africa in June 1994.

Mr Rademeyer also serves on the boards of a number of other Southern African Caltex Petroleum Corporation subsidiaries, and is currently the chairman of both the South African Petroleum Industry Association (SAPIA) and the South African Oil Refinery (Pty) Limited.

*Rural energy supply and use: Renewable energies in context - A South African perspective

**I A KOTZÉ

Highlighting the poverty in the rural areas of South Africa, the paper looks at the country's energy resources, relating them to rural energy consumption patterns. The paper discusses the costs of grid electrification in the rural areas, emphasising that renewable energy resources could play a larger role in supplying energy to these areas. It mentions the formation of an independent company, REFSA (Pty) Ltd, to co-ordinate and finance a renewable energy implementation programme in South Africa and which will, it is hoped, offer opportunities for other business partnerships, locally and from overseas.

Keywords: rural energy; South Africa; energy resources; energy consumption; rural electrification; renewable energy; costs; REFSA (Pty) Ltd

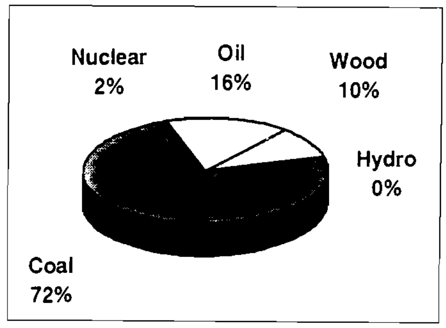


Figure 1a: South Africa's primary energy use (1993)

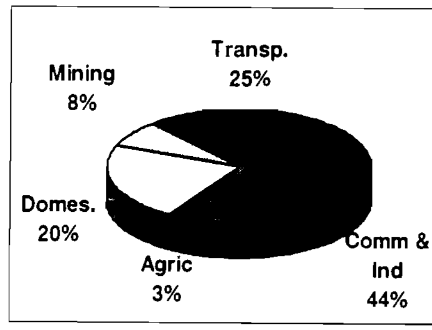


Figure 1b: South Africa's net energy use by sector (1993)

Introduction: The rural poverty situation

The South African economy can be described as a heterogeneous intermingling of First and Third World characteristics. This also holds true for the country's energy economy. With only 4% of the land area and 7% of the population of the African continent, its electrical energy consumption alone is about 60% of that of the continent as a whole. Yet a major part of the South African population, i.e. an estimated 55%-60%, are presently not connected to the national electricity grid and rely on wood (as well as cow-dung and crop wastes), paraffin (kerosene) and coal (if close to the coalfields) for their basic energy needs.

The challenge of the Government of National Unity's Reconstruction and Development Programme (RDP) in the energy field is to provide access to appropriate energy services for this large, growing and often poverty-ridden sector, in support of socio-economic development towards a modern society. In this endeavour South Africa cannot divorce itself from the rest of Africa.

The general prevalence of poverty, compounded by the high rate of unemployment within developing communities, places severe constraints on the ways and means of making affordable energy available. The general magnitude of the poverty situation is not always realised, but it is estimated that about one-third of the population, that is, about 14 million people, are presently living under the accepted poverty datum line.

Access to affordable, secure and appropriate sources of energy is necessary for sustainable human development, although this is not sufficient in itself to ensure development. It is important to note that households have to prioritise energy needs alongside such other basic needs as food, water, housing, sanitation, health and education, as determined by household income or affordability.

The South African energy economy

Because of vast and many as yet untapped coal resources, the South African energy economy is largely coal-based (Figure 1) and this dependency is likely to prevail. South Africa produces some of the cheapest coal in the world and has succeeded in developing electricity generation plants which are able to utilise low-grade coal, as well as being extremely water-efficient. Although South Africa is also one of the largest coal exporters, the estimated resource depletion rate at current production levels is still substantially under 1% of the proven resource per annum. Consequently, currently known resources should have a life of well over a century.

Non-coal conventional energy resources are limited to hydro, nuclear, petroleum and the traditional fuels. Recently a moderate natural gas resource was added in the form of the gas volume uncovered in the Bredasdorp basin off the Mossel Bay coast. Hydroelectricity is generated at four stations, two of which are pumped storage schemes. South Africa also disposes of reasonably large uranium resources, mainly connected to the gold mining operations. At present, it has only one nuclear power station of about 2 000 MW capacity, situated at Koeberg, near Cape Town.

The establishment of a Southern African Power Pool (SAPP) has been mooted for some time. South Africa's acceding to the South African Development Community (SADC) in August 1994 brought further

* This paper was delivered at the ADEME International Symposium on Decentralised Rural Electrification held at Marrakech, Morocco, 13-17 November 1995.

** REFSA (Pty) Ltd, P O Box 786141, Sandton 2146, South Africa

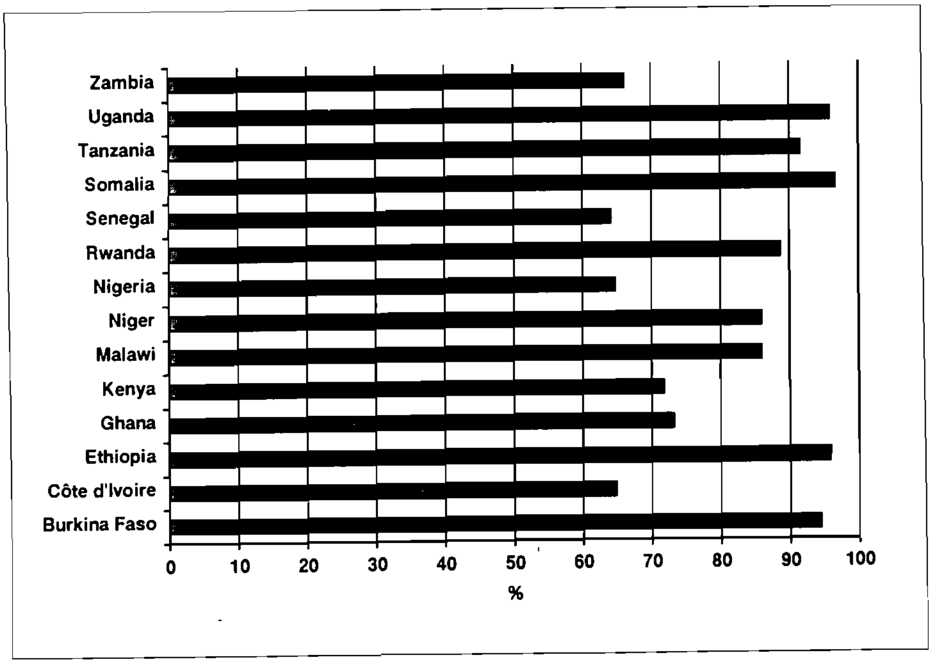


Figure 2: *Biomass energy consumption as a percentage of total energy consumption in selected countries in Africa (1990)*[3]

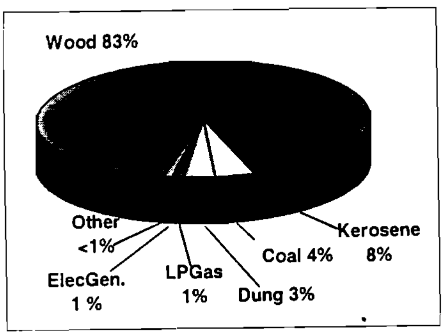


Figure 3: *Net rural energy consumption in South Africa (1993)*[2]

impetus to this concept and an inter-government Memorandum of Understanding, authorising the respective utilities to establish such an undertaking, was signed in August 1995. Although not a Southern African country, Zaire is also included in this arrangement. The SAPP will allow the free trading of electricity between the countries of this region. It will also allow South Africa access to the vast hydroelectric potential found in the countries to the north, notably found the significant potential of the Zaire River, while these countries could in turn benefit through having access to the coal resources in the south. Such an arrangement should stabilise the energy requirements of the region as a whole well into the next century.

The relatively low dependence on biomass as an energy source in South Africa (Figure 1) should be contrasted to the situation elsewhere in Africa (Figure 2), although, as in the rest of Africa, wood remains the main energy source in the rural areas (Figure 3).

In South Africa, being a relatively dry country, the local over-exploitation of the savannah woodland results in severe energy shortages and places an increasing burden on rural women collecting fuelwood and drinking water for household consumption. The increasingly longer distances over which heavy loads have to be carried negatively affects the health of rural women. Even more seriously, the ever-increasing time required to collect fuelwood heavily taxes the time available for engagement in any economic activity or for the production of food.

Rural energy use patterns

Research indicates that people, both rural and urban, use a wide spectrum of fuels for their domestic energy requirements, switching from the traditional fuelwood and crop wastes to the higher order commercial fuels, such as the hydrocarbons and electricity, depending on availability, affordability and utility. Coal is used extensively for cooking and space-heating purposes in the highly urbanised and densely populated Gauteng Province, even in electrified homes. Illuminating paraffin (IP or kerosene) is the single most important hydrocarbon fuel to which households switch, and can indeed be called "the fuel of the poor". Liquefied petroleum gas (LPG), although seen as a clean fuel of high utility, is not widely used mainly due to its relatively high cost.

The natural fuel switching process (which is slow and often reversible during periods of low economic growth), the widespread incidence of poverty, the growing demand for accelerated socio-economic development, the negative environmental impact of current fuel use patterns (urban as well as rural), necessitates a holistic and well-focused approach to energy provision, encompassing the entire spectrum of energy sources, and which can be integrated into a well-planned development programme. This co-ordinated approach is known as integrated energy planning (IEP) and incorporates demand-side, as well as traditional supply-side analyses. Only such an integrated development approach will permit the cost-effective flow of benefits to all sections of the community.

Grid electrification: Rural constraints

Electricity is a particularly important resource. Grid electricity is generally accepted as the modern norm for domestic energy supply. It is relatively easy to generate, can be transmitted over long distances and distributed geographically to consumers at comparatively 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 broadening access to electricity.

South Africa has an installed generating capacity of some 39 746 MW, with an extended national grid spanning some 239 000 km of high voltage transmission lines. This grid is interconnected with the grids of a number of its immediate neighbours. The maximum demand this past winter (1995) amounted to just over 25 000 MW, leaving South Africa with a substantial excess capacity, thus providing the country with a window of opportunity to provide electricity to a large proportion of that sector of the population hitherto neglected.

The National Electrification Forum (NELF) was established in 1993 to devise an accelerated grid extension strategy which is now in the process of being implemented following the targets set in Figure 4.

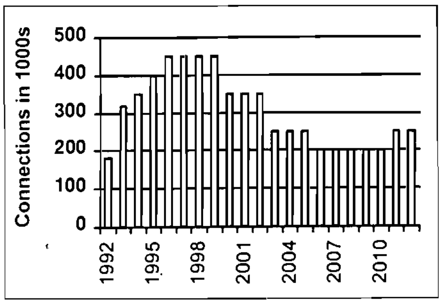


Figure 4: Annual number of grid connections by the ESI[4]

This will increase the percentage of dwellings with an electricity supply from the present 45% to about 67% by the year 2000 and 79% by 2012. Taking population growth into account, this implies that some 2,5 million dwellings will still be without access to the electricity grid at that time. The expected situation in the different provinces is shown in Table 1.

Province	2000 (%)	2012 (%)
Eastern Cape	52	68
Eastern Transvaal	61	75
KwaZulu/Natal	60	74
North West	53	69
Northern Cape	84	92
Northern Province	44	63
Free State	75	85
Gauteng	93	96
Western Cape	91	95
Total South Africa	67	79

Table 1: Percentage of electrified houses in the provinces

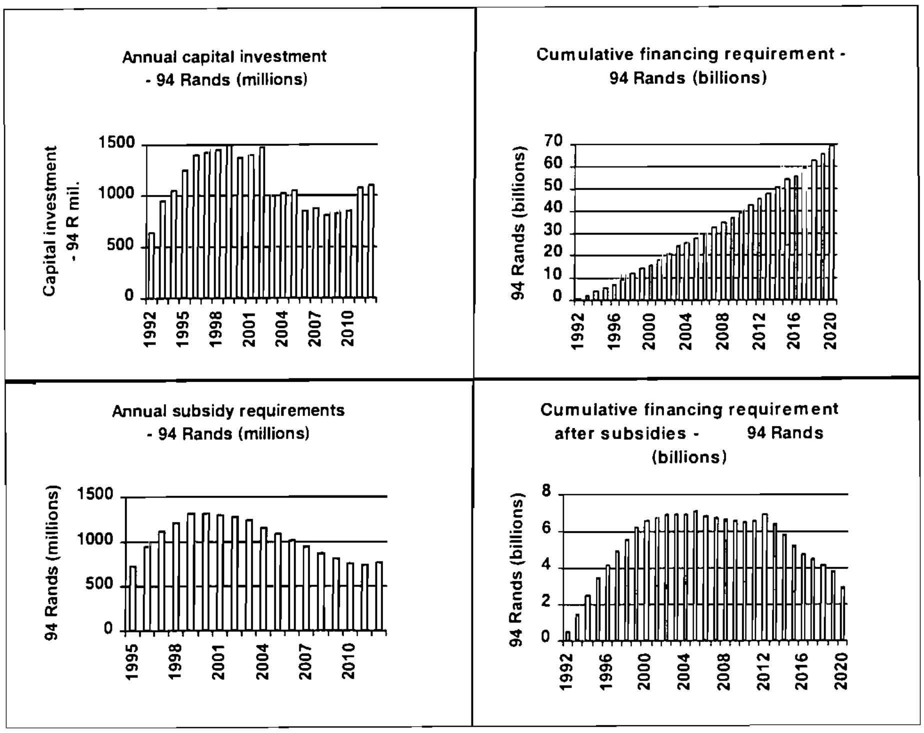


Figure 5: Financing requirements for the national electrification programme[4]

Household category	Number of dwellings		Capital cost per service point (1993 Rands)	
	1993	2012	Portion	Cost
Rural farmworker	900 000	900 000	0-75% 76-100%	R 3 000 R20 000
Rural dense	1 300 000	1 400 000		R 5 000
Rural scattered	1 300 000	1 200 000	0-25% 26-50% 51-75% 76-100%	R 6 000 R 7 500 R10 000 R20 000

Table 2: Rural electrification: Salient data[5]

In order to achieve this accelerated electrification programme, new and innovative distribution and metering technologies, and financing techniques are being developed. In addition, a general restructuring and streamlining of the institutional infrastructure to implement and manage the process is being undertaken.

In practice, the electrification process is subject to formidable economic constraints. Estimating the capital costs of electrification is complex. Based on an average capital cost of R3 000 per service point in the densely populated urban areas and equitable tariffs, it transpires that monthly consumption in newly electrified households is too low to cover recurrent costs. Consequently, the shortfall between operating income and recurrent costs has to be capitalised and substantial subsidisation is required in order to contain financing requirements within controllable limits (Figure 5).

Rural electrification is significantly more capital intensive due to the large distances between service points. Table 2 estimates the capital costs per service point. As a consequence, most rural institutions are without electricity, while the rural domestic use of electricity is extremely low. Even with an accelerated electrification drive, the electrification of rural areas will be a long-term endeavour. This is further exacerbated by the low actual and projected uptake of electricity in electrified rural dwellings (about 2 kWh/day) as indicated in Figure 6. The result is a need for heavy subsidisation with the limited likelihood of achieving a break even between cost and income even in the long term.

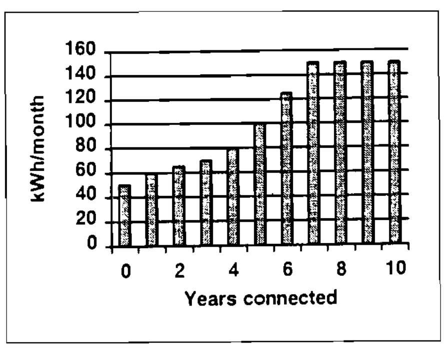


Figure 6: Consumption profile of a rural home owner[4]

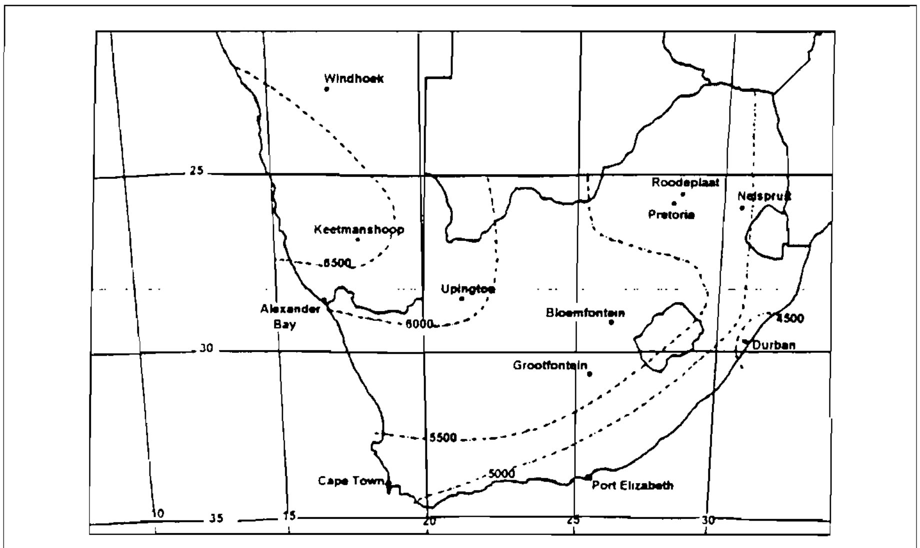


Figure 7: Annual daily average insolation in the Southern African region in Wh/m²/day[6]

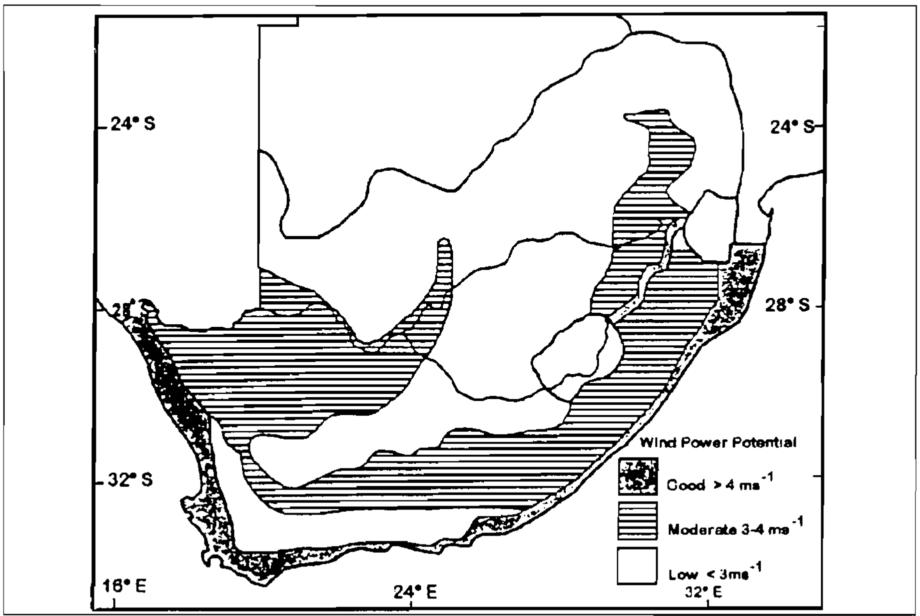


Figure 8: Wind map of South Africa[7]

	S.A.	Namibia	Botswana	Zimbabwe
PV Telecoms Domestic & recreation Water pumping	 2,55 MW_p 1,84 MW_p 0,73 MW_p	 0,5 MW_p		
Total (PV)	5,12 MW_p	0,5 MW_p	0,5 MW_p	0,2 MW_p
PV market growth rate	700 kW_p 20%	500 kW_p	80 kW_p	60 kW_p
Wind Elect. generation Mechanical (water pumping) Annual sales	 430 kW 278 000 units 500 units	 300 units		
Diesel gensets Annual sales	40 000 units (≤50 kVA) 4 000 units			

Table 3: Estimated installed capacity of renewable energies in South Africa at the end of 1994[8,9]

This low consumption of electricity further implies that the major energy needs of rural households, namely, the thermal energy required for services such as, cooking, hot water supply and space-heating, are still to be satisfied through other means. The dependence on traditional fuelwood could be expected to prevail in the foreseeable future, as will the use of commercial hydrocarbon fuels.

It should therefore be obvious that grid electricity, as the sole carrier for the supply of energy in developing countries, faces severe constraints. Current projections indicate that, even in the event that the grid extension programme is successfully carried out, more than 20% of households, some 2 000 rural health clinics and 16 400 rural schools will not be able to be electrified through grid extension over the next two decades.

Some important energy services, such as efficient lighting, media access (e.g. TV, radio), and certain food and vaccine preservation (refrigeration) and water pumping facilities, require electricity. The satellite broadcasting of TV (from 1995 onwards) will enable the entire rural population to access the electronic media and with it, the potential for distance education and the enhancement of literacy. It is also difficult to see how modern education could be effected in schools, and primary health care services provided without access to electricity.

South Africa's renewable energy resources

The Southern African region is well-endowed with sunshine all year round. By comparison, the annual 24-hour global solar radiation average is about 220 W/m² for South Africa, compared to about 150 W/m² for parts of the United States and about 100 W/m² for Europe and the U.K.

The insolation of the subcontinent is shown in Figure 7. This resource has high potential for exploitation, even at current technological levels, for such applications as solar water heating, solar passive housing design and small-scale remote area power supply. Regrettably it is not yet being utilised to its potential.

South Africa also has a fair wind potential, especially along its coastline, where it often compares favourably with that of Europe. In comparison with coal-based electricity, the generation costs of wind-based electricity is still about three times as expensive, so that any large-scale exploitation of this resource neverless lies in the future. For small-scale utilisation, however, the situation is much more favourable, especially when employed in hybrid configurations with PV and/or diesel generator sets. A wind resource map of South Africa is shown in Figure 8.

Figure 9 shows a cost comparison between grid extension, renewable energies and diesel generator sets based on life cycle costing. Clearly, for small electricity needs, i.e. kWh/day, the renewable energies compare favourably with grid extensions of 5 km at the current cost structure.

Table 3 gives estimated data on the total installed capacity of renewable energies in South Africa at the end of 1994.

It is evident from the above discussion that on the macro level, South Africa, or Africa as a whole for that matter, does not have a serious energy supply problem, even in the medium to longer term. Ironically, South Africa does seem to have a serious problem in meeting the energy needs of a significantly large sector of its population. The basic problem is one of distribution at the micro- or household level, a problem which is being faced by most developing countries.

South Africa's substantial solar resources could obviously also be used for thermal energy requirements, such as, for the provision of hot water, the prime demand for energy in the modern household. Solar water heating (SWH) technology is well-developed and is being utilised extensively in countries like Israel. In South Africa it is not yet popular, although the currently installed capacity amounts to some 484 000 m^2 of collector area.

An area of particular importance to South Africa is the solar passive design of low-cost housing. This practice could assist in addressing the high levels of air pollution measured in winter as a result of the extensive burning of coal for space-heating, even in electrified suburbs. Of equal, if not greater, importance is the fact that savings on household energy expenditure increase the disposable income for other life necessities in already cash-strapped budgets. This concept has been adopted as policy in the Policy White Paper on Housing. Promotion thereof is now being planned through large-scale pilot projects in the main centres and in the different climatic zones.

A reasonably efficient and low-cost solar cooker of U.S. origin has recently been introduced to the South African market. The Department of Mineral and Energy Affairs is assisting in the promotion and marketing of this device. Although interesting in concept these devices are of

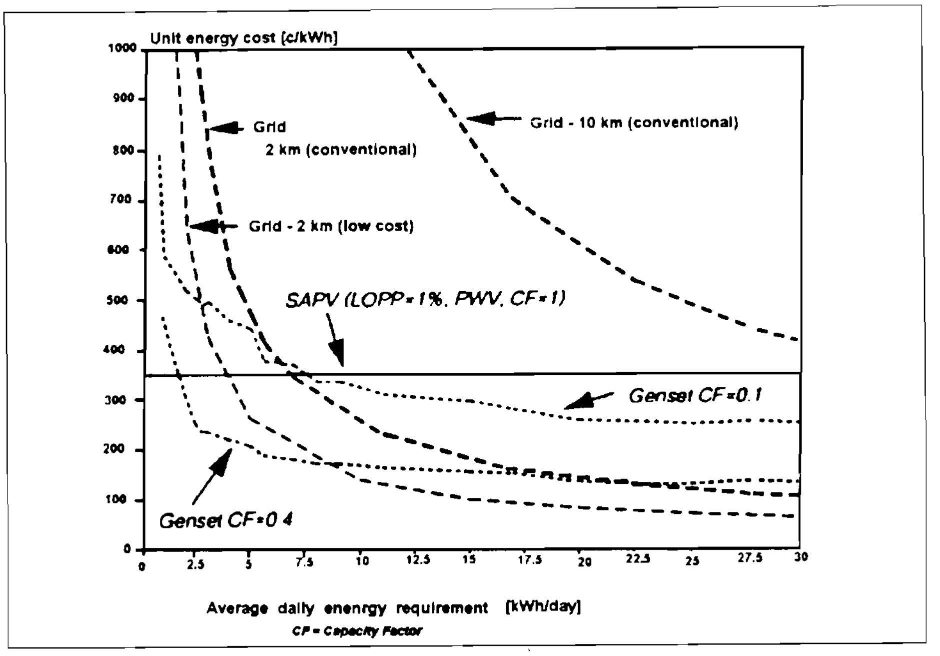


Figure 9(a): Rural grid (conventional technology), diesel gensets, standalone photovoltaic systems.

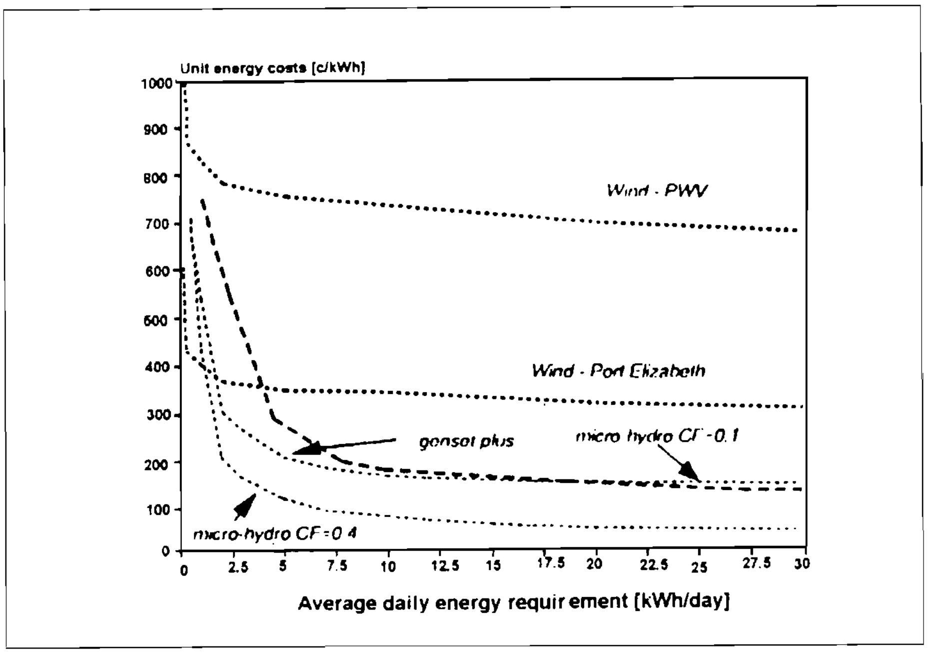


Figure 9(b): Diesel genset-plus-battery systems, wind-battery systems, micro-hydro. (Note: Micro-hydro costs are highly site-specific.)

Key to abbreviations:

SAPV	Standalone PV/battery systems
Wind	Standalone wind/battery systems
CF	Average capacity factor (utilisation over rated capacity)
LOPP	Loss of power probability (an index of power availability)
PWV	Gauteng Province

Figures 9(a) and (b): Cost comparisons between grid electricity and renewable sources as a function of average daily energy requirement, based on life cycle costing[6] limited use and could at best be supplementary to the traditional wood fire.

The utilisation of biogas digesters is largely foreign to Africa, contrary to the situation in India and China where they are employed with great success. This and the use of peat in the promotion and stabilisation of small-scale farming are areas currently being investigated.

REFSA (Pty) Ltd

From the analysis in Figure 9 it is evident that for small electricity supply needs, photovoltaics (PV) is cost-effective. Moreover, it requires very little maintenance. For remote schools and clinics, that is, those approximately 2 km or more from the grid, remote area power supply (RAPS) systems offer the facility of immediate access to sufficient electricity for essential needs. In short, RAPS technologies could be employed to provide electricity cost-effectively to a large number of people who would otherwise not be able to be served.

South Africa has a PV supply industry, including local solar panel assembly facilities of significant capacity (3 MW per annum), with direct access to technological developments abroad.

Clearly then, RAPS, and in particular PV, could be instrumental in the enhancement of rural development in support of the RDP, even in the short to medium term. It would therefore be prudent to complement the accelerated electrification drive with a parallel programme of deploying RAPS systems where appropriate. This will maximise the accessibility to electricity within the constraints of available capital. What is required is the necessary institutional and financial backing in the form of a Revolving Credit and Maintenance Fund and implementation facility.

Experience world-wide would seem to indicate that for the successful implementation of RAPS systems the task should be allocated to a dedicated and independent institution rather than to a conventional electricity utility whose core business is electrification through grid extension. Mobilising the local private sector would contribute to the efficiency of the endeavour, but institutionalised planning and financial backing is of paramount importance to ensure success.

South Africa's Department of Mineral and Energy Affairs therefore decided to investigate the formation of an independent company to co-ordinate and finance a renewable energy implementation programme. The main objectives of the company, provisionally called Renewable Energy for South Africa (REFSA) (Pty) Ltd, are to:

* act as the Government's implementation agency;
* plan and undertake the implementation and financing of renewable energy projects within the context of integrated energy planning, in collaboration with the private sector, appropriate NGOs and development institutions, local authorities, electricity distributors and relevant policy-makers;

"Current projections indicate that, even in the event that the grid extension programme is successfully carried out, more than 20% of households, some 2 000 rural health clinics and 16 400 rural schools will not be able to be electrified through grid extension over the next two decades."

* mobilise grant and loan funding for renewable energy projects both locally and abroad, working closely with the RDP office;
* contract appropriate existing private sector institutions and NGOs in the execution of its implementation task;
* set the necessary standards and system specifications;
* provide for consumer education in the utilisation and first line maintenance of systems to ensure effective use;
* make provision for the long-term maintenance of systems to ensure sustainability;
* while the principle of financing will be cost recovery, setting the levels of subsidies/grant funding, when and if necessary (i.e. the minimum level of service to be provided), will be undertaken in consultation with the grant funder and the relevant policy-makers;
* manage a sustainable Revolving Credit Fund to support its operations;
* publicise the characteristics and uses of renewable energy, including information on contractors, systems typical costs, case-study results and advice to would-be users.

A small but dynamic and versatile body is envisaged, taking into account the need to minimise overhead costs through efficiency of delivery and the effective utilisation of available skills and resources in the country. The aim is to fully involve the local industry on the basis of a public tendering system.

CEF (Pty) Ltd, a parastatal operating in the field of energy, agreed to establish REFSA (Pty) Ltd as a subsidiary (the company has since been established). A pilot project on solar home systems, to be funded by the Department of Mineral and Energy Affairs in conjunction with interested partners, is being planned as the beginning of REFSA (Pty) Ltd's activities.

The Independent Development Trust (IDT) has already electrified well over 150 rural health clinics using RAPS, while Eskom's Technology Group is preparing for an extensive school electrification programme. It is estimated that the backlog of about 2 000 rural health clinics and 16 400 rural schools will be electrified through RAPS over the next decade. By 2012, depending on the availability of funding, a significant proportion of the projected 2,5 million non-electrified households will also be served over the next two decades, largely through REFSA (Pty) Ltd. Scenarios and capital requirements for such an ambitious PV electrification programme are given in Tables 4 and 5. An important implication of this programme is an increase in the local installed PV capacity from the present approximately 5,1 MW_p to about 150 MW_p by 2012.

While the supply of electricity is receiving specific priority, it is envisaged that REFSA (Pty) Ltd will in time be involved in the entire field of renewable energy.

It should, however, also be noted that the energy being made available through the deployment of PV solar home systems will not provide thermal energy for cooking, hot water or space-heating. A sound approach to energy policy will have to

		Year	Schools PV contns.	Annual Capital Basic system	Annual Capital Basic+equip.	Clinics PV contns.	Annual Capital Basic system	Annual Capital Basic+Staff
Schools: Basic system (~500Wp)	R 40,000							
Equipment	R 8,000							
Clinics: Basic system(~500Wp)	R 45,000	1995	800	R 32,000,000	R 38,400,000	100	R 4,500,000	R 5,500,000
Staff quarters	R 10,000	1996	1600	R 64,000,000	R 76,800,000	200	R 9,000,000	R 11,000,000
		1997	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
Assumptions:		1998	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
1. **Schools**		1999	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
Lighting	Total installations after 5 yrs		7800	R 312,000,000	R 374,400,000	1050	R 47,250,000	R 57,750,000
2 class rooms		2000	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
Head masters' office		2001	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
Staff room		2002	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
Capacity for TV/VCR		2003	1800	R 72,000,000	R 86,400,000	250	R 11,250,000	R 13,750,000
Capacity for overhead		2004	1700	R 68,000,000	R 81,600,000	150	R 6,750,000	R 8,250,000
projector.	Total installations after 10 yrs		16700	R 668,000,000	R 801,600,000	2200	R 99,000,000	R 121,000,000
2. **Clinics**		2005	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
Lighting: room+outside		2006	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
Vaccine refrigerator		2007	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
Capacity for inspection		2008	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
light + sterilisation cabinet.		2009	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
Nurses quarters:		2010	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
4x 9 W fluorescent		2011	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
lights		2012	100	R 4,000,000	R 4,800,000	50	R 2,250,000	R 2,750,000
Capacity for 1 TV	Total installations after 2012		17500	R 700,000,000	R 840,000,000	2600	R 117,000,000	R 143,000,000

Table 4: *Schools and clinics: Medium scenario*

SHS monthly payback scenarios										
	Capital to pay back									
			Interest rate		Annual	Annual	Annual	Annual	Annual new Cap.	Annual new Cap.
Period, yrs	No Subs.	50% Subs.	(%) (real)		no. of	Total Cap.	Payback	Payback	requirement	requirement
	R 2,500	R 1,250	3.00	Year	connections	requirement	(5yrs/no subs)	(5 yrs/50% subs)	(5yrs/no subs)	(5 yrs/50% subs)
5	-R 44.81	-R 22.40		1995	500	R 1,250,000	-R 134,429	-R 67,215	R 1,115,571	R 1,182,785
8	-R 29.25	-R 14.63		1996	2,500	R 6,250,000	-R 941,004	-R 470,502	R 5,308,996	R 5,779,498
				1997	7,500	R 18,750,000	-R 3,629,586	-R 1,814,793	R 15,120,414	R 16,935,207
Assumptions:				1998	15,000	R 37,500,000	-R 9,678,896	-R 4,839,448	R 27,821,104	R 32,660,552
1. 1X60W panel + wiring+				1999	30,000	R 75,000,000	-R 21,777,515	-R 10,888,758	R 53,222,485	R 64,111,242
Regulator+ battery (90Ah, 12V)			Total no. of installations after 5 yrs		55,500	R 138,750,000	-R 36,161,430	-R 18,080,715	R 102,588,570	R 120,669,285
2. 4X9W fluorescent lights				2000	60,000	R 150,000,000	-R 45,840,326	-R 22,920,163	R 104,159,674	R 127,079,837
@ 3 hrs each per day.				2001	120,000	R 300,000,000	-R 93,428,230	-R 46,714,115	R 206,571,770	R 253,285,885
3. Power for small 48W B&W TV				2002	150,000	R 375,000,000	-R 163,331,365	-R 81,665,683	R 211,668,635	R 293,334,317
@ 4 hrs per day.				2003	150,000	R 375,000,000	-R 237,939,520	-R 118,969,760	R 137,060,480	R 256,030,240
4. Installations p.a. grow from				2004	200,000	R 500,000,000	-R 319,941,275	-R 159,970,638	R 180,058,725	R 340,029,362
500 in 1995 to 2500 in 1996			Total no.of installations after 10 yrs		735,500	R 1,838,750,000	-R 896,642,145	-R 448,321,073	R 942,107,855	R 1,390,428,927
to 7500 in 1997, etc., to cover				2005	200,000	R 500,000,000	-R 403,287,322	-R 201,643,661	R 96,712,678	R 298,356,339
the **full number** of households				2006	200,000	R 500,000,000	-R 462,436,129	-R 231,218,064	R 37,563,871	R 268,781,936
not grid connected in the				2007	200,000	R 500,000,000	-R 497,387,697	-R 248,693,848	R 2,612,303	R 251,306,152
NEES Medium Scenario				2008	200,000	R 500,000,000	-R 524,273,518	-R 262,136,759	-R 24,273,518	R 237,863,241
by 2012.				2009	200,000	R 500,000,000	-R 537,716,429	-R 268,858,214	-R 37,716,429	R 231,141,786
				2010	200,000	R 500,000,000	-R 537,716,429	-R 268,858,214	-R 37,716,429	R 231,141,786
				2011	200,000	R 500,000,000	-R 537,716,429	-R 268,858,214	-R 37,716,429	R 231,141,786
				2012	200,000	R 500,000,000	-R 537,716,429	-R 268,858,214	-R 37,716,429	R 231,141,786
			Total no. of installations by 2012		2,335,500	R 5,838,750,000	-R 4,934,892,526	-R 2,467,446,263	R 903,857,474	R 3,371,303,737

Table 5: *Solar home systems: High scenario*

take cognisance of this and allow for programmes aimed at widening access to fuelwood and the hydrocarbon fuels, such as kerosene and liquefied petroleum gas (LPG).

Opportunities for business partnerships

In its effort to expedite the development of the nation the South African Government welcomes the assistance of partners from abroad. It should be noted that as far as photovoltaics is concerned the major manufacturers of modules (including two local module assembly plants) and of ancillary equipment are already well represented in South Africa. The envisaged programme on the large-scale deployment of renewable energies offers numerous opportunities for business partnerships. A few of the most important ones that come to mind are as follows:

* **The structuring and operation of REFSA (Pty) Ltd.** While local expertise to staff REFSA (Pty) Ltd exists, experience in large-scale operations in poor rural societies is lacking. It is known that the U.S. National Rural Electric Co-operative Association (NRECA) has gained vast experience in recent years from their involvement in Mexico and Central America, while other countries have gained experience in Asia. The exchange, secondment and/or training of personnel come to mind as possible avenues of interaction.

* **Training and capacity building.** The extent of the operations envisaged in the off-grid electrification of schools, clinics and private households requires the training of a suffi-

cient number of installers and system maintainers. It also offers the opportunity for the establishment of small entrepreneurs to undertake these activities in the rural areas. The recent one-month training course offered at the Peninsula Technikon in Cape Town, in conjunction with the U.S. organisation REFAD, would seem to be a step in the right direction. Likewise, local tertiary education institutions and research organisations, such as the CSIR, could benefit from closer liaison with their counterparts from elsewhere, and vice versa.

* **Rural electrification pilot projects.** Pilot projects are envisaged to assist REFSA (Pty) Ltd in setting up business. A number of unknown parameters need to be established, amongst others, the minimum system size, appropriate system specification, the funding mechanisms to be employed with rural communities, appropriate loan periods and interest rates, the level of customer training required to ensure correct use and adequate first line maintenance, etc. Assistance with the planning, funding and execution of such a project will be invaluable.
* **Funding.** Whereas the RDP fund is seen as the primary source of funding for the rural off-grid electrification programme, the magnitude of the backlogs to be addressed, however, suggests that the mobilisation of additional funding from external sources would be of paramount importance. Based on the principle of full-cost recovery financing, preliminary surveys indicate that 25%-30% of rural communities could readily be served. If a larger portion of rural communities is to be reached, an element of grant funding will have to be introduced to buy systems down to lower cost.

As was mentioned in the introduction, South Africa is intimately linked to the Southern African subcontinent. The SADC countries are planning a SADC/FINESSE (Financing of Energy Systems for Small Energy Users) programme on the basis of a similar programme in South-East Asia. This programme has many parallels with the South African rural energy programme. Thus inevitably, the successes reached in South Africa will have direct bearing on the region as a whole.

Conclusion

Renewable energy technologies stand to play a significant role in the future development of South Africa and Southern Africa as a whole. Various opportunities, some of which have been discussed above, exist for business partnerships in this endeavour.

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Trends and policies regarding renewable energy within a global and African context

* G STASSEN

This paper provides an overview on the current and future global and African renewable energy outlook. In general, the global energy outlook clearly indicates that there is no place for the "business as usual" case. The new global economic and political framework dictates a major change in the structure of energy consumption and production. Within the global energy planning framework there is thus a strong emphasis towards energy efficiency interventions and the accelerating development and applications of renewable energy sources. In general, renewable energy is regarded as a priority within the African energy and development context as it can play a major role in addressing basic energy needs. Various policy aspects and constraints considered to be important for renewable energy development and application within the African context are also highlighted.

Keywords: world; Africa; energy future; renewable energy; energy policy; energy planning; energy development; energy forecasting

Introduction

New energy and development imperatives have fundamentally impacted on the overall development context against which the global and African energy planning framework has developed over the past two decades. A major focus of this planning framework is on energy efficiency interventions and the application of renewable energy sources. It is the aim of this paper to attempt to provide a perspective on the outlook and policy framework pertaining to renewable energy within a global and African energy context.

A global energy outlook

Energy demand over the past two decades or so has risen as the world economy has grown in spite of numerous energy price shocks during and since the respective energy crises of 1973-74 and 1979. The fundamental link between growth and energy has been maintained, although at a decreasing rate of energy intensity. Evidence has also been mounting for some time that current global energy use is neither environmentally benign nor sustainable.

The United Nations Conference on the Human Environment in 1972, the report by the World Commission of Environment and Development in 1987, the United Nations Conference on Environment and Development (the Earth Summit of Rio de Janeiro in 1992), and the report by the World Energy Council's Commission on Energy for Tomorrow's World, released in June 1993, provide overwhelming evidence, *inter alia*, that[(1)]:

(1) the world cannot continue indefinitely on the path of profligacy in its use of natural, finite resources;

(2) energy issues will shift from the industrialised to the developing world within the next three decades;

(3) the developing world's proportion of world-wide energy consumption will rise from 33% to 55%, in the same period;

(4) the ecological consequences of world-wide economic behaviour were worsening and the disparities within and between nations were deepening;

(5) there had been a serious acceleration of major environmental risks;

(6) energy issues are at the heart of most environmental issues.

The above are amplified by the International Energy Agency's[(2)] *World energy outlook*, with forecasts up to 2010, which states that:

(1) world energy demand will continue to increase rapidly and that by 2010 the world is projected to consume between 34% and 45% more primary energy than it did in 1992;

(2) the global energy system is likely to remain overwhelmingly based on the burning of fossil fuels;

(3) by 2010 the Organisation for Economic Co-operation and Development (OECD)** will consume half or less of the world's energy and oil. These shifts have important strategic implications, and OECD countries and many non-OECD countries are becoming more concerned about security of supply issues;

(4) increased fossil fuel-based energy consumption will have a significant impact upon the environment, in that global energy-related CO_2 emissions are projected to increase by between 30% and 40% over their 1990 level;

(5) a continued slow-down in the rate of growth of nuclear-generated power is expected.

A global energy policy framework

Major global developments have fundamentally changed the political and economic context against which the global energy policy framework develops. World-wide concern about the environmental impacts of energy consumption and, more specifically, the possible threat of global climate change, is producing considerable effort over the last few years, especially in the developed countries, to effect a major change in the structure of energy consumption and production on a global basis through adopting a comprehensive energy policy framework.

Within this framework energy supply security remains the primary goal of the OECD countries. Their energy policies, which evolved over the past two decades, furthermore share a determination to contribute to energy supply diversification,

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** The member countries of the OECD comprise the following developed countries: Australia, Austria, Belgium, Canada, Denmark, France, Finland, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Mexico, The Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

industrial competitiveness, sustainable economic growth and environmental protection, as well as being increasingly concerned with the growing globalisation of energy issues as economies and energy markets become more interdependent. Most OECD countries have also stated that energy efficiency is a focal part of their energy policies and programmes. Other considerations, such as the development of renewable energy sources as an important element in meeting energy supply diversification and environmental goals, continue to be important within their overall policy framework[3]. From a global perspective it is thus evident that renewable energy will have to play a pivotal role in providing for a sustainable development system in the longer term. This paradigm shift in the energy policy arena is amplified by O'Keefe and Soussan[4] who argue that:

> Within a global planning framework, the emphasis on an end-use and real cost approach drives investment towards efficiency interventions. An emphasis on efficiency, together with an emphasis on renewable sources of energy that do minimal environmental damage, is a necessary technical focus. Efficiency and renewables are the software and hardware of the sustainable and secure energy economy.

Eden[5] supports this point of departure by stating that:

> If nuclear power continues to be viewed in many countries as unacceptable as a future option, the need for new renewable energy sources (wind, biomass, solar, other) will become more urgent and improved efficiencies for energy use are essential.

Sayigh[6] argues that renewable energy must and can meet the future energy challenges posed by the industrial societies and the developing world as it is environmentally friendly, plentiful and easy to utilise. Moreover, Sodeik[7] states that:

> We know that we have no other possibility than to change the global energy system by a combination of rational energy use and by displacement of conventional forms of energy by renewable energy sources.

In line with this statement the International Solar Energy Society's (ISES) recommendations to the United Nations Conference on Environment and Development in 1991 further underscores the pivotal role of renewable energy sources in the future world development system[8]:

> Renewable energy technologies are indispensable to the goals of environmental protection and sustainable economic development at the global, regional and local levels. The use of renewable energy technologies can reduce or minimise many of the major pollution problems we face today including global climate change, loss of land productivity, loss of biological diversity, ocean pollution, depletion of the quality and supply of fresh water, and waste generation.

In most developing countries, however, a comprehensive energy policy and planning framework is lacking. In the developed countries, the development and application of renewable energy sources is more encouraging and mainly driven within a comprehensive energy policy framework based on security, efficiency and environmental considerations. However, the macroeconomic framework conditions for the use of renewable energy sources in developing countries is presently determined, in the main, by energy pricing policies, elements of foreign trade and commercial policies. Environmental policy aspects are presently of only second-order importance[9]. To date, programmes for promoting renewable energy applications in developing countries have rarely met hopes.

" . . . the macroeconomic framework conditions for the use of renewable energy sources in developing countries is presently determined, in the main, by energy pricing policies, elements of foreign trade and commercial policies. Environmental policy aspects are presently of only second-order importance(9). To date, programmes for promoting renewable energy applications in developing countries have rarely met hopes. "

Many reasons can be identified, however, to explain this current disappointing state of affairs, *inter alia*[10]:

(1) renewable energy technologies pushed were often inadequate or inappropriate to the local conditions, or both;

(2) a primary lack of data concerning some renewable energy resources and uses, which leads to an underestimation of both their actual and potential economic contributions to supplies;

(3) excessive conservatism in technology and resource assessments, arising in part from the unconventional nature of many renewable energy technologies and applications, and the legacy of outdated studies which reflect these same failings;

(4) failures in transferring existing knowledge to the policy community; and

(5) failures of vision in applying existing and broadly accepted assessments to energy projections and policy.

Global renewable energy outlook

Renewable energy accounted for about 17% of the world's primary energy demand in 1990. Despite being the fastest growing type of energy, the global contribution from renewable energy sources is likely to remain small up to 2010[2].

According to estimates by the International Energy Agency[2], some 25 600 PJ of commercial biomass (fuelwood, wood waste, municipal waste, animal and vegetal waste, and black liquor from the paper and pulp industry) were consumed globally in 1992 compared with 14 300 PJ in 1971, implying an average growth rate of 3,8% over that period compared with only 2,4% for total primary energy. If the non-commercial consumption of biomass is included, then the world biomass consumption in 1992 could have been in the order of 35 300 PJ. Even if the lowest estimates are accepted, biomass makes an important contribution to meeting the world's energy needs. Biomass consumption is projected to increase by an average annual growth rate of 0,7%. Although this is not a high rate of growth, biomass consumption in 2010 could be nearly 14% higher than in 1992, thus making an even greater contribution to satisfying world energy demand.

Hydropower is by far the most important renewable source of electricity, and in some countries its share of electricity generation exceeds 50%[3]. It is envisaged that the share of hydroelectricity in the total electricity production in the OECD region is likely to decline from 15,8% in 1992 to 14,75% in 2010, mainly due to the limited availability of economically viable sites. Similar prospects are envisaged for Central and Eastern Europe and the European section of the former Soviet Union. On the other hand, hydroelectric generation is expected to experience substantial growth in the developing countries, with output more than doubling between 1992 and 2010[2].

In 1992, over 80% of the world's electricity from renewable non-biomass resources was generated by the OECD countries and electricity generated from geothermal, solar, wind, ocean thermal and tidal power is assumed to rise within the OECD, up to 2010, by an annual average rate of between 7,1% and 9,3%[2]. Specific applications of renewable energy, mainly related to electricity generation, are significant in some OECD countries as briefly outlined below[3]:

(1) In countries with large areas of forests such as, Canada, Finland, France, Sweden and the United States, the use of wood as an energy source continues to develop.

(2) Italy, Japan, New Zealand and the United States continue to develop high-temperature geothermal resources for electricity generation.

(3) Wind parks for electricity generation continue to be developed in Denmark (installed wind turbine capacity stood at 455 MW at the end of 1992 and is expected to grow by about 80 MW per year to 2005), the United States (installed wind turbine capacity totals around 2 000 MW), Portugal (first wind farm of 1,8 MW was commissioned in 1992), Greece (plans electricity generation of 117 GWh by 2010 from wind energy) and the Netherlands (targets total wind energy capacity of 1 000 MW by 2002).

(4) Active solar energy use in Greece, mainly for water heating, is expected to increase at an annual rate of 4,9% between 1991 and 2010.

Electricity generated from renewable sources in developing countries is assumed to increase at an annual average rate of around 8,5% up to 2010[2]. Moreover, in many developing countries, the continuing and expanding use of renewable energy is very important. According to the International Energy Agency[11] this is reflected:

> In the energy balances where renewables contribute about 40% of energy needs in Latin America, 50% in the Asia-Pacific region and 50% in Africa, mainly in the form of biomass (primarily fuelwood) which creates environmental problems. In some countries, renewables contribute more than 80% of total primary energy requirements. It has been estimated that over 2 billion people in developing countries depend on fuelwood and charcoal for their household energy needs.

A global renewable energy policy framework

Against the aforementioned global energy policy framework, all OECD countries have initiated policies and programmes targeted at accelerating and increasing the use of renewable energy technologies. Government action includes a variety of activities necessary to secure the economic and commercial environment to facilitate the introduction of renewable energy technologies. These activities fall into three general categories[12]:

(1) direct funding of research, development and demonstration projects and programmes;

(2) development of institutional frameworks to facilitate the use of renewable energy through legislative and regulatory means, such as establishing databases, developing and introducing standards and codes of practice for renewable energy devices, initiating information dissemination and training activities, and instituting leadership activities in public institutions;

(3) measures to improve economic competitiveness and market penetration of renewable energy technologies through fiscal incentives (e.g. exemption from specific taxes, accelerated depreciation, tax credits and tax deductions) and financial incentives (e.g. grants, subsidies, low interest and long-term loans, and loan guarantees).

In the United States, the promulgation of the Energy Policy Act in October 1992 introduced a wide range of measures to promote renewable energy, including a tax credit for electricity produced from new wind installations and certain types of biomass facilities, a five-year demonstration and commercialisation programme to accelerate the commercial application of renewable energy supply (and energy efficiency) technology, and a five-year R&D programme for cost-effective power generation from renewables[3].

The government of the United Kingdom is working towards 1 500 MW of electricity generating capacity based on renewable energy sources by 2000. The non-fossil fuel obligation (NFFO) requires regional electricity companies to buy electricity from renewable sources in addition to nuclear generation. Only about 5% of the non-fossil fuel levy went towards renewables in 1992/93[3]. According to the U.K.'s Association of Independent Electricity Producers[12], a framework for the encouragement of renewable energy projects should be established through the NFFO, and the framework should demonstrate a will to see growth in the generation from renewable energy and hence, give prospective generators sufficient confidence to invest their time, effort and capital.

Sweden has set up a fund to grant support for investments in biofuelled combined heat and power projects. Denmark adopted two laws in 1992 providing for a subsidy on power produced from wind, biogas or hydropower and sold to the grid, and guarantees private wind turbine operators a price equal to at least 85% of the local electricity companies' pre-tax price for residential consumers. Finland is preparing a special bioenergy programme to promote and develop the use of wood-based and agricultural biomass, peat and municipal waste. A new law in Germany obliges the electricity supply industry to buy electricity generated from renewables at 60%-85% of the average kWh price[3].

Most of the developing countries, on the other hand, have a complete lack of comprehensive energy policies or programmes aimed at the development and application of renewable energy sources. This problem is further exacerbated and places renewable energy systems at a competitive disadvantage by price policies involving direct subsidisation of electricity consumption, restrictions on hard currency and a lack of favourable import policies[9].

Nevertheless, many developing countries have initiated actions in the energy field focusing to a much greater extent on the development and application of renewable energy sources. These actions have come at a time when conventional energies are becoming more difficult to supply, and the adverse environmental consequences of fossil fuel usage and tree felling are increasingly realised. This aspect is emphasised by Dayal[13] who states that:

> There is, therefore, a great need for a transition from present energy systems, heavily dependent on hydrocarbons, to a non-depletable, more sustainable mix of energy sources that relies increasingly on new and renewable sources of energy that provide clean energy and help preserve the environment and the ecology.

In Malaysia, renewable energy development and application is in line with national energy policy relating especially to the national rural electrification programme[14]. Biomass resources are closely linked to afforestation and agricultural production in China. Geothermal energy, solar energy, tidal energy and wave energy are also being developed in China. It is also estimated that a further 8 000 MW of small hydroelectric stations will be erected by 2000, enlarging total capacity to 20 000 MW. A series of windmill and wind turbine systems have also been developed in China[15].

India started an integrated energy and food-energy approach of which their national biogas programme forms an integral part. A national programme on improved cook-stoves has also been launched, saving an estimated 4 million tonnes of fuelwood per annum. It is proposed to achieve annual energy generation savings of about 15 000 MW by the year 2000 through the utilisation of non-conventional energy sources[13]. In Sri Lanka, renewable energy applications are an integral part of the National Integrated Rural Energy Development Plan which was launched by the government in 1989[16].

The Arab League***, through the Arabic League Education, Culture and Scientific Organisation (ALESCO), also plays a very active role in the development and the application of renewable energy within their member countries. They focus on joint applied research and development, conducting surveys to determine Arab potential in renewable energy, setting up an Arab strategy for renewable energy techniques, putting forward applicable programmes in Arab countries according to their specific energy needs, and the training of personnel in the field of renewable energy[17].

*** Countries of the Arab League include: Tunisia, Libya, Morocco, Algeria, Jordan, Syria, Egypt, United Arab Emirates, Bahrain, Iraq, Qatar, Saudi Arabia, Kuwait and Oman.

An African renewable energy perspective and energy outlook

The African energy system in general is characterised by the following[2,18,19,21,22,23]:

(1) For many African countries, biomass accounts for 50%-90% of the national energy supply. The main users of commercial energy, in the form of oil, coal, electricity, etc. are in the formal sector of the economy and in the urban areas. Traditional fuels (e.g. fuelwood and, to a lesser extent, charcoal) are generally used in the rural and peri-urban areas, the informal sector, as well as in certain industries in a number of African countries.

(2) The household sector is the largest single energy consumer in general, with traditional fuels, on average, accounting for up to 90% of the energy consumed in this sector.

(3) A growth rate of fuelwood consumption which is the highest of all continents.

(4) The fact that decisions on energy issues are politically driven rather than market-orientated is probably the most significant shortcoming throughout Africa.

(5) Institutional energy structures often lack adequate organisation, which makes the collection of reliable data on the status of resources and the consumption of energy by locality and sector extremely difficult.

(6) Energy prices are set by government. Supply, demand and environmental considerations play little part in energy price determination.

(7) Low per capita energy consumption.

(8) Dependency on oil as a commercial fuel such that the latter represents nearly 50% of the energy bill in many African countries.

(9) Environmental-related concerns and priorities which differ from those in the developed countries in that governments are more concerned with economic growth than environmental protection. Africa accounts for less than 1% of the world's emissions of energy-related carbon dioxide, and most people are rather concerned with primary subsistence issues than environmental concerns;

(10) Energy disparities between and within countries regarding the production and consumption of energy, as well as the diversity of energy sources.

(11) Persistently low levels of energy exchanges between African countries.

(12) A net depletion of fuelwood over time. Current practices of biomass production, transformation and end-use are unsustainable and have adverse effects on Africa's environment.

(13) A high energy intensity, even if measured on a purchasing power parity basis and before the use of traditional energy is taken into account.

Total primary energy demand in Africa is projected to increase by an annual average of 3,8% between 1992 and 2010. When traditional energy is included, however, the annual average growth rate of total primary energy drops to 3,3%[2].

An African energy policy framework

As in the case of developing countries in general, integrated energy planning at a national level is often lacking in the African energy policy context, mainly owing to a range of institutional deficiencies[21]. This fact is underlined by a group of African energy experts who state that[24]:

> An essential requirement for the rational use and development of energy sources to meet the needs of the rural population of Africa is the existence of sound national energy plans and programmes, and these are often lacking in Africa. Policy at the macro level is vital for creating a conducive climate for energy development and diffusion, for formulating fiscal, pricing and subsidy policies, for creating a solid institutional infrastructure, and so on.

It is furthermore argued that a coherent African energy strategy including the following is urgently needed[20]:

* innovative policy instruments and institutions;
* mobilisation of financial resources;
* management, training and technology acquisition;
* energy efficiency;
* increased supply of environmentally benign modern fuels and technologies, such as wind, biogas, hydro and solar.

Against this background, the African Development Bank, with the assistance of the United Nations Development

Programme, launched the African Energy Programme in 1992, the aim of which was to serve as a basis for the elaboration of coherent policies to the countries and sub-regions of Africa, thereby paving the way for a smooth integration of the energy sector. The development of renewable energy is a cornerstone of this programme[22].

Moreover, according to Sall[22],

> In terms of commercial energy we have always been in the history of consumers and not innovators such that all the great technological revolutions experienced by humanity have escaped us. With renewable energies, whose development has just started, we can become operators, active partners. Africa should not let this opportunity slip by.

An African renewable energy outlook

Renewable energy sources are widely regarded in African countries as suitable alternatives to fossil fuels and as such, should form part of national energy policies and the focus of future actions[24]. The status of renewable energy in Africa is encouraging, and many of the sources, such as biomass, solar, wind, small-hydro and geothermal energy, are widely used. According to Mwanza and Pashkov[25], commercial renewable energy, from 1995 onwards, will be making a small but useful and growing contribution to Africa's energy supplies, and by 2025 it could be producing substantial amounts of energy in the form of heat and electricity. It is also assumed that electricity generation by renewable energy sources in Africa will grow by 4% per annum up to 2010[2].

A number of renewable energy applications have already been implemented successfully and cost-effectively in some African countries, namely[25]:

(1) biomass programmes in Kenya, Ethiopia and Zimbabwe, where biomass is converted into liquid fuels, electricity and biogas;

(2) solar-efficient design in buildings in the Ivory Coast;

(3) solar hot water provision for domestic, commercial and industrial purposes in many African countries;

(4) photovoltaics are widely used in Africa for water pumping and telecommunications;

(5) windmills for water pumping and small-scale hydropower schemes;

(6) geothermal programmes in Kenya.

An African renewable energy policy framework

African countries in general regard the utilisation of renewable energy as a priority in the energy sector[25]. Especially in the Southern African region, there is a growing appreciation by governments that renewable energy can play an important role in meeting the energy requirements for specific end-uses[26]. The development of renewable energy technologies in Africa furthermore goes hand in hand with measures to improve energy efficiency[25]. To this end a renewable energy strategy was formulated by the Southern African Development Co-ordinating Conference in 1990 to create a framework for systematic development of new and renewable energy sources of energy (NRSE) in the Southern African region[27].

"African countries in general regard the utilisation of renewable energy as a priority in the energy sector. Especially in the Southern African region, there is a growing appreciation by governments that renewable energy can play an important role in meeting the energy requirements for specific end-uses. The development of renewable energy technologies in Africa furthermore goes hand in hand with measures to improve energy efficiency."

A number of constraints have been identified in the African context, which form the basis of the above strategy, namely[28]:

Technical

* inadequate investment in science and technology;
* lack of locally produced components and raw materials;
* lack of private sector capacity in the manufacturing, distribution, installation and maintenance;
* a general lack of data for the design of NRSE systems.

Financial

* scarcity and severe foreign exchange restrictions;
* affordability of NRSE technologies;
* a lack of access to financing for acquiring necessary resources;
* a lack of suitable financing arrangements.

Institutional

* a lack of knowledge of NRSE markets, including energy needs of target groups;
* a lack of awareness of NRSE technologies
* a lack of an institutional framework to ensure quality and sustainability of NRSE.

Manpower and training

* a general lack of trained manpower in NRSE technologies;
* a lack of training institutions; and inadequate curricula.

Policy

* a lack of clear national government policies;
* restrictions on foreign exchange;
* inappropriate import duties and sales taxes.

Against this background the renewable energy policy framework within the African context is guided by the following objectives, *inter alia*[27]:

(1) to improve information exchange among countries as a way of sharing experience and ideas;

(2) to undertake capacity building through training of staff in government and non-governmental organisations;

(3) to strengthen renewable energy institutions;

(4) to raise awareness amongst energy end-users;

(5) to strengthen institutional capabilities to disseminate and mobilise resources for the implementation of renewable energy.

Conclusion

It is evident that renewable energy will become a cornerstone of future energy policy in the global as well as the African context. However, many constraints still need to be overcome in the current policy, planning and market sphere in order for renewable energy to realise its full potential in support of the transition to a sustainable development system.

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Energy saving opportunities in the South African clay-brick industry

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The clay-brick industry has one of the highest energy consumption rates per Rand of value added in the industrial sector in South Africa. With this in mind, a study of the sector was undertaken in order to obtain an energy profile of the sector, as well as to identify potential energy cost saving opportunities. The industry was surveyed telephonically and by means of a questionnaire, and selected factories were visited. It was found that factories firing bricks in clamp kilns were less energy efficient than those firing in non-clamp kilns. Although a change in technology from clamp kilns to the more efficient and technologically advanced non-clamp kilns is certain to take place, cost constraints make it unlikely that this will occur to any significant extent in the near future. There are, however, many opportunities for reducing energy costs within the constraints of the existing technology. By taking advantage of these opportunities, it is estimated that the industry could save 38% of its energy costs, or R169 million per year.

Keywords: energy management; energy conservation; South Africa, clay-brick industry; energy costs; energy utilisation; industrial energy; energy consumption

Introduction

In 1993[1,2] the structural clay products industrial sector consumed 38 PJ of energy, which is approximately 4% of energy used in the industrial sector. The clay-brick industry forms 80% of the structural clay sector as a whole and, in terms of energy consumed per Rand of value added, is the third highest energy consumer in South Africa[1,2].

This high energy intensity, together with the relatively uniform output, makes this an appropriate industry for further study. A study of the clay-brick industry was therefore initiated with the following objectives:

- forming a profile of the industry;
- obtaining data on energy use in the industry;
- observing the use of energy in individual factories;
- identifying energy saving opportunities in the industry.

The data for this study were obtained through postal and telephonic surveys, and through energy audits of selected factories.

The brickmaking process

The manufacture of bricks takes place in five main stages; mining, crushing, forming, drying and firing. A flow chart of the brickmaking process is shown in Figure 1.

Mining

The clay is mined from the ground with earth-moving equipment and then transported to the crushing and forming plant. Diesel in the main type of energy used in this process.

Crushing and forming

The clay is then crushed by mills and rollers until it is of a uniform consistency. Water is added to the clay and the bricks are formed either by extrusion and wire-cutting, or by moulding. The main energy input in these operations is electricity.

Drying

Drying methods vary depending on the level of sophistication of the factory. Open air-drying is used extensively because it involves no capital expense and no commercial energy input. Wastage levels can be higher for this type of

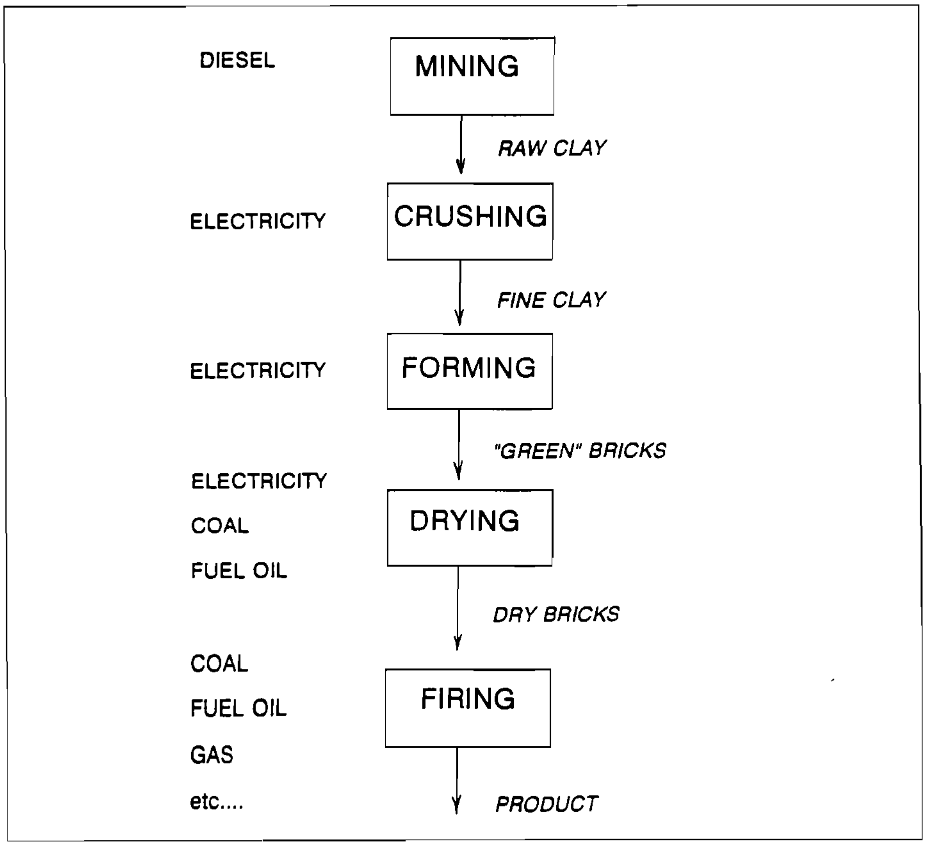

Figure 1: The brickmaking process

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drying since the unfired bricks are exposed to the weather.

The more technologically advanced factories dry bricks in tunnel- or chamber dryers. These often use heat recovered from the kiln to minimise external energy input. In some cases all of the dryer requirements are supplied from this source. Depending on the level of automation, handling losses are generally much less than in open air-drying factories.

Firing

The firing of bricks consumes approximately 90% of the total process energy. Kilns range in sophistication from the most basic clamp kilns to the most advanced computer-controlled tunnel kilns.

In clamp kilns, unfired bricks are packed into large stacks (clamps) and set alight. Once the clamp has burned out, the fired bricks are unpacked and sorted. Coal, which is distributed between the bricks, is used as the fuel. Coal dust (or "duff") is added to the body of the brick during the crushing and forming process.

Hoffmann and transverse arch kilns are continuous chambers through which the fire advances. The bricks are packed in front of and removed from behind the advancing fire in a continuous process. These kilns generally fire with coal but can also use either heavy fuel oil (HFO) or gas.

Tunnel kilns are long tunnel-like structures through which the bricks travel on special kiln cars. The temperature profile of the kiln is carefully controlled by means of burners and circulation fans, resulting in a superior quality of brick. The fuels used are either coal, heavy fuel oil or gas, and these kilns are generally the most fuel-efficient.

For the purposes of this study, factories were divided into two groups, namely, those using clamp kilns and those using non-clamp kilns. Non-clamp kilns consist of tunnel, Hoffmann and transverse arch kilns.

The factory surveys

Names and addresses of factories were obtained from the Clay-Brick Association, as well as from the Central Statistical Services' Register of Manufacturers[3]. For the postal survey, 75 questionnaires were sent out and 25 replies were received. The telephonic survey also targeted 75 factories and information was obtained from 30. The survey therefore covered 42% of the estimated 130 factories and represents 60% of total annual brick production.

From the surveyed factories, a sample was selected for individual visits in order to ensure a good understanding of the working of the industry and to support the telephonic and postal surveys. The sample taken for individual visits was selected in order to give a good representation of the industry in respect of:

- *Geographical distribution.* A constraint here was travelling expense, and so only factories which were close to the major centres were chosen.
- *Size representation.* The size of the factories varied in terms of production, and the sample had to reflect the overall distribution.
- *Different processes and fuels.* The sample had to contain the major technologies used to manufacture bricks in the country.

	Clamp	Non-clamp	Overall
Number of factories			
surveyed	33	22	55
visited	7	6	13
Total in industry	90	40	130
Production (in millions)			
Average/factory/year	23,7	34,1	28,2
Total for the industry	2 200	1 500	3 700
Energy use			
Specific energy consumption (SEC) (MJ/kg)	4,01	2,89	3,45
Total (PJ)	26	12	38
Cost of energy (R million/ year)	222	198	420

Table 1: The extent and main results of the survey

Energy type	Diesel	Electricity	Coal,HFO, gas	Total
Operation	Mining	Crushing and forming	Drying and firing	
Clamp				
Range	0,03-0,26	0,01-0,18	1,70-5,68	1,80-6,18
Average	0,09	0,07	3,85	4,01
Non-clamp				
Range	0,03-0,12	0,10-0,27	1,26-3,63	1,25-4,84
Average	0,07	0,15	2,60	2,89
Average	0,08	0,11	3,23	3,45

Table 2: Energy use of surveyed brick factories (MJ/kg fired product)

The extent of the survey and the main results are shown in Table 1. The total number of factories in the industry was estimated to be 130 (90 using clamp kilns and 40 using non-clamp kilns) of which 55 out of this total were surveyed.

Energy use

The information from the surveys can be split up into the different operations by grouping the energy types as shown in Table 2.

As can be seen from Table 2, the factories with non-clamp kilns use more electrical energy than those with clamp kilns. This is because of the higher degree of automation in non-clamp kilns such as, kiln car movement and recirculating fans. Firing energy, however, is higher for the factories with clamp kilns. Since these are the dominant users of energy, the overall energy consumption for clamp kilns is approximately 39% higher than for non-clamp kilns.

Energy costs

The principal fuel used in clamp kilns is coal and for non-clamp kilns, HFO or gas. Because of the price differences between these fuels, non-clamp kilns have a higher energy cost than clamp kilns even though they may be consuming less energy. This is shown by the average costs of energy in Table 3.

Regional influences

The price of energy is made up of the cost at the source plus the cost of the transport to the end-user. It follows then that the price of energy will vary from region to region. Table 4 compares the cost of energy and energy consumption in the major regions.

For clamp kilns, the cost of energy in the Eastern and Western Cape is double that of the Gauteng region, due to the higher coal prices. It is interesting to note that specific energy consumption is lower in the Cape regions, which may be as a result of the higher energy costs.

For non-clamp kilns, the cost of energy is highest in the Gauteng area, due to the use of gas which is not available in other areas. In KwaZulu-Natal the high carbonaceous content of the clay and the extensive use of coal contributes to the low consumption of energy and cost of energy.

The potential for energy savings

It is unlikely that each factory will be able to improve efficiencies to the levels of best practice because of the differences in clay characteristics, climatic conditions and technologies between factories. To estimate the savings that are possible, however, a figure has been estimated as being "attainable" for most factories. Called the improved average, this is an energy figure between that of the most efficient factory and the industry average. The savings that would result if the industry worked at this level are shown in Table 5.

A total of R164 million can be saved by the industry in energy costs by improving energy efficiency and without changing the technology. However, if changes are made from clamp to non-clamp operation then greater savings can be expected.

Energy and financial saving opportunities

A number of opportunities to save energy were identified from the factory visits and surveys. These include:

Energy type	Diesel	Electricity	Coal,HFO, gas	Total
Operation	Mining	Crushing and forming	Drying and firing	
Clamp				
Range	3-31	2-30	18-181	33-211
Average	11	12	78	101
Non-clamp				
Range	3-15	16-45	11-240	31-270
Average	8	26	98	132
Average	10	19	88	117

Table 3: Energy costs of the surveyed brick factories (Rands/1 000 bricks)

Region	No. of factories	Energy cons. (MJ/kg product)	Cost of energy (R/1 000 bricks)
Clamp			
Gauteng	5	4,30	65
W.Cape	8	3,36	119
E.Cape	9	4,10	143
KwaZulu-Natal	0	0	0
Non-clamp			
Gauteng	9	3,22	154
W.Cape	3	2,68	145
E.Cape	2	2,80	118
KwaZulu-Natal	6	2,35	96

Table 4: Regional comparisons

	Clamp	Non-clamp	Total
Present specific energy consumption (SEC)(MJ/kg)	4,01	2,89	3,45
Improved average SEC (MJ/kg)	2,40	1,80	2,10
Saving	40%	38%	39%
Present cost of energy (R millions)	222	198	420
Cost saving (R millions)	89	75	164

Table 5: Cost savings possible from improved average energy consumption (R millions/annum)

Electricity

Electricity is sold under a number of different tariffs and factories are often not aware that they could be eligible for a more cost-effective option. For example, one factory changed to the time-of-use tariff to make use of off-peak electricity and saved R8 000 in the first month with no decrease in electricity consumption. Although this is not an energy saving *per se*, it is a significant cost saving.

Another saving opportunity is in power factor correction. One factory installed power factor correction equipment and saved an average of R1 000 per month. Payback on the equipment was less than one year.

The load factor of a factory is an indication of the smoothness of electricity use. A low load factor indicates peaks in electricity use. Savings are possible by a factory rescheduling activities in order to decrease its maximum demand component of electricity cost.

Coal

Savings in the use of coal fall into the categories of supply, storage, handling and end-use.

The costs of different grades of coal have to be considered. A sample of filter cake was taken from a factory in the Western Cape and the calorific value and moisture content determined. This was compared to Grade A peas and found to be 28% more costly per unit of energy. Thus it may be more cost-effective to crush Grade A coal as opposed to using filter cake in this instance.

In the storage and handling of coal, many opportunities for saving come down to good housekeeping. In some factories, coal was stored outdoors leaving it open to weather erosion. Also, coal is often spilled during handling.

As with any fuel, it is important to maintain the correct air fuel ratio for firing. To effect this, it is preferable to use properly set up mechanical stokers rather than hand stoking. Ash handling is also important. For example, one factory that fired bricks in a continuous kiln experienced high wastage due to ash forming an insulating layer on the bricks and thus causing underfiring problems.

Compressed air

Compressed air is an expensive service and also one which is often neglected. The inlet air to a compressor should be cool and dust free and the distribution system regularly maintained. This was often not the case in the factories that were visited. It is also possible to save energy costs by reducing the delivery pressure of the compressed air. A 20% reduction in pressure reduces power requirements by up to 10%.

Insulation

A general rule of thumb for insulation is that if a surface is too hot to touch, then it requires insulation. Table 7 shows the losses from uninsulated surfaces.

Surface temperature above ambient (°C)	Heat loss (W/m^2)	Cost per month (R/m^2)
50	500	39
100	1 250	98
200	4 000	310
300	8 000	622

Table 7: Heat loss from uninsulated surfaces

With the high temperatures used in the brickmaking process, there are many applications for insulation. In many factories the insulation was inadequate or non-existent and there is a large potential for energy saving in this area.

Wastage

Typical wastage rates for clamp kiln factories are 15%-25% of production. This represents a 15%-25% energy loss. An improved waste management programme can result in savings, as one clamp operation visited proved with a wastage of under 5%.

Brick perforations

Perforated bricks save energy through reduced mass as well as quicker drying and firing due to increased surface area. Historically, these bricks have only been fired in non-clamp kilns, but recently some clamp kiln factories have successfully experimented with firing perforated bricks.

Energy monitoring

By monitoring energy usage, any changes can be acted upon timeously to minimise losses. Very few brick factories have such a system in place and consequently much energy and money is lost needlessly.

Conclusion

A survey of the energy usage of the clay-brick industry has shown that there is a large spread in specific energy consumption between factories, even those using the same technology. There are significant opportunities for energy conservation and it is estimated that if the industry adopted sound energy management techniques there would be a saving of around R169 million per year.

It has been shown that clamp kilns are less energy efficient than non-clamp kilns. In view of their better energy utilisation, lower pollution levels and higher potential output per year, it is likely non-clamp factories will gradually replace clamp kiln operations.

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* Exploring the interface between energy, development and public health

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This paper is a summary of the research project[4] on the relationships between electrification and health conducted by the Community Health Research Group of the Medical Research Council in 1995. It begins by outlining the health risks of the environments in which most South Africans live, and, drawing on a large international and national literature, points out the health risks of current domestic energy sources. By means of economic analyses, it argues that widespread domestic electrification could save up to 3 000 lives per year and a total saving of R800 million. The implications of electrification for the provision of health care in rural areas are considered. The paper concludes by pointing out that poverty and social factors, such as age, gender, notions of health and space, are likely to attentuate the potential health gains of electrification.

Keywords: South Africa; domestic energy; health; rural areas; urban areas; electrification

Historical inequities in environmental infrastructure provision, such as water, sanitation, housing and electricity, have resulted in negative health outcomes for many South Africans[1]. The Reconstruction and Development Programme (RDP), which, among other development initiatives, envisions the electrification of 2,5 million homes by the year 2000, aims to improve the health status of those who have borne the brunt of apartheid planning[2]. Infrastructural development, of which electrification is a component, has a positive effect on health at two levels. Firstly, provision of adequate services modifies the root causes of environmentally determined ill-health and, secondly, through improved primary health care. Integrated strategies for improving quality of life and alleviating poverty will thus have significant health benefits, although flexibility and sustainability in the implementation of such strategies is essential. As Lerer and Yach[3] point out, limitations of access and equity in the provision of services, such as water, sanitation and electrification, are most apparent at the level of the ultra-poor, who often benefit least from the decline in mortality and morbidity associated with infrastructural development. The research upon which this paper is based, was prompted by a concern with the equitable distribution of and access to domestic electricity, a resource which improves the production of health within households[4]. The health production function of electrification is demonstrated by the equation:

MERD = F(electricity, development)

where MERD (Reduction in Morbidity from Energy Related Disease) is a function of the relationship between electrification and development (such as, improved water supply, sanitation, housing, education and health care).

The relationship between electricity and health has not been extensively researched, as the industrialised world had achieved near-complete access to domestic electrification by the 1950s. What does exist, however, is a large body of literature which explores the health consequences of the use of energy derived from biomass, both internationally and in South Africa[4,5,6]. While not wishing to repeat the extensive literature reviews conducted by van Horen[6] and the recent technical report on the health impact of electrification published by the Community Health Research Group (CHR)of the South African Medical Research Council[4], it is useful to summarise some of the main findings.

Exploration of the interface between energy and poverty in South Africa produces a bleak picture of high levels of indoor and outdoor air pollution, burns, paraffin poisoning, low income and inefficient energy consumption. Air pollution is usually cited as the chief health problem associated with non-electrical energy sources. Coal and biomass fuel produce particulates and gases, their nature and volume being dependent on composition and the efficiency of combustion. Air pollution levels have been positively correlated with respiratory morbidity in both children and adults[4,7]. Exposure to particulate matter of 10 microns or less is associated with acute respiratory infection (ARI), especially among children and the elderly, and recent research indicates that particles of 2,5 microns or less may be harmful, as they can lodge in the lung alveoli[8]. South Africa currently has only limited capacity for the monitoring of small (<10 microns) particulate air pollution. This is of particular concern in the light of growing evidence of negative health outcomes associated with levels of air pollution which are well below current World Health Organisation (WHO) and U.S.A. Environmental Protection Agency (EPA) maximum limits[4].

However, while an important cause of ill-health, air pollution is not the only direct source of energy-related disease. Electrification will reduce injury from paraffin poisoning and burns. Based on national paraffin sales, Yach[10] has calculated that at least 16 000 South African children are hospitalised for paraffin poisoning, with poisoning rates in rural areas being three times as great as in urban areas. South Africa's burn death rate is estimated to be approximately four times that of the industrialised world. The devastating effect of fires in the home in informal settlements and childhood burns contribute to the high mortality[11,4].

Accelerated national electrification could be expected to have a considerable impact on health through the reduction of respiratory disease, burns and paraffin poisoning, in addition to improving quality of life. Negative effects of electrification, including hot water scalds, electrocution and the current debate concerning the association between electromagnetic frequency and some forms of cancer[4], should also be taken into account. On the basis of national electrification plans, mortality data and international findings, it is estimated that approximately 3 000 lives per year will be saved when South Africa attains high domestic electricity

* Based on a technical report entitled *Electrification and health*, which is available free of charge from the Community Health Research Group of the Medical Research Council.

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coverage. Reductions in morbidity and mortality associated with national electrification will result in savings within the health sector due to a reduced demand for curative services. Widespread domestic electrification (with a switching rate to complete reliance on electricity of 54% in newly-electrified households) will result in a saving of approximately R800 million in direct health costs[4]. Whilst it is unlikely that these savings will be directed to other parts of the economy, they will permit budgetary reallocations within the Health Department. This reallocation can be expected to lead to further improvements in health status and thus reduce the demand for health services. Hence, electrification can be expected to create its own health multiplier effect.

A reliable energy supply is required for the provision of effective rural primary health care. Research in Mpumalanga and the Northern Province indicates that many rural clinics do not have reliable vaccine storage facilities, both as a result of inappropriate appliances and unreliable energy sources. In addition, few of the clinics had electric lighting, a significant factor in determining operating times and the capacity to handle after-hours emergencies. None of the clinics studied had television sets or computers, electric appliances which potentially play an important role in telemedicine and health promotion[4].

Domestic electrification will also have a number of social benefits. These include altering the shape and nature of entrepeneurship (also considered to be a factor in reducing migration and population mobility), stimulating growth in the consumer market, and reducing or altering the time taken to perform domestic functions, thereby altering the division of labour within households. However, all of these benefits are predicated on three factors, namely, (i) the easy availability of electricity, (ii) the ability and willingness to convert to electricity as the main energy source within the home, and (iii) the presence of electric appliances. It is likely that the health improvements to be gained from electrification will be attenuated by the high levels of poverty. Case material generated by the Community Health Research Group in John Mampe 1 (an informal settlement area in Kimberley) and the rural village of Elim in the Western Cape, indicates that the effects of domestic electrification are experienced differentially, depending on a number of social factors. Most important of these were: (i) gender and age; (ii) energy dispenser location in relation to the social constructions of domestic space; (iii) appliance purchasing priorities (especially as these were integrated with perceptions of space); (iv) affordability of electricity; and (v) notions of health. The research thus confirms that the positive health effects of electricity, at the domestic level, accrue on the basis of socially and culturally constructed applications of domestic space[4,11,12]. The installation of electricity in John Mampe 1 made manifest gender and power differentials within household units. Men were the main income earners in the settlement and this, in conjunction with socially-constructed spatial perceptions, meant that the appliances prioritised tended to be for entertainment purposes (TVs and radios), rather than for the preparation of food, such as stoves, hot-plates or fridges. Where entertainment appliances are purchased in preference to fridges and stoves, women (as the main preparers of food) are not likely to fully enjoy the benefits of electrification[4]. Equity in access to electricity is thus moderated at the level of the household by social relationships predicated upon gender roles.

It was found that age and the socio-cultural meanings given to electricity or alternative energy sources are important factors in electricity usage and thus in determining the health benefits of electrification. The elderly of Elim appeared to be highly reluctant to use electricity for cooking. As pensioners, their incomes were limited and the costs of electrical installation in the village were passed on to consumers by the Moravian Church, which owned the land on which they lived. As a result, electricity was regarded as an expensive energy source, even before appliance prices were considered. Elderly residents expressed their resistance to electricity in terms of personal notions of health and well-being. For instance, electricity was considered by one woman to be likely to exacerbate her bronchitis. Others justified the fact that they had not installed electricity on the grounds that it was not a fuel to which they were accustomed. Notions of 'custom', frequently given as a reason for non-utilisation of electricity, contain within them socially construed meanings which revolve around epistemologically generated constructions of the world, and thus involve personal perceptions of health.

It has been shown that provision of electricity has a major impact upon health (as a result of reduced air pollution, decreased burns and paraffin poisoning), and could result in a reduced demand for health care services. However, the case-studies outlined in this paper show that the provision of electricity at the domestic level does not automatically ensure that all residents of electrified dwellings have equitable access to this energy source. Differentiation occurs in terms of gendered divisions of labour, the social meaning of space and age, and is particularly apparent when incomes are low. The implications of such differentiation for equity, particularly as regards the impact on health, are important for the success of electrification in South Africa.

Acknowledgements

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Poverty and power: Energy and the South African State

Anton Eberhard and Clive van Horen

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UCT Press (1995). 227p.

The number of books on energy in South Africa can be counted on the fingers of one hand and therefore the appearance of a new one is to be welcomed. The main title is possibly not a good one since it sounds like a revolutionary tract instead of the summary of a multi-year and multi-person analysis of the problems of the developmental sector of South African society in obtaining adequate access to energy and especially to electricity.

Although published in paperback form, the book is not light reading, as it is a detailed description of the findings of a study by the Energy for Development Research Centre (EDRC) at the University of Cape Town. This study is the result of work undertaken by the authors and some twenty researchers on a project funded by the Netherlands Government, Norwegian Government and the European Union. The project has attempted to identify the problems facing the household sector, and especially those of the poor, in the peri-urban and rural areas. The authors point out that the poor spend proportionally a greater amount of their disposable income on energy than the rich, and that the cost of transitional fuels such as, candles and paraffin, is greater than the cost of electricity, on a per unit of energy basis.

Furthermore, the authors state that South Africa has not had an adequate energy policy to date and that the policy that has been implemented was based on the desire for energy independence due to the sanctions imposed on South Africa because of its apartheid policy. They show that the cost of this policy has been very high, with the main expenditure being on the Atomic Energy Corporation (AEC), Sasol and Mossgas. However, the authors tend to lay the blame for all past actions on apartheid and I would disagree with some of the authors more political statements. For instance, I would disagree with their findings that electricity costs could have been lower if it had not been for the policy of apartheid.

A large proportion of the book is given to the possible means of implementing and funding the electrification programme in South Africa. This gets into the realm of politics and is a strong case for governmental intervention. I would argue strongly that cross-subsidisation by a utility to provide electricity to consumers, where the cost of the energy (capital plus operating) may never be recovered, is bad in principle and has been found to be counter-productive in many countries, and in South Africa in other industries (such as, the South African Railways) during the apartheid regime. If support for the poorer communities is justified in terms of social justice, and by the cost-benefits due to improved social conditions, then such backing should be direct support by Government.

The book is a very useful compendium of information, especially with regard to the supply and demand situation of households in various areas. More attention could possibly have been given to non-electricity supply and demand, and more discussion of the potential solutions for the rural energy problems. The book is well-written but better proof-reading would have sorted out the many problems that exist with the diagrams such as, Figure 5.2, for instance, where the temperature line appears to be missing.

All in all, this a necessary book for anyone working in the area of energy for development or in the electricity industry. One does not necessarily have to agree with everything but the book does provide a good overall perspective. The authors must be congratulated on an able summary of a large project.

Professor R K Dutkiewicz, Director,
Energy Research Institute

COMPARATIVE ENERGY COSTS IN SOUTH AFRICAN CITIES RELATED TO HEATING VALUE

MAY 1996											
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)	297,83	87,78	R/Ton	1,06	0,31	0,69	3,39	1,00	2,20	28,0	MJ/Kg
Elect.	21,47	24,43	c/kWh	5,96	6,79	6,06	19,02	21,65	19,32	3,6	MJ/kWh
Heavy Furnace Oil	71,89	90,01	c/litre	1,75	2,20	1,75	5,59	7,00	5,59	41,0	MJ/litre
Illum. Paraffin	126,12	139,68	c/litre	3,41	3,78	3,41	10,87	12,04	10,87	37,0	MJ/litre
Petrol (Premium)	210,00	206,00	c/litre	6,05	5,94	6,05	19,30	18,94	19,30	34,7	MJ/litre
Diesel (Heating)	199,39	210,79	c/litre	5,14	5,43	5,14	16,39	17,33	16,39	38,8	MJ/litre
Power Paraffin	151,62	165,64	c/litre	4,04	4,42	4,04	12,90	14,09	12,90	37,5	MJ/litre
LPG	130,87	148,88	c/litre	4,78	5,43	4,78	15,24	17,33	15,24	27,4	MJ/litre
Gas Gaskor	–	18,09	R/GJ	–	1,81	–	–	5,77	–	–	–

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. 37, May 1995)

Net maximum generating capacity

Country	Year ended	Thermal (MW)	Hydro (MW)	Nuclear (MW)	Geo-thermal (MW)	Total (MW)	% of total
Angola[a, c]	12/94	135,36	201,52	–	–	336,78	0,70
Botswana[a, b]	3/95	172,00	–	–	–	172,00	0,36
Congo	12/94	18,20	74,00	–	–	92,20	0,19
Kenya[e]	6/94	72,30	568,80	–	30,35 [d]	671,45	1,40
Lesotho[a, b]	3/95	1,56	3,27	–	–	4,83	0,01
Malawi[a]	3/94	25,03	164,60	–	–	189,63	0,40
Mozambique[a, f]	12/94	121,30	509,60	–	–	630,90	1,32
Namibia[a, b]	6/94	147,00	240,00	–	–	387,00	0,81
South Africa[b]	12/94	34 673,00	2 247,00 [g]	1 840,00	–	38 760,00	80,88
Swaziland[a, b]	3/94	9,50	40,50	–	–	50,00	0,10
Tanzania[a]	6/94	137,95	379,00	–	–	516,95	1,08
Zaire	12/93	37,50	2 442,16	–	–	2 479,96	5,17
Zambia[a]	3/94	84,00	1 670,00	–	20,00	1 774,00	3,70
Zimbabwe[a]	6/94	1 191,00	666,00	–	–	1 857,00	3,87
TOTAL		36 825,90	9 206,45	1 840,00	50,35	47 922,70	100,00
SADC		2 024,60	3 874,49	–	–	5 919,09	12,35
South African Customs Union		35 003,06	2 530,77	1 840,00	0	39 373,83	82,16

(a) Member of the Southern African Development Community (SADC) (excludes South Africa)
(b) Member of the South African Customs Union
(c) Available capacity
(d) Includes wind turbine capacity of 0,35 MW
(e) Effective capacity = sent-out capacity + own use capacity
(f) Includes Cahora Bassa
(g) Includes pumped storage

(Source: *Eskom Statistical Yearbook 1994*, p.50)

Gross production of electricity

Country	Year ended	Thermal (GWh)	Hydro (GWh)	Nuclear (GWh)	Geo-thermal (GWh)	Total (GWh)	% of total
Angola[a]	12/94	201,00	736,00	–	–	937,00	0,47
Botswana[a, b]	3/95	1 011,00	–	–	–	1 011,00	0,51
Congo	12/94	–	322,07	–	–	322,07	0,16
Kenya	6/94	158,65	3 047,51	–	261,62 [c]	3 467,78	1,75
Lesotho[a, b]	3/95	0	0	–	–	0	0
Malawi[a]	3/94	4,23	827,66	–	–	831,89	0,42
Mozambique[a, d]	12/94	27,76	171,00	–	–	198,76	0,10
Namibia[a, b]	6/94	207,40	671,70	–	–	879,10	0,44
South Africa[b]	12/94	154 785,00	3 127,00 [e]	9 697,00	–	167 609,00	84,58
Swaziland[a, b]	3/94	1,10	125,00	–	–	126,10	0,06
Tanzania[a]	6/94	284,90	1 499,40	–	–	1 784,30	0,90
Zaire	12/93	5,40	5 373,60	–	–	5 379,00	2,71
Zambia[a]	3/94	13,00	8 069,00	–	–	8 082,00	4,08
Zimbabwe[a]	6/94	5 439,40	2 095,60	–	–	7 535,50	3,80
TOTAL		162 138,84	26 065,54	9 697,00	261,62	198 163,00	100,00
SADC		7 189,79	14 195,36	–	–	21 385,15	10,79
South African Customs Union		156 004,50	3 923,70	9 697,00	0	169 625,20	85,60

(a) Member of the Southern African Development Community (SADC) (excludes South Africa)
(b) Member of the South African Customs Union
(c) Includes wind turbine
(d) Includes Cahora Bassa
(e) Includes pumped storage

(Source: *Eskom Statistical Yearbook 1994*, p.51)

Utilisation of net maximum generating capacity

Country	Year ended	Thermal (kWh/kW)	Hydro (kWh/kW)	Nuclear (kWh/kW)	Geo-thermal (kWh/kW)	Total (kWh/kW)
Angola(a)	12/94	1 486	3 652	–	–	2 782
Botswana(a, b)	3/95	5 878	–	–	–	5 878
Congo	12/94	0	4 352	–	–	3 493
Kenya	6/94	2 194	5 358	–	8 620	5 165
Lesotho(a, b)	3/95	0	0	–	–	0
Malawi(a)	3/94	169	5 028	–	–	4 387
Mozambique(a, c)	12/94	229	336	–	–	315
Namibia(a, b)	6/94	1 411	2 799	–	–	2 272
South Africa(b)	12/94	4 464	1 392 (d)	5 270	–	4 324
Swaziland(a, b)	3/94	116	3 086	–	–	2 522
Tanzania(a)	6/94	2 065	3 956	–	–	3 452
Zaire	12/93	143	2 200	–	–	2 169
Zambia(a)	3/94	155	4 832	–	–	4 556
Zimbabwe(a)	6/94	4 567	3 147	–	–	4 058
TOTAL		4 403	2 831	5 270	5 196	4 135
SADC		3 551	3 664	–	–	3 613
South African Customs Union		4 457	1 550	5 270	–	4 308

(a) Member of the Southern African Development Community (SADC) (excludes South Africa)
(b) Member of the South African Customs Union
(c) Includes Cahora Bassa
(d) Includes pumped storage

(Source: *Eskom Statistical Yearbook 1994*, p.52)

Production and trade of electricity

Country	Year ended	Gross production (GWh)	Imports (GWh)	Exports (GWh)	Available (GWh)	% of total	Estimated kWh per capita
Angola(a)	12/94	937,0	–	–	937,0	0,47	104
Botswana(a, b)	3/95	1 011,0	298,0	–	1 309,0	0,65	935
Congo	12/94	322,1	183,6	–	505,7	0,25	220
Kenya	6/94	3 467,8	264,0	–	3 731,8	1,87	174
Lesotho(a, b)	3/95	0	312,2	–	312,2	0,16	156
Malawi(a)	3/94	831,9	–	0,83	831,1	0,42	104
Mozambique(a, c)	12/94	198,8	699,9	–	898,7	0,45	58
Namibia(a, b)	6/94	879,1	882,5	27,8	1 733,8	0,87	1 238
South Africa(b)	12/94	167 609,0 (d)	58,0	2 628,0	165 039,0	83,07	4 199
Swaziland(a, b)	3/94	126,1	546,9	–	673,0	0,34	821
Tanzania(a)	6/94	1 784,3	–	–	1 784,3	0,89	77
Zaire	12/93	5 379,0	52,5	1 278,3	4 153,2	2,08	110
Zambia(a)	3/94	8 082,0	–	855,0	7 227,0	3,61	927
Zimbabwe(a)	6/94	7 535,0	2 007,4	0	9 542,4	4,77	918
TOTAL		198 163,1	5 305,0	4 789,9	198 678,2	100,00	1 101
SADC		21 385,2	4 746,9	883,6	25 248,5	12,71	317 613
South African Customs Union		169 625,2	2 097,6	2 655,8	169 067,0	85,10	3 764

(a) Member of the Southern African Development Community (SADC) (excludes South Africa)
(b) Member of the South African Customs Union
(c) Includes Cahora Bassa
(d) Includes pumped storage

(Source: *Eskom Statistical Yearbook 1994*, p.53)

Energy news in Africa

Electricity

Algeria

Algeria's Societé Nationale de l'Electricite et du Gaz (Sonelgaz) has estimated that the country will need to lay out $10 billion over the period 1993-2002 for electricity and gas facilities. It has devised a plan which calls for investments of $17,7 billion for the period 1996-2010 in three periods of five years.

With regard to electricity production, the plan calls for the phasing-out of existing steam turbine power stations totalling 640 MW, while Sonelgaz will launch projects for fourteen combined cycle stations with a capacity of 600 MW (a total of 8 400 MW) of which nine (5 400 MW) are to come on line by the year 2010. The decommissioning of gas turbines would result in a loss of 1 300 MW. However, they will be replaced by five 100 MW units and six 200 MW units.

With regard to the diesel-fuelled power stations serving remote towns or isolated networks, generators totalling 50 MW will be replaced with new equipment totalling 70 MW. The only hydro project presently under construction, the Beni Haroun, is not included in this programme.

In relation to transmission, the plan provides for 5 350 km of ultra-high voltage lines and 2 750 km of HV lines with 25 UHV/HV transformer stations and 118 HV/MV substations, including 32 regional and 86 local stations. On the distribution side, Sonelgaz provides for heavy maintenance work and upgrading of 14 600 km of existing line which will result in the connection of more than 3 million new subscribers to the grid. A rural electrification scheme will bring electricity 350 000 new subscribers.

(Source: Africa Energy & Mining, 14 February 1996)

Ghana

Bidding was due to start by the end of March 1996 for the second phase of a power station to be built on barges for Western Power, a private affiliate of the Ghana National Oil Corp. The second part of the power station, which will operate on gas from South Tano, is to be financed by Japan and is expected to double the facility's installed capacity from 130 MW to 260 MW. Each of the two sections will need two barges and will have a nominal capacity of 144 MW, with three 48 MW turbines. A third, combined cycle section, with a capacity of 150 MW, is being considered. However, it is unlikely that the start-up of the first section will take place this year.

An earlier loan of $120 million, granted by Japan's Overseas Economic Co-operation Fund for the project, will be devoted exclusively to building 160 km of transmission lines for the network supplying the west of the country from the power station.

(Source: Africa Energy & Mining, 13 March 1996)

Ghana's Volta River Authority (VRA), which is charge of part of Ghana's National Electrification Project (NEP), has awarded contracts to the Indian firm KEC International for the supply and installation of 860 km of medium voltage transmission lines, and ABB SAE Sadelmi for a substation at Yendi. The equipment is being co-financed by the government of Ghana, the Danish overseas development agency, Danida, and the International Development Association. This forms part of the first phase of the NEP which aims to provide electricity to the main towns in thirteen districts.

The NEP will be implemented in stages, firstly to supply the main towns in districts, then villages close to the lines, and finally about 3 654 centres, by the year 2020. Electricity provision for the Western and Central provinces, Grand Accra and certain regions of the Volta basin, will be undertaken by the Electricity Corporation of Ghana.

(Source: Africa Energy & Mining, 13 March 1996)

Mauritius

Disagreement between partners has led to the abandonment of the Union Saint Aubin Power Project in Mauritius. The power station was to have run on coal and sugar-cane waste. The plantation was to have built the 35 MW power station, together with the Central Electricity Board (CEB).

However, the project for a sugar-cane waste and coal power station at Belle-Vue and the extension of the Fuel station are still to go ahead.

(Source: Africa Energy & Mining, 13 March 1996)

Rwanda

The Rwandan Government has begun a pre-qualification process to privatise Electrogaz's network on a farm-out basis, based on the Ivory Coast model. The operating company will pay a fee to the government on each kWh sold, while existing equipment and future investment will remain under government control.

With regard to current operation of the network, Rwanda has received Canadian assistance which has allowed for the start-up of a 15 MW diesel power station at Gikongo in Kigali. However, only two-thirds of the country's electricity needs are being met.

(Source: Africa Energy & Mining, 14 February 1996)

South Africa

Eskom is to sell off six coal-fuelled, 500 MW power stations which were mothballed in the 1980s. Some twenty companies, local and international, were requested to submit offers for the power stations which are located at Sasolburg and Newcastle (KwaZulu-Natal). Some of the companies approached were Electricité de France, RWE and Siemens (Germany). Licenses to the private sector for production, transmission and distribution of electricity are to be awarded by the National Electricity Regulator.

(Source: Africa Energy & Mining, 14 February 1996)

Southern Africa

The framework agreement on co-operation signed in September 1995 between the European Investment Bank (EIB) and South Africa has created a favourable investment climate in the Southern African electricity sector.

Loans were also granted to Zimbabwe to restore the Kariba hydroelectric power station. With regard to interconnections between South Africa and neighbouring countries, these projects include the restoration of the line from Cahora Bassa via Mozambique, and the final touches on the construction of a second interconnection with Cahora Bassa via Botswana and Zimbabwe.

(Source: Africa Energy & Mining, 14 February 1996)

The first accords concerning the Southern African Power Pool (SAPP) that will manage the distribution of supplies were signed late in 1995. It is claimed that the dovetailing of electricity networks will result in the Southern African countries economising in millions of dollars as well as guaranteeing their power supplies.

The South Africa-Zimbabwe power interconnection between the Matimba power station (South Africa) and Insukamini (Bulawayo) was inaugurated in Zimbabwe on 8 March 1996. With the new line, Zimbabwe will have 300 MW at its disposal which will enable it to cut back on electricity purchases from Zambia and Zaire. It is expected that access to South Africa's coal- and nuclear-based electricity will cushion Zimbabwe against shortages in electricity which it has frequently experienced from its own hydroelectricity sources.

Tanzania and Zambia reached a similar interconnection agreement, with a feasibility study for interconnection with Zambia. Planned capacity has been reduced from 300 MW to 200 MW, the same capacity that the Zambia Electricity Supply Corporation (ZESCO) pledged to put at TANESCO's (the Tanzanian electric utility) disposal in late 1994 when a first feasibility study awarded to Tron Horn was completed. The 630 km-long line between Serenje and Central Zambia and Mwakibete (Mbeya) to expected to cost about $320 million. Tanzania hopes that within two years at the latest, power shedding could be something of the past. The Ubungo facility presently has a 100 MW capacity and will eventually also receive gas from Songo-Songo, which is expected to reduce electricity production costs. There are also plans for a fifth turbine. Tanzania is also considering a new hydroelectric project.

In 1997, the 400 kV Cahora Bassa-Harare interconnection and the rehabilitated 550 kV Cahora Bassa-South Africa line is to come into service. Four other projects are expected to be launched by the end of 1998.

During 1996, the Kapichira hydroelectric power station (128 MW) in Malawi and the Kapanda station (520 MW) in Angola are expected to come on line. The 72 MW power station at Muela in Lesotho will follow in 1997. In 1999, the 180 MW Lower Kihansi power station in Tanzania, as well as the reinforcement of the 660 MW coal-fired Hwange power station in Zimbabwe.

(Source: Africa Energy & Mining, 13 March 1996)

Hydroelectricity

Impoundment of the Katse reservoir in Lesotho has begun. The filling of the reservoir is on target to enable the key part of the Lesotho Highlands Water Project to be commissioned at the end of 1996.

The double curvature concrete arch dam, which is more than two-thirds complete, will be one of the largest of its kind.

The Katse dam is to be 180 m high, more than 700 m long, with a concrete volume of more than two million m^3.

As well as generating electricity for Lesotho, the Katse reservoir will provide water for the main industrial area of Gauteng in South Africa.

(Source: International Water Power & Dam Construction, November 1995)

Shortly after the year 2000, it is expected that the Sounda Gorge in the Congo will house a hydroelectric project which could cost between $700-$925 million. The Sounda Gorge project has been described as amongst the most high-powered non-mining projects to be undertaken by South African business as the money for Phase 1 ($50 million) has been put together by South Africa's Rand Merchant Bank (RMB), of which the RMB will contribute $15 million, with the balance coming from the Congolese Government and European institutions. Other investors could be brought in for the other phases.

Phase 1 (50 MW) of the project is expected to start in July 1996 when Interpro, a South Africa engineering group, will install two hydroelectric turbines in the existing diversion tunnel. Sultzer and ABB are to build the turbines and alternators. Italian and German companies are bidding for the civil engineering contract. By late 1997, these turbines are expected to supply about 10 MW of electricity, even before work has begun on the main dam.

The second phase of the project is expected to extend it to 240-250 MW. The first two phases will provide for a volume of 14 billion m^3 of water held behind a 45 m high dam. With the third phase, the dam will be 132 m high, with the water volume coming from the Kouilou River rising to 35 billion m^3.

When Phase 3 is completed, the project will generate 1 000 MW of electricity, approximately fourteen times that of the Congo's current output, making the Congo independent of electricity imports from Zaire and in fact, enabling the country to become an exporter of power.

(Source: Mining Mirror, March 1996
Africa Energy & Mining, 14 February 1996)

Oil and gas

Nigeria's liquefied natural gas (LNG) export project is to go ahead at last. In its present form the project has been under discussion since 1988, ultimately dating back to the mid-1960s. Following investments totalling \$3,8 billion, LNG is expected to start flowing in 2000.

Participants in the project are Shell (25,6%), Elf (15%), Agip (10,4%) and the Nigerian National Petroleum Corporation (49%). Buyers of the LNG will be Italy, Spain, Turkey and France. Total sales will be 5,6 billion m^3/year which could possibly increase to 6,6 billion m^3/year.

(Source: African Review, February 1996)

At the end of December 1995, BP and Algeria's Sonatrach signed an agreement under which BP will explore for gas in Algeria's remote In Salah region, which is expected to be capable of producing 10 billion m^3/year by the early part of the next decade. If sufficient reserves are found, the gas will be exported to Europe through existing pipelines by means of a 50:50 joint venture between BP and Sonatrach.

BP is expecting to spend \$100 million on the initial exploration of the area over two to three years, followed by \$3,5 billion over five years on field development and pipelines.

(Source: African Review, February 1996)

In South Africa. Mossgas has been given permission by Government to develop three satellites of the current Mossel Bay field. This is expected to enable the firm to maintain its output of synthetic oil products until the end of the decade.

(Source: Africa Energy & Mining, 13 March 1996)

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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 collaboration with countries in the region, and energy audits in industry.

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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, which was on heat transfer in nuclear engineering, from Cambridge University in the U.K. 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 what was then the Electricity Supply Commission (now Eskom), 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 1978/79. He presently serves on a number of international committees dealing with alcohol fuels, energy demand-side management, environmental matters, etc.

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Andrew Hibberd worked as a production engineer before joining the Energy Research Institute in August 1994. He is currently involved in industrial energy efficiency and has completed projects in the clay-brick and textile industries. He intends submitting a dissertation on energy use in the South African clay-brick industry for a Masters degree in 1996.

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Izak (Sakkie) Kotzé started his career, first as Technical Assistant in the Physics Department of the University of Pretoria and later, as Research Assistant in the Engineering Physics Department of the University of Virginia while studying part-time. After teaching at the Universities of Pretoria and Port Elizabeth from 1969 to 1974, he joined the then Uranium Enrichment Corporation of South Africa (later the Atomic Energy Corporation of South Africa) as Materials Scientist, where he assisted in the establishment of a Surface Science Laboratory and Materials Science Division.

In 1988 he spent a year at the Department of Trade and Industry as Techno-economist, engaged in the promotion of technology in South African industry. In 1989 he joined the then National Energy Council, which was later incorporated into the Chief Directorate: Energy of the Department of Mineral and Energy Affairs where he held the position of Director: Energy for Development. In this capacity he was responsible for the promotion of renewable energy and the development of policy in respect of the household energy sector, with special emphasis on the urban and rural poor.

On the 1 April 1996, Dr Kotzé was appointed as General Manager of REFSA (Pty) Ltd which is an independent company set up to co-ordinate and finance a renewable energy implementation programme for South Africa.

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Len Lerer is a specialist pathologist and epidemiologist currently conducting research into the health impacts of infrastructural development. For the past 4 years, he has managed a project which has focussed on the health aspects of electrification in South Africa. Dr Lerer has published widely on violence and injury control, and is a member of local and international public health organisations. He has been involved in various initiatives designed to ensure health-promoting energy provision.

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Fiona Ross has conducted research into the social relationships which determine and mediate fuel use in informal settlements in the Northern and Western Cape. Her interests have been to explore the social and cultural contexts within which energy is used at a domestic level. Incorporated into this research is an exploration of the ways in which household energy decision-making is conducted. She has worked as a researcher for the Medical Research Council, and is presently engaged at the University of Cape Town as a researcher.

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Deon Stassen obtained a B.Sc. degree at the Rand Afrikaans University (RAU) in 1978, and 1982 a B.Sc.(Hons.) 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 what was then the 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 Manager of the Energy Policy Programme in the Centre for Policy Analysis.

Deon has also been chairman of the Photovoltaic Industries Association, and in January 1996 was again elected as chairman of the Solar Energy Society of Southern Africa. He was also active in the Working Groups of the National Electrification Forum.

Forthcoming energy and energy-related conferences: 1996/1998

1996

JUNE 1996

10-12

SUB-SAHARAN OIL & MINERALS Johannesburg, South Africa

Enquiries: Europe Energy Environment, London, U.K.

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Fax.: +44 (171) 600 4044

18-20

AFRICA UPSTREAM 96 Cape Town, South Africa

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7-9

AFRICA OIL 96 Cape Town, South Africa

Enquiries: Geoff Davies, AIC Conferences

Tel.: +61 (2) 210 5700
Fax.: +61 (2) 223 8216

SEPTEMBER 1996

2-5

ATC 96: SIXTEENTH ANNUAL TRANSPORTATION CONVENTION Johannesburg, South Africa

Theme: Towards integration of Sub-Saharan transportation

Enquiries: Conference Planners, P O Box 82, Irene 1675, South Africa

Tel.: (012) 63 1681 (Cilla Taylor)
Fax.: (012) 63 1680

OCTOBER 1996

7-8

2ND ENVIRONMENTAL MANAGEMENT, TECHNOLOGY AND DEVELOPMENT CONFERENCE Fourways, Gauteng, South Africa

Enquiries: Lesley Stephenson, Conference Secretary, P O Box 327, Wits 2050, South Africa

Tel.: +27 (11) 716 5091
Fax.: +27 (11) 339 7835

1998

SEPTEMBER 1998

11TH WORLD CLEAN AIR CONGRESS AND ENVIRONMENTAL EXPOSITION Durban, South Africa

Theme: Interface between developing and developed countries

Enquiries: Congress Secretariat, Mrs Ammie Wissing, P O Box 36782, Menlo Park, Pretoria 0102, South Africa

Tel./Fax.: +27 (12) 46 0170

Recent energy publications

BENNETT M R

The introduction and promotion of solar cooking (Phase 1). Mar-1996. 12p. + appendices.
Report No. EO9504

Outlines the progress made with regard to sourcing and visiting organisations in certain rural areas of South Africa to introduce and promote solar cooking in South Africa. As Phase 1, this only covers the establishment of the infrastructure and methodology in order to go on with Phase 2. Includes a report from Kenya, "Assessment of the impact and potential for solar box cookers in Kenya" (Nov.1994).

HOLTZHAUSEN J P

Leakage current monitoring of polluted insulators on AC power systems. Mar-1996. 20p.
Report No. EL9008

The aim of the project was to gain more information on the ability of non-ceramic insulators to withstand prolonged exposure to polluted environments. In this project it was decided to concentrate on non-ceramic insulators and coatings. The synthetic insulators that withstood the previous test period were retained and some new synthetic insulators and coatings were fitted. Reports on the finds and makes recommendations for insulators at a site such as Elandsbaai.

MASANGO G M

A socio-economic and technical study of PV installations in Soshanguve - Phase I. Mar-1996. 14p. + appendices.
Report No. EO9516

The objective of this study was to compile and analyse data relating to the historical background of the installation of PV solar home systems in Soshanguve Township, near Pretoria.

SPIES P H

Environmental scanning and scenario development for long-term energy planning in South Africa. Jan-1996. 18p. + appendices.
Report No. EG9301

Discusses the three-year project undertaken by the Institute for Futures Research, University of Stellenbosch, on environmental scanning and scenario development for long-term energy planning in South Africa. Describes the methodology, the main results, the conclusions and recommendations.

All these reports are Final Reports and are the result of research funded by the Chief Directorate: Energy, Department of Mineral and Energy Affairs.

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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