PROCEEDINGS OF THE

African High-level Regional Meeting on Energy and Sustainable Development

FOR THE NINTH SESSION OF THE COMMISSION ON SUSTAINABLE DEVELOPMENT

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Contents

Acknowledgements *v*

Foreword *vi*

Regional perspectives

Energy and sustainable development: Key issues for Africa 1
Ogunlade Davidson and Youba Sokona

Renewable energy technologies in Africa: An overview of challenges and opportunities 20
Njeri Wamukonya

Access to energy

Rural electrification: A challenge for improving access to energy by the poor 31
N. Nziramasanga

Rural electrification reform and programme in Cameroon 39
Jean Pierre Ghonnang Zekeyo

The South African non-grid programme process 47
Njeri Wamukonya and Chris Lithole

Financing frameworks to facilitate sustainable development: Experiences in the AREED project 55
F D Yamba

Gender concerns in accessing energy for sustainable development 63
S B Misana

Renewable energy: Prospects and limits

Sustainable development in Africa through renewable energy 68
Faouzi Senhaji

Renewable energy in Morocco: limits and prospects 75
Mohamed Berdai

Barriers to the use of renewable energy technologies for sustainable development in Ghana 81
Ishmael Edjekumhene and Abeeku Brew-Hammond

Renewable energy technologies in Egypt: Opportunities and barriers 91
Elham Mahmoud

Rural energy

The role of woodfuels in Africa 99
Daniel Gustafson

An overview of biomass energy issues in sub-Saharan Africa 102
Koffi Ekouevi

Challenges in meeting biomass energy needs in West Africa 109
Mamadou Dianka

Botswana biomas energy projects: The challenge of mainstreaming biomas energy plans to facilitate sustainable development 115
Fanile Mathangwane, Michael Utke, Sam Bok, Masego Kealotswe and Gayle Best

Access to energy: Power sector reform

Overview of the power reform programmes in sub-Saharan Africa 123
Dibongué Kouo

Implications of power sector reform in South Africa on poor people's access to energy: Lessons for Africa 127
Alix Clark

The structure of the power sector, power sector reforms and implications for expanded access to electricity in Southern Africa 136
R S Maya

Regional cooperation: Opportunities and limits

Using new financial instruments for improving oil trade across Africa: opportunities and limits 150
Lamon Rutten

Regional cooperation for sustainable energy supply: Experiences with the development of the gas pipeline in West Africa 156
A O Adegbulugbe, J-F K Akinbami and F I Ibitoye

Oil and gas in Africa's energy future prospects and opportunities for intra-African trade 165
Tsatsu Tsikata

Statements and background

Statement by the Executive Director of the United Nations Environment Programme, Dr Klaus Toepfer 168

Statement by Mr Bakary Kante at the Opening of the Experts Segment 170

Cleaner fossil fuel technologies for Africa's sustainable development: Status of World Energy Council Cleaner Fossil Fuels Systems Committee Action Plan 172
Barbara N McKee

Energy for sustainable development in least developed countries: Statement by Ms Yvette Stevens, the Special Coordinator for Africa and Least-Developed Countries of the United Nations Department for Economic and Social Affairs 176

Appendices

Appendix 1: *Agenda of the Meeting* *178*

Appendix 2: *List of participants* *181*

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Njeri Wamukonya
Editor

Foreword

Sustainable development issues have been high on the international agenda for the last decade or more. Even though it has been recognised for a long time that energy generation and consumption are key contributors to environmental degradation, energy issues were not addressed specifically at the Earth Summit. Indeed, energy has not been the subject of a major United Nations meeting since the UN Conference on New and Renewable Sources of Energy in 1981, where the focus was solely on renewable energy.

It is, therefore, very encouraging that energy for sustainable development has been identified as one of the main themes for the ninth session of the Commission on Sustainable Development (CSD 9), which will be held in April 2001. This topic selection for the CSD9 meeting reflects an increased global concern not only with greenhouse gas emissions, but with the full range of environmental impacts associated with energy production and use and the important role energy plays in development.

The United Nations Environment Programme (UNEP) jointly with the Government of Kenya and the UN Department for Economic and Social Affairs (DESA) organised the "African High-Level Regional Meeting on Energy and Sustainable Development" in January 2001 at UNEP headquarters in Nairobi, Kenya. The purpose was to support the preparations for CSD 9 and enable African countries to discuss key issues related to energy for sustainable development in their regional context.

This report presents the technical statements and papers prepared for the technical workshop. As the reader will quickly notice, the papers reflect the views of the range of experts who participated. Speakers and participants came from ministries or agencies dealing with energy issues, rural development and finance institutions, utilities, private enterprises, NGOs, and research institutions.

The papers follow the themes identified for the CSD 9 session but provide an Africa-specific perspective. In the region, increased access to energy is clearly still a major development issue and has strong links to another key theme – rural energy. A number of papers address these issues from the woodfuel or biomass side, as the majority of the rural population in African countries relies on this energy source and will continue to do so for the foreseeable future. At the same time, improved access to commercial energy forms, particularly through rural electrification programmes, received much attention, and several papers present new approaches and experience gained in this area.

On the commercial energy supply side the major challenge facing most African countries is the need to reform institutional structures, especially in the power sector. These reforms are generally part of larger economic reform packages promoted by the World Bank, International Monetary Fund, and other financial institutions. In the energy sector the reform process offers an opportunity to introduce more efficiency and competition but it must be managed to ensure that social and environmental concerns are not neglected as a result of privatisation. Several papers address these issues and share experiences from on-going programmes.

Finally, the report provides several excellent regional overview papers that integrate the different issues mentioned above and put them in a regional perspective. These papers obviously contributed much to the success of the meeting and provided the main input to the final ministerial declaration.

I find the papers in this volume one of the best recent presentations on African energy issues in a sustainable development context, and would like to thank the authors for their contributions, particularly Ogunlade Davidson, Youba Sokona and Njeri Wamukonya for not only preparing the regional overview papers, but also putting together the overall programme for the technical meeting and facilitating the speedy publication of the proceedings in time for CSD 9.

In addition I would like to thank the Danish Ministry of Foreign Affairs for funding the technical meeting, and Mark Radka and Yinka Adebayo in UNEP and Walter Shearer and Michel Lokolo in UN DESA for their invaluable contributions to the whole workshop process.

This report has been prepared by the UNEP Collaborating centre on Energy and Environment as the technical organiser of the workshop. The report does not express any formal views of UNEP or UN DESA, but only those of the authors of the individual papers and presentations.

John M Christensen
Head UNEP Collaborating Centre on Energy and Environment
March 2001

REGIONAL PERSPECTIVES

Energy and sustainable development: Key issues for Africa

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1 INTRODUCTION

Over 175 nations from all over the world adopted in 1992 the Agenda 21 at the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil. This conference focused on sustainable development and human dimensions, while acknowledging the importance of the provision of energy in achieving sustainable development. The role of energy in sustainable development was also echoed with greater emphasis in June 1997 Special Session of the UN General Assembly that reviewed Agenda 21. It was further stated that sustainable patterns of energy production, distribution and use are crucial to improvements in the quality of life of people. This rationale forms the basis of the declaration that the ninth session of the UN Commission on Sustainable Development (CSD-9) scheduled for April 2001 should contribute to a sustainable energy future for all. Specifically, the sectoral theme to be discussed will be energy/atmosphere and the economic sector to be discussed will be energy/transport.

Energy is pivotal for economic and social development. While lack of access to energy services constitutes a major obstacle to sustainable development, improved access of the poorer sections of the population to energy services contributes directly to poverty alleviation.. Access to affordable and appropriate energy services must and should grow significantly in order to improve the standard of living of the world's growing population. This is particularly crucial for African countries. To this end Africa will need to embark on an energy growth paradigm that departs from well-known conventional paths that have yielded significant benefits for a large number of the regions in the world. Expanding access to energy services using innovative growth paradigms and applying energy efficient, environmentally sound, cost effective technologies and systems to all sector of the economy within a capital constrained context remains a major challenge for Africa. This challenge becomes even more difficult because Africa has limited access to existing global technologies efforts due to financial, technical and institutional barriers. New approaches that include different stakeholder roles, improved policy environment, and substantial financial and technical inputs are therefore required.

Table 1. Selected energy and climate change parameters of Africa and other regions

Region/country	*1999 GDP per capita ($)*	*Energy production/ consumption ratio (1997)*	*Carbon emissions /capita (metric tons) (1997)*	*Energy/GDP ratio (MJ/1997$)*
Africa	738	2.33	0.27	20.26
China	820	0.99	0.65	43.58
FSU/E. Europe	1 976	1.15	2.05	68.79
Japan	33 904	0.2	2.35	5.38
Middle East	3 532	3.42	1.42	27.75
Other Asia	964	0.72	0.36	20.26
N. America	25 039	0.88	4.28	12.87
S. America	2 889	1.28	0.58	13.93
W. Europe	20 123	0.64	2.19	7.8
World Total	4 919	1.0	1.03	14.35

Source: Adapted from World Economic Outlook, 1999, Energy Information Adminstration

Africa has on the average over 7% of the world's fossil fuel sources and the only area globally with recent finds of oil and gas (BP, 2000). Further, it has over 10% of global hydro resources and abundant renewable energy resources, but as a region, it is the lowest consumer of commercial energy in the world (UN, 1999; BP, 1999). Economic and environmental constraints limit the continent's capacity to exploit these resources using well-known strategies. Utilising new strategies which are generally more expensive will make it difficult. Providing adequate, affordable, efficient, and reliable high quality energy services with minimum adverse impacts on the environment for improving the quality of life of most Africans remains an uphill task.

The dual energy system of African countries poses specific challenges in achieving sustainable development because it requires satisfying the present and future needs of all. Most rural areas in Africa are deprived of modern energy services and the gap between rural and urban areas is becoming increasingly wide. Between 30% and 80% of the African population live in rural areas and only 3-5% have access to modern energy services. Further, the rural areas are more vulnerable to the adverse environmental impacts of population growth due to their extremely weak social infrastructure. For many African countries, coping with the rapidly growing urban energy demand is difficult; satisfying the rural demand can be very challenging. The task for these countries is to develop energy strategies that are economically efficient, environmentally sound, institutionally coherent and socially equitable.

However, there are signs that Africa is presently going through an economic transition, with economic growth rates surpassing population growth rate. Since 1996, the growth rate has shown an upward trend, 4.8% in 1996, 5% in 1997 and 4.9 % in 1998. There also signs of slowing population growth rates: 2.7% in the last few years with expected lower rates in the future. Growing urbanisation, with rates doubling national growth rates, is a serious cause for concern due to limited social services provision in urban areas and the development of the basic infrastructures. Despite current political conflicts, the number of countries with democratic and participatory governments are on the increase. These positive features of the continent can provide an environment for attracting both domestic and foreign investments in the energy sector.

This paper describes the energy situation of the continent, including its energy resources, production and use, before looking at the major challenges facing the continent to achieve its sustainable development objectives. The opportunities for growth are discussed as a prelude to commenting on the strategies and policies for energy growth in Africa.

2 Africa's energy situation

Africa is a continent with abundant, diverse and un-exploited renewable and non-renewable energy resources that are yet to be used for improving the livelihood of the vast majority of the population. Inadequate financial resources, social infrastructure, human and institutional resources can be blamed for this deficiency, but major policy shifts in the energy sector are also urgently needed if the continent should exploit existing and potential opportunities in achieving this goal.

A feature that distinguishes African energy systems from most parts of the developing world is its over-dependence on low quality energy

sources, mostly firewood and charcoal to satisfy cooking needs. The production of wood and charcoal is inefficient coupled with the use of cooking devices that are about 10-15% efficient . Another important feature is the unevenness in the production and use of energy in the continent. On an average, about 40% of total commercial energy is used in six countries in the northern sub-region, and a similar share in Southern Africa with over 80% by one country, South Africa. The other 45 or more countries use the remaining 20%. Similarly, the major oil and gas producers are limited to about ten countries concentrated in a few areas, and 96% of coal is produced in South Africa. This skew in energy consumption is not only due to the occurrence of energy sources, but represents the levels of industrial and other economic activities in the continent. This feature has a profound impact on the overall energy situation of the continent.

2.1 Energy resources

Africa is endowed with vast quantities of both fossil and renewable energy resources. Africa's share at the end of 1999 of coal, oil and gas of global reserves was 6.2%, 7.7% and 7.2% respectively; if exploited at current rates, they will last for 268, 98.3 and 28.2 years. Further, it is the only continent in the world with substantial new finds of oil and gas. Exploiting these resources in a sustainable manner for the benefit of many is crucial to its future development.

These resources are unevenly distributed, however. Oil and gas are concentrated in Northern and West Africa and even that are mainly in few countries, Algeria, Libya and Nigeria (see Table 2). Other countries with significant oil and gas reserves out of these regions are Angola, Equatorial Guinea, Gabon and Congo. More recently, some countries are reporting smaller but significant oil and gas reserves. These include Sudan, Cameroon, and Tunisia for both oil and gas, and Mozambique, Namibia and Tanzania for gas reserves only. As shown in Table 1, coal reserves are dominant in the southern region, of which over 95% are in South Africa. As a result of this skewed distribution, over 70% of countries in the continent import oil and gas to satisfy their needs. This feature represents a major drain on their economies because of weak foreign exchange earnings. As an example, in Tanzania oil imports constitutes only 7% of total energy consumed, but accounts for over 60% of its total export earnings (WEC 1992). This feature, coupled with poor fossil fuel infrastructure and weak integrated energy networks, has contributed to the relatively low exploitation of these vast fossil reserves in the continent. Exacerbating the uneven spread of resources, regional trade in oil and gas is relatively low, resulting in more than half the countries spending 20% to 35% of their total export earnings on oil imports from outside the continent.

Table 2: Regional fossil fuel reserves (1/1/99)

Region	*Petroleum (1000 bbl/d)*	*Nat. gas (Bcf)*	*Coal (million ST)*
Northern	1 151	1 534	6.11
West	471	221	0.263
Central	83	4	0.261
East	149	0	0.12
Southern	588	85	176.97
Africa	**2 42**	**1 844**	**183.7**

Source: U.S.DOE, 2000

It is important to note that new oil and gas deposits are being found in the continent regularly, a feature that accounts for the growing reserves shown in Table 3. In the past 20 years, oil reserves grew by over 25%, while gas grew even faster by over 100% for the same period.

Table 3: Crude oil and natural gas reserves in Africa, 1979-1999

Year	*1979*	*1998*	*1998*	*1999*
Crude oil	57.1	58.8	75.4	74.9
Natural as	5.96	7.55	10.22	11.16

Source: BP, 2000

Geothermal deposits are available in the continent but limited to Eastern Africa along the Rift Valley and concentrated in Kenya and Ethiopia.

Currently, Africa has over 10% of the world's hydro resources and significant other renewable energy resources. Two large areas of Africa that are particularly rich in hydro resources are the axis of the great African lakes from Kenya to Zambia, and the Atlantic coastline from Guinea to Angola. The Democratic Republic of Congo that lies between these two zones has nearly 60% of total African hydro resources, estimated to produce 1 100 TWh, with 46% technically exploitable, and 27% economically exploitable. The Western African region, mainly Ghana, has almost 34% of the total.

The natural forest resources in Africa look impressive and significant. Existing forest area covers 22.2% of the total land area. Biomass resources are estimated at about 82 billion tons, with an annual average growth of 1.7 billion. This can work out to 2.7 tons per capita, and is more than sufficient to cover the annual per capita demand of about one ton. However, these aggregated numbers conceal the major differences in resource distribution and production that

exist between sub-regions and within countries, with, for example, major differences between the northern region (mostly desert) and central Africa (with the major share of forest covers); in southern Africa, the forest cover of Malawi is only 0.38% as against 53% for Swaziland.

Although biomass is a renewable resource, its pattern of use can easily lead to major shortages as in the "fuel-wood crisis" in the Sahel in the 1980s. Though similar crises has been predicted for other areas, nothing of that scale has yet to occur, but the fact remains that vast areas that were once highly productive in biomass have now been completely depleted. It is estimated that annual loss of tropical forest due to excessive clearance and mismanagement is over 11 million hectares. The African savannah is also being lost at a very high rate. In the Sudan, 31 km^2 of the woodland savannah is lost annually, while Ethiopia is left with only 3% of its total forest cover. However, these data on biomass loss need caution: for example, in Mali, Burkina Faso and Kenya, more recent studies tend to invalidate the trends forecast in the 1980s of a major shortage of biomass supply. These studies show that the productivity of forests and the number of trees might have actually increased.

Africa being mainly within the tropics, most countries in the continent enjoy long hours of sunshine with significant radiation that can be exploited. Wind resources are available in selected sites, mostly along the coastlines in the northern, western and southern Africa.

Africa therefore, is not short of energy resources, which can give the continent the energy security it requires. The challenge is to develop strategy of accessing the well-known technologies through overcoming the major barriers that exist.

2.2 Energy production and use

The production and consumption of both commercial and traditional energy has been on the increase throughout Africa, the former mainly due to increase in industrial activities and urbanisation and the latter mainly due to population pressure. Though the production of commercial energy has remained around 7% of the world's total, it has doubled between 1970 and 1997. The production of natural gas grew faster than oil and coal. Oil still dominates the commercial energy production in Africa though its share has declined. In 1970, this share was 86% (coal, gas and hydro being 11%, 2% and 0.5% respectively) but in 1997, oil declined to 63%, while coal increased to 19%, natural gas 15% and hydro stayed the same (USDOE, 2000).

However, the unevenness in the occurrence of fossil reserves is reflective of the pattern of energy production in the continent. Southern Africa accounts for 99% of coal production, with South Africa responsible for almost all of it, while natural gas production is concentrated in northern Africa, mostly in Egypt and Algeria. Crude oil production involves a slightly wider spread in north, west, central and southern Africa; among the countries involved are Algeria, Egypt, Libya, Nigeria, Cameroon, Gabon and Angola.

Due to poor infrastructure and slow economic performance of most countries, Africa has remained a net exporter of its fossil fuels for some time now, with over 50% of all commercial energy produced exported out of the continent (see Table 1). Further, the poor integration networks in the continent has made many countries import these fuels using their meagre foreign exchange while others export them out of the continent. Table 4 shows energy exports from the different regions. Every region is a net exporter of commercial energy except the eastern, while the northern region is by far the largest exporter. Most of the exports go to Europe and USA. Northern Africa exports oil and gas, west Africa mostly oil, and southern Africa coal.

Consumption of commercial fuels by African countries has been growing on an average of 2.7% annually between 1980 and 1997, though it grew by 3.1% between 1990 and 1997. However, higher growth rates are required for the continent to compete with other world regions, though it should be noted that the consumption rate now exceeds population growth, which has been around 2.5% per annum and is predicted to be around 2% in the next few years. Also, there has been a slight increase in Africa's share of commercial energy consumption globally, from 2% in 1970 to 3% in 1997 (2.7 to 3.8% for coal, 2.7 to 3.4% for oil, and 0.1 to 2.4% for natural gas) (USDOE, 2000). These shares are very low because the continent hosts 14% of the world's population. Low levels of industrialisation and low incomes, leading to equally low ownership of appliances and vehicles, are major contributors for this low share.

Table 4: Regional modern fuels production and consumption, 1997

Region	*Production (EJ)*	*Consumption (EJ)*	*Net exports (EJ)*
North	12.67	4.64	8.05
West	5.74	1.42	4.31
Central	1.99	0.31	1.69
East	0.12	0.42	-0.32
Southern	7.42	5.22	2.21
Africa	**27.93**	**12.02**	**15.91**

Source: Adapted from USDOE, 2000

Northern Africa produces almost half of the oil and gas, while around 80% of these resources are consumed in the north and southern Africa (see Table 4). In 1997, South Africa, Egypt, Algeria, Nigeria and Libya accounted for 78% of all commercial energy consumed in the continent and they also account for most of the commercial energy produced. With the exception of these countries, most countries are net importers of commercial energy

Electricity generating capacity in Africa with respect to the population is low; as of 1997 the capacity was only 94 GW accounting for only 3% of the global total despite the global population share of 14%. Thermal sources form 76% of the total. As shown in Table 5, generating capacity varies among the different regions, 88% from thermal resources in northern Africa and 81% in southern Africa, while hydro is significant in the east and west. Also, coal dominates southern Africa while oil and gas is predominant in the north. Due to the proliferation of hydro capacity within the continent, 22% of total electricity production is from hydro, with east and central Africa being dominant; it accounts for over 80% in certain countries such as Cameroon, Zambia, Democratic Republic of Congo, and Ghana. Nuclear accounts for only 2% and is located in only one country, South Africa. Geothermal accounts for 0.1% of the total: Kenya has a plant of 45 MW and has almost completed another plant of 64 MW with another plant of 100 MW going to be available in the next few years. In comparison to the population, access to electricity still remains very low (see Table 5).

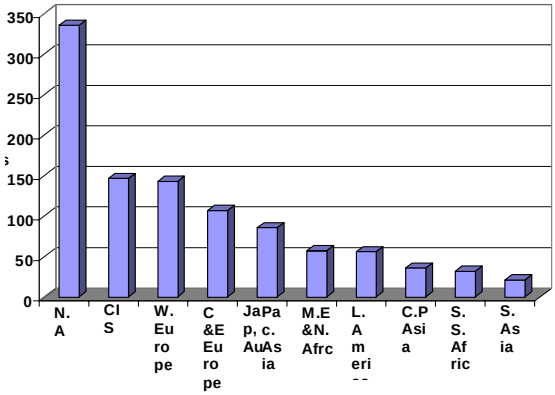

Figure 1: Primary energy use per capita for different world regions, 1995 (in Gigajoules)

Africa as a whole is the lowest consumer of total energy use globally, as shown in Figure 1, but large disparities exist in the continent, especially in modern energy use. Per capita modern energy consumption varies by a factor of more than 10 between the highest and the lowest users. Enormous disparities also exist between urban poor and rural users and higher income groups throughout the region. However, due to economic policies such as "structural adjustment" that have led to reduced income, reversals in the

Table 5: Electricity generation, 1997

Region	*Capacity (GW)*	*Share (%)*			
		Thermal	*Hydro*	*Nuclear*	*Other*
North	32.88	87.7	12.3	0	0
West	9.61	52.2	47.8	0	0
Central	4.34	8.9	91.1	0	0
East	2.76	33.8	63.5	0	2.7
S. Africa	43.83	81.2	14.6	4.2	0
Africa	93.5	75.8	22.2	2.0	0.1

Source: USDOE, 2000

Table 6: Trends in sectoral modern energy consumption in Africa (EJ)

Region	*Industry*		*Transport*		*Residential*		*Commercial*		*TOTAL*	
	1980	*1996*	*1980*	*1996*	*1980*	*1996*	*1980*	*1996*	*1980*	*1996*
North	1.48	2.53	0.74	1.48	0.47	0.95	0.11	0.12	2.8	4.96
West	0.32	0.53	0.42	0.53	0.32	0.32	Neg.	Neg.	1.05	1.37
East	0.11	0.11	0.11	0.21	0.11	Neg.	Neg.	Neg.	0.37	0.32
Central	0.11	0.11	0.11	Neg.	0.11	0.11	Neg.	Neg.	0.37	0.21
South	2.95	2.64	0.84	1.58	0.53	0.53	0.21	0.22	4.53	4.96
Total	4.96	5.91	2.22	3.8	1.53	1.9	0.32	0.34	9.12	11.82

Source: USDOE, 2000

energy ladder can be observed in several African cities, with people reverting to traditional fuels. As a result, per capita modern energy consumption has been declining in the last 10 years. Pressure from population growth also contributes to this.

Energy consumption patterns in Africa reveal the imbalances in the region. Oil still accounts for 80% of commercial final energy consumption, shared almost equally between the transport and industrial sectors. Industrial energy consumption is the major share of total commercial energy consumption between 1980 and 1996, with southern Africa being dominant – largely due to South Africa – as shown in Table 4. However, with the exception of South Africa, the 'industry' category can be misleading, as it is largely mining and the expected multiplier effect on the economy is not as expected. Industrial imports are still prevalent in most countries. Despite the low ownership of cars in the continent (only about 20 per 1000 people), the transport sector consumes a large share of the commercial energy, as shown in Table 6. The relatively large share of public transport uses a significant share of the total. Northern and southern Africa dominate the total as can be seen in Table 6. The number of cars per 1000 varies from about four in Sierra Leone, to 17 in Côte d'Ivoire and 50 in South Africa.

Electrification in Africa is extremely low, as previously stated, resulting in very low per capita consumption (see Table 7). The northern and southern regions uses up to 82% of the total. Eskom, the power utility in South Africa, is the world's fifth largest utility. Countries with significant consumption outside these regions are Kenya in the East and Nigeria in the west. There is significant electricity trade in the continent and countries notable in this area are Ghana, Zambia and South Africa, in 1997 exporting 0.3, 1.2 and 6.6 TWh respectively. The industrial sector dominates the use of electricity, but this is also due to South Africa and a few countries in the North, and is not the case for most countries. As compared to income, electricity is expensive and remains a luxury for large share of the population.

On average, 68% of total energy consumption throughout Africa is consumed in the household, and in countries such as Burundi and Burkina Faso, this share is as high as 90%. An interesting feature is that the patterns of energy use even in oil-producing countries are similar. Since traditional fuels account for 77% of household consumption in the region as a whole, it is clear that the household is an important actor in the energy sector.

Table 7: Electrification in selected African countries

Country	*% access*
South Africa	48
Zimbabwe	17
Swaziland	14
Botswana	13
Namibia	11
Zambia	10
DR Congo	5
Tanzania	5
Mozambique	5
Malawi	4
Lesotho	3
Togo	2

Sources: FT, 2000, various issues Africa Energy Journal, 2000

The use of this low quality traditional energy is far from uniform: a very small fraction is used in the north as opposed to large quantities in west, central and east Africa. High biomass use raises serious problems because of its very low conversion rate of 15% or less, high wastage, and the poor quality method of production. Also, the health and other environmental problems associated with its use are significant. There is more variation in the reliance on traditional fuels in the east and southern regions than in west and central Africa, ranging, for example, from 14% in South Africa to 70% in Sudan. It is estimated that, on average, the southern region, excluding South Africa, relies on fuel-wood for 89% of its energy needs, but with South Africa included the figure declines to 58%, illustrating the influence of that country in the sub region. In north Africa, biomass (largely agricultural residues) represents about 30% of the total energy use, such as Morocco.

Despite the dominance of biomass fuel, other fuels are used in African households. A number of factors influence the choice of fuel used, with the most significant being household income: in general, the higher the income the more likely that the household will choose modern fuel. Furthermore, lower-income households are the lowest consumers of energy and total energy consumption increases with income. Households with higher socio-economic status and levels of education consume more energy and are better disposed to acquire fuels such as LPG for cooking and electricity. This correlation is largely manifested in urban areas. In rural areas the same trend can be discerned, although blurred by the degree of social homogeneity, the non-diversification of energy uses, the inaccessibility

of alternative energies, and the unchallenged dominance of fuelwood.

Another feature of the African energy system is the substantially higher share of family budget used for energy services in both rural and urban areas. While it is common to spend less than 5% of household income for energy services in most regions of the world, African households spend a lot more (9.5% in Burundi, 22.3% in Equatorial Guinea). Higher expenditure on energy has significant implications for African countries with relatively low incomes. Poor households are limited to firewood and charcoal because they are unable to purchase higher quality fuels. This explains the continued dominance of traditional energy use in both poor urban and rural households despite the many efforts that have been made to reduce the demand for fuelwood.

Another feature of the African energy system that requires some comment is its high energy intensity in comparison to the rest of the world. In 1997, Africa consumed 28 MJ per 1997 US$, when the world's average was 14 MJ. Also, this intensity increased by 71% between 1970 and 1997 while the world's average declined by 28% in the same period. Therefore despite energy consumption being lower in the continent, the energy used to produce GDP is much higher. The high use of inefficient traditional energy that is poorly linked to the economy, and a weak industrial sector are contributing factors to the high-energy intensity in the continent.

2.3 Energy policy and planning

Energy policy and planning is relatively recent in Africa because it mainly started after the mid 1970s, as a result of the oil crises in 1973 and 1980. Most governments were forced to set up ministries of energy – but generally as a part of an existing ministry, which has not always had a positive effect in energy policy-making. The main focus of these ministries was oil supply security and reduction of oil imports. This assisted greatly in setting up co-ordination structures for energy but, apart from the negative economic impact of oil reduction, the multi-disciplinary nature of energy production and use led to inadequacies in using only one ministry. This led to the setting up in some countries of energy commissions/councils or directorates as high policy-making media for all the different stakeholders in energy. The result of this structure was mixed. At the time of the oil crises, the use of renewable energy gained prominence but these activities were limited to R&D and a few disjointed pilot projects. Very few countries had the institutional structure to cope with the production and use of these energy resources.

Energy policy in African countries has suffered from several features which have contributed largely to ineffectiveness. A major weakness is the lack of suitable regional and national energy policy analysis institutions, which have resulted in most of the energy policies being externally conceptualised. In the relatively few institutions that exist, their agendas are not in line with government's interests. Another feature is the lack of adequate data for effective policy analysis. Most of the available data are incomplete and outdated and cannot be used to cope with the rapidly changing situation in the energy sector. The situation is worsening for traditional energy systems that require new approaches for proper analysis.

3 Challenges for sustainable growth

3.1 Energy-development-environment nexus

Africa is a large continent with significant varied natural resources that has not always been used in a sustainable manner for the development of the continent. There has been serious imbalance in their use, quite apart from the different methods of use. Soil and vegetation in some areas are overexploited, while water, energy, minerals and organic resources are underused, or extracted and exported in their crude state. As a result, expanding the use of these resources to satisfy developmental needs, especially, energy presents major challenges because optimal use of these resources is required while minimising negative environmental impacts. The current high dependence on natural systems in the continent makes this task more difficult because of the inter-linkages between development and environment.

The main environmental concerns of Africa outlined by the respective governments are land degradation and desertification and its effect on food security, protection and use of forests, effective management and protection of bio-diversity, water scarcity and water management, marine and coastal, and air pollution, and drought and climate change (UNEP, 1997). Expanding energy provision substantially in the continent –which is needed for both survival and developmental needs – will have both direct and indirect linkages to all these environmental concerns if current use patterns continue. The extensive use of biomass energy is related to land degradation and forest protection while increased fossil fuel use will accelerate climate change and increase air and water pollution.

As already mentioned, firewood and charcoal use in Africa is the highest in the world and forms about 67% of total primary final energy use on the continent. If current population pressure continues and use patterns do not change, then satisfying future demand will pose a major environmental problem. Firewood and charcoal are the biomass energy forms with the most adverse environmental impacts and are contributors to deforestation, which is currently a serious problem in the continent. Also, deforestation has negative local impacts, such as increased erosion, and global environment impacts in that it quickens climate change and affects biodiversity. A wider use of firewood and charcoal can also lead to serious health effects because of the cooking activity associated with these sources. The smoke from cooking (mainly affecting women and children) can lead to serious respiratory problems. If substitutes are not found for firewood and charcoal especially for the urban poor, then these problems will intensify.

Expanding the use of fossil sources in the continent, as required for development, can pose serious environmental challenges, both in increasing air and water pollution and accelerating climate change. Air pollution (lead, particulate and sulphur emissions) will increase due to increased oil consumption, especially in the transport sector. Also, petroleum extraction, processing and transport has serious attendant environmental problems, especially oil spills, which the continent lacks the capacity to cope with. Fossil fuel processing and burning can lead to increased emission of greenhouse gases, which will increase the continent's contribution to climate change.

3.2 Meeting growing urban needs

The growth of urbanisation in Africa, predicted to be over 50% by 2010, will be a developmental, energy and environmental challenge. Though Africa is the least urbanised continent, concentration of population is a problem, with the number of cities with more than one million is increasing, from only one 30 years ago to 18 by 1990 (World Bank, 1995). Lagos in Nigeria and Cairo in Egypt are the fifteenth and eighteenth largest cities in the world, with annual growth rates of 5.68% and 2.24% respectively. Population growth, employment needs, aspiration to higher quality of life, natural disasters, and political conflicts are driving up urbanisation rates in the continent. The challenge is to develop adequate social support services (solid waste disposal systems, sewage treatment, and industrial and other pollution control systems) to support these high growth rates. The energy requirements are not only significant, but need high quality energy supply because of existing energy infrastructure and current use patterns. An important feature of current urban use patterns is satisfying the needs of the urban poor, whose existing reliance on firewood and charcoal is unsustainable.

3.4 Rural energy access

Satisfaction of basic rural needs (food, health, housing, etc) requires significant and diverse energy source because these areas are deprived of adequate high quality energy. Existing scarcity and the relatively high cost of energy only perpetuates and worsens poverty in rural Africa. Access to high quality energy will present serious problems because if the current system continues then firewood and charcoal should be in adequate supply with minimum impacts on the environment. If other energy sources are to be provided, then the necessary support infrastructure will have to be provided to ensure efficient supply and use.

In certain rural areas, access to fuelwood is very difficult, with people travelling longer distances to collect fuelwood. In the Sahel, rural people travel distances of over 15 to 20 kms in order to gather the fuelwood needed, as there is no organised public transport. Limited access to energy by the poor only marginalises them from society and worsens their living conditions.

Providing energy to meet basic needs remains a daunting problem because this will result in the exclusion of a large number of people. There will be a need for policies on subsidy or cross-subsidisation.

3.5 Regional co-operation and trade

Co-operation among African countries on the political level is quite significant as demonstrated by the operation of the Organisation of the African Unity (OAU), but trade among African countries is low, only about 6% of total trade; this is lower than in other developing regions (the figure in Asia is 40%). A low manufacturing base, poor communication facilities, and limited trading commodities are some of the factors responsible for weak trading relationships between countries.

Though energy trading is progressing between countries for oil, hydropower and gas, it needs to continue with greater intensity as the small and fragmented nature of most countries in the continent cannot develop the respective markets to ensure economic viability. Also, most countries in the region will find it difficult to cope with the requirements to undergo transactions with major economic blocs in the world.

However, 39 African countries are now members of the World Trade Organisation (WTO) and five are observers. Also, several trad-

ing blocs have emerged within the continent in recent times. The main ones are:

- Common Market for Eastern and Southern Africa (COMESA), with 21 members and a population of 385 million;
- Southern African Development Community (SADC), with 14 countries and a population of 190 million;
- Economic Community of West African States (ECOWAS) with 16 countries and a population of 220 million;
- West African Economic and Monetary Union (UEMOA) which unites eight countries of the CFA Franc monetary zone; and
- the Union of Magreb Arab states (UMA).

There are some overlaps between COMESA and SADC with eight states being members of both (see Table 8), and ECOWAS and UEMOA, also with eight countries being members of both.

A major challenge to regional cooperation and trade is security between nations, though there are now signs of improvements. Conflicts between neighbouring countries create an unsecured environment for trade and destroy confidence and trust among countries. Another challenge is that a fear of loss of sovereignty tends to prevent trade among countries.

4 Opportunities for energy growth

Transforming Africa from its present situation in which most countries are struggling to satisfy their survival needs to a state in which majority of the countries are achieving their sustainable development goals should be the main interest of various stakeholders, including decision makers at different levels, and academics. It should be noted that, in satisfying sustainable development needs, social welfare and environmental protection are just as important as economic growth. The energy requirements to satisfy this task are huge and could be achieved by developing Africa's vast renewable and non-renewable energy resources. However, there are options available to the continent because of the large pool of technologies in the public domain that could be exploited, although access still remains a thorny problem. These options include energy efficiency (supply and use technologies), development of renewable energy technologies, and development of cleaner fossil fuels

4.1 Energy efficiency technologies

Utilisation of efficient production and use technologies can be an important strategy in the increase of the supply and use of high quality energy in the continent. Due to the current trend of technological progress in world markets, a significant number of improved energy efficient technologies are available. As mentioned previously, an energy strategy for development of the huge fossil fuel resources in the continent is required. One current projects that is an example of developing the fossil sources of the continent is the West African Gas Pipeline that aims at supplying four countries with high quality energy. There are now improved technologies with energy and technical gains that the continent can access. This also presents opportunities for African countries to access to use exciting power generating options such as combined power systems (for example, gas turbines and combined heat and power systems).

Improving the efficiency of existing plants offers significant opportunities for African countries. Most power plants are operating at efficiencies far lower than either prescribed standards or in comparison to other regions. This deficiency varies from 5-10%. The problem is most noticeable in high transmission and distribution (T&D) losses in power plants. T&D losses in Tanzania and Democratic Republic of Congo are 24% and 42% respectively, compared to less than 10% in many countries. Using well-known technologies and certain measures these losses can be reduced and on an average, 5-10% more power can be available to satisfy the huge amount of suppressed energy demand in the continent.

Promoting demand-side management (DSM) in the energy sector provides new opportunities for African countries. This is useful because it also promotes economic efficiency, because energy costs are reduced for the same output, hence for the same energy cost; productivity and competitiveness will improve. Some studies have shown that use of technically proven cost-effective energy efficiency measures can result in saving 10-30% of energy consumption. As an example, it is estimated that at least 15% can be achieved through housekeeping measures in Ghana, and 40% of electricity consumption for air conditioning could be saved with more efficient equipment and practices.

4.2 Development of renewable energy technologies

Africa has significant renewable energy sources that can be harnessed for satisfying certain niches in the energy sector. The most pervasive are mini-hydro sources, which have associated matured technologies, and solar energy that also has some associated matured technologies. Wind energy is only available in a few countries. However, due to the economic situation for most African countries only matured technologies will be useful at this point. Biomass

energy is yet to be exploited significantly as a high quality energy source in the continent, with the exception of agro-based industry that uses agricultural residue for steam and electricity production and ethanol production for transport fuel in a few countries.

Due to recent technological progress and the market success of limited renewable technologies, certain off-grid systems are becoming cost-effective and their use in African countries is increasing. Solar PV systems are among these technologies that are been used for households and a small number of commercial purposes. It is estimated that about 100 000 small-scale systems have been installed in Kenya, South Africa and Zimbabwe. The market for such systems is estimated to be up to 1500 MWp, over 10 ten times the current level.

The potential for other systems, such as small-scale gasifiers using biomass residues and increased exploitation of wind energy, is great. The use of ethanol is also important because of the widespread availability of sugar industries in continent; and the technologies associated with sugar are improving. Opportunities to use other renewable systems, such as biogas for specific situations, are increasing.

Renewable energies have a very important niche in Africa and they are receiving much attention in the international arena. However, when a development perspective is taken, they cannot be the sole energy solution to development needs. There is a need to identify their role and limits in the future African energy system.

4.3 Development of fossil energy sources

There have been continuous new discoveries of oil and gas in the continent, as shown in Table 3. Also, significant investments are now put into oil and gas exploration, as in Equatorial Guinea, Chad, Sierra Leone, Nigeria, Gabon, Tanzania, Mozambique, Namibia and South Africa. Most of the foreign direct investments recorded recently on the continent were for oil and gas exploration. The associated technologies of these fuels are also becoming more efficient. Africa needs to develop these technologies for satisfying the level of energy required for its developmental needs – a level beyond what can be realised from energy efficiency and renewable energy technologies.

However, caution is needed with this type of development. Most of the current work in this area such as the LNG processing in Nigeria is for export, without adequate development of the use of gas in the downstream end. As a result benefit to the country becomes marginal. Also, care should be taken to ensure that the most up to date technologies are employed so that adverse environmental impacts, such as oil spills and methane leaks from gas distribution system, are minimised .

5 Strategies and policies

Africa needs substantial energy services to not only increase its net productivity but to also be an active participant in world manufacturing and trade. To achieve this task using some of the opportunities discussed above, African countries will need to embark on specific strategies and policies, which can be outlined as follows:

- energy services provision;
- international investments and cooperation;
- regional cooperation and planning;
- regional trade;
- rural energy provision;
- institutional organisations and reform;
- human resource development;
- energy research, development and demonstration;
- donor assistance;
- rational energy pricing;
- mobilisation of financial resources;
- climate change opportunities.

5.1 Energy services provision

The key to high quality energy growth in Africa is the provision of adequate energy services for the household, transport, agriculture and industry sectors. However, the provision of high quality electricity will go a long way in achieving this goal because of its flexibility and reliability; therefore electricity provision will be briefly discussed before looking at the specific economic sectors.

Access to electricity is a thorny problem because by world standards it is extremely low, as was shown earlier. On an average it is below 30% for urban areas and less than 10% for rural areas. To increase this share, strategies and policies should be focused on the following:

- There is a need to increase the efficiency of existing power plants through rehabilitation and overhauling. In Nigeria, NEPA's capacity was increased from 1000 MW to 3000 MW by this process. This exercise does not only increase capacity but also increase the efficiency of operation. Reduction of T&D losses using well-known methods can easily achieve 10% more power output.
- The use of DSM tools can assist the power sector. Apart from improved T&D, the use of energy efficient appliances can prove useful. Many countries now have improved refrigerators and compact fluorescent lamps –

but higher penetration rates are needed as the case of CFLs in South Africa.

- Regional integrated power planning is required, because it will provide optimal results and cut down wastage. This will be discussed further below.
- Advanced technologies for power production such as combined cycle gas powered plant, have higher thermal efficiencies and are more economically feasible than many plants. New gas finds only confirm this strategy.

The household sector provides some opportunities for African countries to achieve sustainable development. The provision of adequate power will satisfy most of the energy needs in the domestic sector especially in the urban areas. The activity that requires attention beyond power requirements is energy for cooking. The use of LPG for cooking in urban areas should be promoted, as has been done in Senegal, Mauritania and Ghana. This measure has many advantages, including a substantial reduction in urban use of traditional fuels, and a multiplier effect in the production of ancillary components such as gas stoves and gas cylinders, as was shown in Ghana.

Expanding energy services for the transport sector in Africa is very challenging because both transport equipment and transport infrastructure are inadequate. The dilemma is that optimal transport services are required for economic and social development, which are elements of sustainable development. Hence suitable policies and strategies must be embarked on to ensure adequate transport services are provided. Among these are the following:

- Promotion of public transport systems, because not only they are more efficient but the economic constraints of the continent will limit private transportation to only a few. Systems should include city travel and intercity and rural travel.
- Promotions of more efficient freight travel modes and improved management practices. Electric powered railways can prove very efficient for both passengers and freight movements. Freight scheduling using modern control methods will be very useful.
- Improve environmental safeguards such as use of unleaded fuel, improved testing and monitoring, congestion reduction, traffic management, dedicated travel lanes, etc.
- Promotion of environmentally friendly infrastructure that reduces travel distances, better road maintenance, improved walkways, improved road signs, multi-modal paths, etc.
- Promotion of non-transport measures such improved telecommunications and modern computing systems or reduce the need for motorised transport of goods and persons, for instance through adequate urban planning and land use policies.

The industrial sector in Africa needs substantial growth because, despite the continent having 14% of the world population, it only accounts for 3% of global manufacturing. Apart from producing adequate electricity, African countries can improve energy provision in the industrial sector by taken certain measures. These are:

- Promotion of agro-based industries that are self-sufficient in energy and can even be energy exporters. Sugar processing and palm processing are among such industries.
- Promotion of energy efficiency schemes through continuos energy audits and monitoring.
- Promotion of standards that promote energy efficiency or affecting fuel choice.

Many countries are at present embarking on various expanded high quality energy projects that if achieved can change the face of the continent. Among these are the following:

- Egypt is preparing to increase its existing 16 620 MW as of 1997 by 10 000 MW by 2010. Also, they are starting to drill more wells for oil during 2001.
- Nigeria which at present flaring gas that is equivalent to 460 000 barrels of oil a day but has now to eliminate it by 2004. Nigeria Liquefied Natural Gas (LNG) has exported more 3 million tons mostly to Europe, with plans for the US. Constructions are underway that will increase production to 8.7 million tons and then 15 million tons. There are also the Chevron and Exxon-Mobil gas liquid projects. Nigeria, which at present has a capacity of 3 000 MW, is working towards upgrading it to 5 000 MW by 2001 by overhauling and rehabilitation of existing facilities. Also a gas fired plant of 276 MW is being constructed.
- South Africa is involved in intense activity to search for gas along its coastline.
- Senegal has ended the contract of the Consortium of Hydro-Quebec of Canada and Elyo of France. This Consortium has now signed a 20-year contract with the utility in Togo and plans to invest US$36 million in five years in a country with less than 10% access to electricity.
- Uganda has two new dams with a capacity of 80 MW added to the 180 MW from Nalubale, and plans three other 40 MW units by 2004. A Norwegian Consortium is planning another 150 MW by 2006. Also, from

rural electrification programmes another 100 MW from mini hydro plants is planned.

- Zimbabwe intends to construct a 1 400 MW thermal station through an independent power producers scheme.

Natural gas production

With new finds of gas in African countries and the increasing interest in exploration, developing gas is a promising future for the power sector of the continent. The West African Gas Pipeline Project is one such promising project. Some countries can also use local reserves for power supply, as is being planned in Ghana. Conversion of gas to liquid, which is receiving a lot of attention, can provide opportunities for Africa (OGJ, 1997). Natural gas development for African countries can be useful because, with modern technology such as combined-cycle gas-powered plant it is now cheaper than modern hydro power plant – 5 US cents compared to 7 cents for hydro (OGJ, 1997).

5.2 International energy investments

Despite political unrest in a few places, the continent is showing a bright future for international investments. Apart from the steady increasing economic growth of over 3.5% for a few years and declining population growth rates, return on investments in Africa is 25% while it is 18% in other developing regions (OGJ, 1997). Unfortunately, despite a growth of 25% in FDI in Africa for 1999, but it only represents 1.2% of global FDI flows and 5% of such flows to developing countries (UNCTAD, 2000).

Africa needs external energy investments for two main reasons. Firstly, donor assistance is declining, only 0.25% of GNP for ODA by developed countries, far below the agreed UN target of 0.7% announced during the Earth Summit process some years ago. Since countries that need aid normally do not attract FDI, such funds can provide leverage funds to investments and also assist with social infrastructure development. Secondly, the financial needs of African countries are well beyond their financial capability and the amount that can be mobilised from multi-lateral banks. For example, the World Bank estimated that at least US$17 billion will be needed for new power projects in sub-Saharan Africa excluding South Africa by 2005. Governments can provide US$5 billion, and the World Bank, the African Development Bank and other lenders can provide US$2 billion – hence the balance of US$10 billion will have to come from investments.

The major challenge for African countries is to create an enabling environment for attracting FDI and become part of the trans-national and multi-national networks. In recent years most African countries, in adopting the stringent measures of the "structural adjustment" programmes by the World Bank/IMF, have created this environment, but investment has been slow and is still restricted to loans and paltry donor assistance. However, there are policies and strategies that be considered. Among these are:

- African countries must embark on measures that will deliver positive economic messages to the rest of the world – such as the continued economic growth for the last five years, the highest rate of return in the world for local investments, security of investments, etc.
- Institutional reform is required in the legal and business sectors, such as, new institutions such as business intermediaries as information brokers using modern communications systems, improved legal and banking systems to cope with business demands, and developing pro-active investment agencies to help attract foreign investments.
- Developing local business sector with direct government support and establishing viable regional and sub-regional networks can help to create partners for foreign investors.

However, African countries should put mechanisms in place to ensure the attraction of investors with long-term perspectives and not the short-term natural resource prospectors that now pervade the continent.

5.3 Renewable energy development

- Renewable energy has a promising future for African countries because of the limited access to high quality energy by the vast majority and the availability of renewable energy resources. However, due to the current economic constraints of African countries and the limited technical capacity of the people that need energy the most, the use of renewable energy technologies (RETs) in Africa will contribute only a minimum share in the immediate future, probably under 5%. The areas that show great promise in certain niche markets are as follows:
- PV solar home systems in areas that cannot access grid electricity or may not do so soon. The Kenya PV programme is an example. Other countries with promising programmes are Botswana, Senegal, South Africa, and Zimbabwe.
- Solar powered and wind operated water pumps, as in Mozambique, Mauritania and Kenya.
- Electricity production from sugarcane industry as is being done in Mauritius using advanced technologies. More than half of African countries produce significant

amounts of sugar. The production of ethanol as transport fuel, as in Zimbabwe and to a lesser extent in Malawi, can provide significant foreign exchange earnings for oil-importing countries.

- Development of mini-hydro schemes for electricity production, as demonstrated by the rural electrification programme in Uganda, which aim at a total of 100 MW of such plants. The capacity within the continent is enormous.

There are certain strategies and policies that African countries need to institute for the continent to obtain maximum benefits from these technologies. These are as follows:

- **Financing schemes –** Since most of the intended users in the niche markets are poor, they will be unable to purchase these technologies by cash, hire purchase or cash deposits. The possible groups that can purchase through cash will be small and can easily get saturated. Hire purchase is difficult because the interest rate will be higher than commercial rates – high even for the middle- and high-income groups. Cash deposits can involve time wastage. Government support in the form of direct or indirect subsidy, reforming taxes and duties, supporting special financing schemes, reducing transaction costs, are some measures that be considered (Davidson & Turcson, 2000).
- **Technical appraisal and testing –** Technical policies need to be instituted to ensure that RETs are treated as engineering devices that are subjected to proper engineering appraisal and testing to establish suitability and safety. Testing should assist the setting up of performance standards of the equipment and code of practice of the operators. The efforts of Zimbabwe, South Africa and Kenya are examples that should followed.
- **Technology transfer and job creation –** The development, dissemination and use of RETs can involve significant amount of technical skills and human resource. With suitable policies, significant skills can be transferred, as in the case of ethanol production in Zimbabwe (Davidson, 1998). Measures should be instituted to ensure proper training of the different levels of technical personnel involved. Existing training institutions can be useful. The areas that require attention are product design and modification, product downsizing, after-sales servicing, and maintenance.
- **Product manufacturing –** The technical capacity and competence of most African countries will prevent them from undertaking manufacturing of advanced RETs or their components but many can manufacture ancillary components such as batteries for solar home systems and controllers.

5.4 Rational energy pricing

The use of more rational energy pricing can assist in stimulating use and ensuring equity growth. Wider use of cross-subsidies that aim at reducing subsidies to the rich and assisting the poor will lead to improvement in economic efficiency and environmental quality in the energy sector. This will also help to improve the quality of government expenditure. Rational energy pricing will encourage energy services to be adequately paid for by those who can afford to pay for them, with the poor being assisted to achieve a decent livelihood. Studies have shown that removal of subsidies can result in reduction of primary energy consumption by certain groups that can increase supply to disadvantaged groups.

Subsidies are provided for different reasons, however, depending on the macro-economic environment of the country. Reasons may include encouraging consumption on an equitable basis, protection of local employment and protection of local industry. They should support energy security as well as social policy. There is a need to search for initiatives in energy policy that will satisfy both social policy and energy security.

All global subsidies benefit the wealthy, which sees an opportunity to increase its consumption (sometimes leading to shortages), while the poor go back to traditional sources of energy which subsequently become cheaper. All targeted energy subsidies (e.g., kerosene) result in suppliers rationing their stock to sell to a more profitable market (transport in the case of kerosene). Finally, a rise in taxes on products consumed by the wealthier class (particularly in countries with short supply of wood), often brings about a rise in overall energy prices. In other words, this type of taxation has a negative effect on the poor.

5.5 Rural energy development

Providing energy for rural areas to ensure energy security will require embarking on policies that aim at closing the gap between the needs of populations and the proposed solutions and the other components of local development. It has to stimulate and accelerate the transition to viable energy systems. In the African context, particularly in the agricultural sector, this is essential to ensure food security. This transition requires political vision and long-term mobilisation and a strong component of community development.

Only community-based management programmes that are integrated and sustainable, whether in urban or rural areas, are capable of

satisfying the needs of all and, in particular, of the poorest populations. These programmes take into account the natural and technical resources of the region, human capabilities, needed financial resources, and the environmental constraints. In the savannah zone, a reflection on integrated and sustainable management of urban agricultural systems would provide a rich learning field for this effort. In effect, proposals to produce biomass energy from currently under-valued products (from agriculture, the savannah and the transformation of certain resources) and reduce reliance on fossil fuels hold potentially rich prospects for such countries as the Sahelian ones.

The integrated and sustainable management of new rural agro-forestry systems also offers interesting prospects in this regard. However, we must base our studies, now even more than in the past, on the maximum possible use of local natural resources. The energy problems of rural areas that are outside the national commercial energy networks (electricity, gas, transport, etc), and full valorisation of food and non-food oils produced from trees and annual farm crops, should be approached systematically.

The complex problem of energy in rural Africa calls for a combination of solutions. In effect, resolving the woodfuel problem will not meet the growing demand for fuel for motorised agriculture, nor will it provide energy for small food-based industries; it will not transform and/or conserve local production in agriculture, livestock or fishing. Singular solutions to diverse problems risk missing their targets, and they multiply costs by requiring adaptation to each specific problem, as was demonstrated by rural electrification. Moreover, the present equation of energy and environment issues with global sustainable development brings to reflections on rural energy a new perception that is above all based on the notion of diversification (Sokona, 1999). The current equation of energy and the environment, which is further locked into the issue of sustainable global development, gives a new perspective on energy development in rural areas, based on the notion of diversification.

Such a diversified approach should begin with a solid research foundation, and see to it that Africa does not systematically adopt ready made solutions nor should the continent attempt to replace success stories without contextualising acclaimed "best practices".

5.6 Privatisation in the energy sector

Africa, as elsewhere, is going through privatisation in most areas of the energy sector, including more traditional government roles such as transport infrastructure. Early results are mixed, because of different local conditions such as the regulatory environment, access to disposable income, stakeholder participation, etc. Regarding these factors, Africa is in a unique position because of the very low incomes, poor savings potentials, and weak regulatory systems; special strategies and policies are needed to ensure that the special circumstances of the continent energy sector are addressed.

The most important feature in Africa is low access to high quality energy that is needed in the industrial and transport sector that are the main drivers of the economy. Therefore, any privatisation strategy should not only aim at providing efficient services but also to increase access. If this is not considered then the case of Senegal, in which the government terminated an 18-month contract between the Senegalese government and Hydro-Quebec of Canada and Elyo of France because of inadequate supply, will be repeated. Two areas receiving attention currently:

- **Independent power producers –** As a result of the technology growth trends and the forming of new alliances, there is now a growing interest from both government and the private sector for independent companies' participation in power production. Several countries are now looking at this opportunity. Tunisia's programme, which aims to be supplying 300 MW every 2-3 years through IPPs starting 2001, is an example for other countries.
- **Independent operators in oil and gas –** There is a wide range of independent oil and gas operators in the continent. Some operate with concessions from the government and others work with the public groups. The activities of Energy Africa in at least six countries in West and Southern Africa is an example of such activity.

However, African countries need to put in place a good regulatory system in place to ensure that they get optimal benefits and that access to high quality energy by the vast majority are addressed. Also, private participation is most efficient with competition and worst with a monopolistic environment.

Regional energy cooperation and planning

Due to the fragmented nature of African countries, cooperation especially in planning presents significant opportunities for growth and cooperative planning activities within the continent. This will lead to minimisation of existing wastage, optimal efficiency and increase the chances for effective competition with other developing regions.

As a result of the present fragmented state of energy production and use patterns in the conti-

nent, there are major deficiencies, which can be either substantially reduced or eliminated by strengthening regional cooperation in the energy sector. Such strengthening can include regional or sub-regional planning, establishing a common energy framework, improved information exchange through sharing, and better use of human capital.

Regional planning can provide an important step forward in achieving the benefits described above and two areas that can accelerate regional planning in the energy sector are regional integrated electricity planning and joint procurement and distribution of petroleum products.

Regional integrated electricity planning

– This type of planning, that should aim at complementing national planning, will focus on rationalising the supply and use of electricity so that optimal results will be achieved. It consists of planning using both supply and demand initiatives and their related costs. This planning will help to maximise existing capacity so that added capacity will provide genuine added value to the energy sector. A study done on SADC shows a surplus capacity of over 11 000 MW within the sub-region (see table below), due to the isolated traditional uncoordinated national planning that is currently practised in the region which results in significant stranded assets that are a burden to their economies. This gives credence to the formation of the South African Power Pool (SAPP) that hopes to balance the surplus/deficit situation and transform power planning from national self-sufficiency to regional self- sufficiency. This type of planning allows identifying viable future options such power imports. The study shows that likely importers will be: Botswana (70%), Lesotho (100%), Malawi (20%), Namibia (35%) Swaziland (100%) and Zimbabwe (20%). It should be noted that there are now plans for setting up the West African Power Pool (WAPP).

Table 8: Surplus power capacity in selected SADC countries

Country/utility	*Surplus capacity (MW)*
South Africa (Eskom)	7 450
Mozambique	1 900
Angola (ENE)	450
DR Congo (SNEL)	1 400
Zambia (ZESCO)	320
Less deficit in others	(350)
Total surplus capacity	11 170

Source: African Energy, 2000, vol. 2 No.5

Regional petroleum procurement – The petroleum consumption of most African countries is relatively small by world standards and because these countries presently operate in isolation each pay the same overheads regardless of the amount needed. It has been shown that if optimal choice is made among countries in sub-region, up to 30% savings can be made (Davidson, 1992).

5.7 Regional trade

The current trends in world trade demand that Africa should operate as a group to participate in world trade and this can be achieved to a great extent by the regional cooperation already discussed. The world has been divided into several well-organised trade blocs, and Africa will be unable to participate if they operate in isolation.

Although energy trade exists in a number of countries, especially in electricity from hydro resources, there is potential for more of such practices. If suitable inter-connection facilities are established more such trade will be made. Proposals have been made for systems in southern and east Africa, but are yet to be undertaken. The current work on the SAPP is a possible project that can minimise not only power losses but also environmental impacts and maximise economic benefits. However, for such level of cooperation, coordinating centres will be required that are efficient and suitably staffed; furthermore, aspects such as legal and fiscal frameworks need to be harmonised.

Energy standards in many countries, connected to their colonial pasts, need to be upgraded and improved to ensure harmonisation and compatibility. This will assist to improve the design quality of equipment and operating conditions. Also, there will be need to ensure that suitable mechanisms are put in place to ensure compliance.

Strengthening of information among countries is very important for future development in the energy sector. Present development in information technology should be fully exploited for this purpose.

5.8 Energy research, development and demonstration

Energy research in African countries started in earnest in the mid 1970s, largely driven by the responses to the oil crises, and was mostly externally funded – an issue that significantly influenced the agenda. In terms of government expenditure, it was given a low priority because the agenda was not clearly linked to current government priorities, which were import restrictions and grid expansion and economic constraints. These features have affected energy R&D since

then; however, more recently, although energy research funding has not changed, the agenda has been broadened to include some government interests. As a result, some funding by government and local agencies has evolved, though this is still a minor share.

The present situation of the energy sector in Africa requires two types of innovation, which can only be achieved through dedicated and targeted research programmes. These are the capacity to modify/adapt technology options and measures to suit local conditions, and the capacity to combine indigenous knowledge and modern techniques to develop new options to tackle African problems.

As energy R&D in the world is becoming more complex, specialised, and expensive, African countries will find it difficult to participate, unless substantial investments are made on R&D along with some level of centralisation, such as development of regional and sub-regional centres. In areas such as advanced energy technologies, work will be limited to scientific tracking, testing and product/process modification. Other areas such as policy development, development of less advanced technologies such as renewable energy technology, associated equipment for fossil technology, training schemes, etc, are activities in which local, sub-regional and regional centres can be involved.

Setting up cooperative R&D networks among local and sub-regional/regional institutions is very important for maximising gains and achieving optimal solutions, because of limited capacities. Exploiting the major technological progress made in information technology will provide these networks with opportunities in achieving their desires.

An important task that was carried out in the 1980s by African energy R&D institutions that proved useful then was energy data collection and analysis. These efforts which largely supplemented efforts by the joint UNDP and the World Bank Energy Sector Management and Assistance Program (ESMAP) failed to continue because of lack of resources and political will. Also, although data analysis is the work of R&D institutions, baseline data collection should be a routine activity by specialised local energy institutions. Lack of this information has led to a major deficiency in policy development in Africa, especially in the household sector: most policies in the residential sector are based on old and inappropriate data. A suitable and well-funded programme should be instituted to ensure that baseline energy and energy-related data collection be a regular and continuos exercise.

Limited and full field testing of engineering products is a very important activity in technology development that has been largely ignored in the use of relatively inexpensive energy products in African countries, especially in rural areas. As a result, many devices were considered failures because the strict engineering rules and procedures for such testing were not followed. Demonstrations using well-known engineering principles are required for energy products. This will be needed for imported products that were not designed for the local conditions in which they would be used.

5.9 Climate change opportunities

African countries are only minor contributors to the changes expected in the world's climate, giving only 3% of global GHG emissions; but nearly all countries have signed the UN Framework Convention on Climate Change (UNFCCC) and most have ratified it. A clear indication by these countries to participate in the climate change debate is shown in their participation in the adoption of the Kyoto Protocol and discussions that followed. As the debate has progressed, certain opportunities have been revealed, which African countries can use to expand their energy services provision in a sustainable way. The main opportunities are as follows:

1. Technology transfer: The UNFCCC provided for the transfer of financial and technological resources to non-Annex 1 Parties by Annex 1 Parties in Article 4.5 of UNFCCC. The Inter-Governmental Panel on Climate Change (IPCC) in its technology transfer report of mitigation and adaptation technologies outlined several measures that could be employed by developing countries such as those of Africa to access climate-friendly environmentally–sound energy technologies. Among these are the following:

- setting up clear well-enforced regulations for taxes, codes, and standards and reflecting true costing as best as possible;
- setting up simplified transparent procedures for project approval;
- creating awareness about climate friendly technologies;
- technology needs and needs assessment;
- encouraging demonstration programmes;
- developing communication and information infrastructure;
- developing national systems of innovation, to integrate the elements of capacity building, access to information and creation of an enabling environment for successful technology transfer.

2. Capacity building – Capacity building through the UNFCCC provisions includes the building of human and organisational capacities.

To access the climate friendly technologies, a wide range of technical, business, management and regulatory skills are required at local level. Also, improving competence in associated services such as organisational know-how and regulatory management is essential. Building organisational and institutional capacities are also important. Activities for building such capacities include the following:

- development and expansion of business firms;
- encouraging industry and professional associations;
- developing stakeholder forums;
- developing national information systems and improving network to international systems.

3. Global Environment Facility (GEF) – The financial mechanism for UNFCC offers opportunities to tackle certain elements of the challenges highlighted such as barrier removal for penetration of energy technologies and energy efficiency. Unfortunately most of the African energy stakeholders are not aware about the operational strategy of the GEF. The use of this facility should be maximised in the energy sector.

4. Clean Development Mechanism (CDM) – When CDM becomes operational it will provide opportunities for Africa to access energy technologies, but it will need the African countries to develop certain activities before the CDM becomes operational. These include national institutions for CDM with the activities of project development and selection, and R&D activities to develop positions on key issues (additionality, supplementarity, baselines).

5.10 Reforming and strengthening energy institutions

Energy institutions became formally understood as such after the oil crises of the 1970 and were therefore focused on security of supplies. However, these institutions in general, with the exception of a few, suffered many drawbacks that need to be addressed. These include lack of well co-ordinated and comprehensive energy policy with capacity for integration to the rest of the economy, little or no policy analysis, weak stakeholder collaboration, poor policy implementing mechanisms, inadequately trained human resource, limited scope, and poor interlinkages with other arms of government. These weaknesses prevent these institutions from performing their expected tasks. Among these was policy analysis that has led to uninformed decision making and poor responses to international shocks. As a result, these countries are largely influenced by external initiatives that are not always in their regional or national interest. Hence the energy institutions need to be reformed or strengthened to be more responsive to the demands of the energy sector, using appropriate strategies and policies. These will be discussed under three areas, policy analysis, national institutional collaboration and regional institutional building.

Policy analysis is crucial if the region, sub-regions and countries want to take full ownership of their energy sector and be capable of screening and implementing external advice effectively. Due to some of the technical and financial weakness of the continent, external intervention is quite common. These interventions need to be analysed within the regional, sub-regional or national context to identify their full costs and benefits before accepting, modifying or rejecting. Also, policy analysis assist to provide early warning to unpredictable events such as sudden changes in fuel price and to develop adequate coping measures. Searching for trade advantages and suitable partners is an activity for policy analysis; tracking down technical innovation and development is another. The weaknesses alluded to earlier will limit the capacity of African countries to be active participants in the development of some advanced energy technologies, hence tracking down these rapid technological progress is a necessary task. However, for such an institution to be effective, effective national and international links are needed, along with well-trained human resources with the needed support equipment infrastructure.

National energy institutions have been ineffective because of the inability to retain the capacity built since the 1970s, and poor linkages of the energy sector. Poor rewards and an inadequate support system have contributed greatly to losing the capacity developed by both national and international efforts in the 1970s and 1980s. As a result, there is a shortage of needed skills in the energy sector. Improving the working environment will assist, but in the present era of international opportunities for competent staff, increasing numbers of trained staff can prove to be a useful strategy. Adequate programmes through present national and sub-regional institutions should be established, aimed at training a large number of energy professionals at undergraduate, graduate and continuous educational levels.

Policy-making is an important function for national institutions, and measures are needed to ensure that comprehensive policies are formulated, based on well-informed decisions. This policy should address all the various aspects of energy including sources, conversion, transportation and use, and imports and exports. Such a policy should be participatory and integrated. The involvement of relevant stakeholders is im-

portant because this increases the chances of compliance, since their interests will be considered. Integrating energy policy at two stages is necessary for comprehensibility: linking all sub-sector policies/plans and then linking with other sectors of the economy. In general, an energy policy should consider energy as an integrated trans-sectoral resource, whose distribution depends on technological necessity, economic optimality and variability, and social desirability.

National energy institutions should form a framework of the policy-making bodies, the legal bodies, the financial institutions, education and training institutions, testing and standards, investment centres, and operating units, including NGOs and private bodies. This framework should not only identify institutions but also have suitable established mechanisms for effective institutional linkage.

Competent and adequately staffed regional/sub-regional institutions on energy and related matters are urgently required if African countries are to benefit from the various national and regional opportunities that exist within the energy and related sectors. Africa is made up of a number of countries with limited capacity to face the challenges alluded to earlier, especially human resource requirements. Development of sub-regional and regional institution will not only maximise resources for optimal benefits but will substantially increase the continent's capability to compete with other regions for the various opportunities available internationally. Also, the concepts relating to modern energy development are becoming complex and highly specialised, and therefore resource-demanding. No single country can cope, and regional or sub-regional centres are needed.

Due to the benefits of resource pooling, competence maximisation, and work environment improvement, most regions in the world are developing and strengthening their regional and sub-regional centres. Africa can only compete with similar centres. This will also assist the continent's chances to effectively participate in joint R&D projects.

5.11 Donor assistance

Donor assistance in the energy sector has been extremely useful, especially in the renewable energy development in Africa. Most of the R&D efforts after the mid 1970s on energy were funded by donor support. However, for optimal benefits, certain strategies and policies are required to ensure local ownership of projects. These include:

- measures to ensure that there is a positive interaction between projects/programs and national development priorities;
- establishing a co-ordinating mechanism among donors and create linkages with local NGOs;
- providing a mechanism of documenting good practices and lesson learnt from projects, and ensuring possible replication;
- ensuring donor assistance to promote long-term capacity building and other identified weaknesses;
- establishing an effective monitoring and evaluation system

6. Conclusions

Energy issues pose a major problem in Africa, more so than anywhere else in the world. In the decades to come, Africa will have to consume far more energy if it is to climb out of under-development and satisfy its societies' demands for better living conditions. The energy challenges are particularly serious on this continent because, although it is generally considered to be rich in resources and highly diverse in energy potential, the people have access to very little of this. Therefore, challenges ahead require political will, as well as commitment to innovation and applying energy efficient, environmentally sound, cost effective technologies and systems to all sectors of the economy.

Africa needs substantial high quality energy services that are adequate for meeting the sustainable development needs of the continent. It is currently the lowest consumer of these services worldwide, though it has abundant renewable and non-renewable resources. However, using these resources poses serious economic, technical and environmental challenges. Ensuring, in a foreseeable future, adequate access to energy services for the majority of the African populations, in an environmentally, socially and economically sustainable way, will require remarkable efforts, substantial investments, as well as changes in existing institutions, policy frameworks and lifestyles. This paper has attempted to identify these challenges and also suggest strategies and policies to cope with them.

For African countries to exploit the different opportunities outlined in this paper, a major mind shift is required in four ways. The first shift is realising that the energy services needed for Africa to be part of global manufacturing and world trade is substantial, and benefits from incremental growth will be minimal. Secondly, a true reflection of the African energy system is to increase access and efficiency with priority on the former. Thirdly, African countries will not compete globally by exporting increasing amounts of its fossil fuels but increasing the use regionally. Lastly, African countries need to increase their

ownership of externally funded projects. If these shifts are adhered to, then the continent will benefit from global trends of increased privatisation, new partnerships, and progress in technology development.

References

British Petroleum 2000. B P Statistical Review of World Energy. British Petroleum: London.

Davidson, O.R "Challenges and Prospects for Power Development in Africa". Journal of Industry and Environment Review. Vol.17, No.1 1994 UNEP IE/PAC. Paris, France.

Davidson, O.R "Transfer of Renewable Energy Technologies for Sustainable Development: Opportunities for Developing Countries" The European Network for Energy Economics Research (ENR) ENER Bulletin, 22.98.

Davidson, O.R " Energy Initiatives in Africa for Cleaner Development". Chap. 5 in "Promoting Development while limiting greenhouse gas emissions: Trends and Baselines" UNDP/WRI, 1999.

Davidson, O. and Y. Sokona: Technological Opportunities and Emerging Challenges in Implementing the United Nations Framework Convention on Climate Change (UNFCCC) in Africa. ENDA. 1997.

Davidson O R . 1992. Energy issues in Sub-Saharan Africa. Annual review of energy and the environment, 17, pp 359-403.

Davidson O. R. 2000. Technology Transfer and Climate Change (in Climate Change in Africa). Globe Southern Africa: Cape Town, South Africa.

Farinelli.U (ed). 1999. Energy as tool for Sustainable Development for African, Caribbean and Pacific countries. UNDP: Geneva, Switzerland.

Goldemberg J & Johansson T B. 1995. Energy as an instrument of socio-economic development. UNDP: New York..

Kennedy J L 1997. Sub- Saharan Africa energy future brightening. Oil and Gas Journal, July 28.

Kerekezi S & Ranja T.1997. Renewable Energy Technologies in Africa. AFREPEN: Nairobi, Kenya.

Rowlands I H (ed). 1998. Climate Change Cooperation in Southern Africa. Earthscan Publications Ltd: London.

Ruffin A (ed). African Energy Journal: Power for Africa's future: February-March 1999 Vol 1 no 1, June –July 1999 vol 1 no 3, January –Feb 2000 Vol 2 No 1, March-April 2000 vol 2 no2, September – October 2000 Vol 2 no 5.

Thompson J. 2000. Africa recovery. United Nations Department of Public Information Vol. 14.no 3.

UNDP. 2000.World Energy Assessment: Energy and the challenge of sustainability. UNDP Bureau for Development Policy: New York.

U.S. Department of Energy/ Energy Information Administration. Energy in Africa: www/eiaa.doe.gov/ emeur/cabs/africa.html.

Sokona, Y, S. Humpreys and J.P. Thomas: Developmant: A Centerpiece of the Kyoto Protocol; An African Perspective. SEI, 1999.

Sokona, Y., 2000. Widening Access to Rural Energy Services in Africa: What Prospects from the Multifunctional Platform Case in Mali? In World Markets Series, Business Briefing: Global power Engineering & Technology, pp 76-78.

Sokona, Y. et al. 1999. Energy as a Tool for Sustainable Development for African, Caribbean and Pacific countries. EC and UNDP, 134 pages.

Sokona, Y. et al; 1999. Sustainable Development in West Africa: Beginning of the process. SEI-Boston, 75 pages.

Sokona, Y et al. 1998. The Clean Development Mechanism: What Prospects for Africa? In The Clean Development Mechanism: Issues & Options.UNDP, pp 109-118.

Sokona, Y. et al. 1995. L'énergie en Afrique: situation de 34 pays. Enda-édition, série Etudes et Recherches n°177-180.

Renewable energy technologies in Africa: An overview of challenges and opportunities

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1 Introduction

Africa is a net primary energy exporter, but the majority of its population lacks access to modern fuels, and many countries rely on imported energy. On average, Africans consume a mere 0.3 to 0.6 tons of oil equivalent per capita – 20-30 times less than Europeans and Americans. The bulk of the energy consumed is derived from traditional fuels such as fuelwood, charcoal, and agricultural residues. Africa's per capita electricity consumption, 490 kWh in 1998 (IEA, 2000), is lowest in the world. The continent has the lowest CO_2 emissions per capita, but has higher CO_2 per GDP.

Many African countries are characterised by a discernible energy divide between rural/peri-urban and urban areas. The rural and peri-urban sectors are typically heavily dependent on biomass, use little modern energy forms and have low energy consumption. As most countries embark on rural and peri-urban electrification, the role of decentralised renewable energy technologies (RETs is) becoming increasingly evident. Extension of grid to these areas is financially prohibitive – hence the use of RETs as an option.

To effectively address the major ailments facing the continent, including poverty, the majority need to access useful modern energy carriers for sustainable economic growth. The most common and widely distributed renewable energy technologies in Africa are biomass and solar. Hydroelectric power technologies are restricted to certain sites, and wind and other renewables constitute only a small share of the total energy supply. Recent rural electrification initiatives are to a large extent using decentralised solar photovoltaic (PV) systems. The implementation models include use of private entrepreneurs, publicly owned utilities and donor-funded projects.

Employment of RETs for sustainable development faces various challenges, including the establishment of suitable institutional frameworks, levelling of the playing field between grid and off-grid electrification, meeting all energy services, lack of awareness of the RETs and poor technical support. Opportunities for RETs exist. Various strategies to remove the barriers have been explored and can be adopted to facilitate increased penetration of these technologies in African countries. This paper highlights the challenges facing RETs in Africa and provides strategic options for promoting their use.

2 Challenges facing renewable energy development and utilisation

Despite the rising awareness on the potentially important role of renewable energy in meeting national energy goals, the sector is still generally marginalised. Often renewable energy, expect in areas endowed with hydro resources, have been considered as add-ons even in the policy formulation context.

The use of RETs has nonetheless experienced some upsurges during the oil and electricity crisis, offering a fallback when the conventional fuels are inaccessible or too expensive. In the 70's when the share of oil import bills rose from 20% to 50% for most of the African countries (Karekezi and Ranja, 1997), there was a marked rise in investments in RETs. Nationalised policies causing elevation of petroleum fuel prices or scarcity of conventional modern fuels generally influence shifts towards renewables. These factors have been responsible for the switch to wood and charcoal in Kenyan institutions. In Botswana, some institutions continue to use fuelwood despite a directive from parliament to stop, mainly due to similar reasons. The recent electricity shortages in Kenya have triggered higher interest in renewables. Notwithstanding, various challenges face large scale penetration of RETs. Some of the main challenges are discussed in this chapter based on some field experiences.

2.1 Leveling of the playing field

Levelling of the playing field between grid and off-grid electrification, between conventional technologies and RETs, is mentioned in various

national energy policies or programme objectives. Commitment to this agenda is, however, rarely reflected in action plans and project implementation. An example is the Kenyan government's ten-year electrification plan which, by designating electricity generation sites, has curtailed use of RETs since most of the sites are not suitable for use of RETs. Subsidies for fossil fuels, nuclear energy and large-scale hydropower plants have been a common phenomenon but are rarely extended to RETs – although a few countries, such as South Africa, are beginning to consider large-scale subsidisation of RETs.

While RETs can technically meet most energy needs, their wider use is hampered by high unit energy costs. Capital costs for RETs tend to be prohibitive compared to conventional technologies. A solar water heater costs about 2.5 times more than a similar sized electric hot water storage system (UNDP/GEF, 2000). The Advisory Project for Household and Building Energy Issues in Lesotho, a project aimed at establishing constraints hampering application of solar home systems concluded that high capital investment is the key barrier to penetration of this technology (EDG & Sechaba, 1997). This barrier has been identified in nearly all RETs projects (Northrop et al, 1995; Foley, 1995).

The tariff structure for conventional energy render RETs uncompetitive. This is one of the major barriers in the use of RETs for electrification in Ghana (UCCEEa, 2000). In some parts of rural Ghana, grid customers pay a monthly tariff which is half of what the solar home system (SHS) users pay, despite the fact that grid costs six times more than SHS; the balance, unmet through tariff, is absorbed by the government. (Ahiataku-Togobo, 2000). In South Africa, grid-connected customers enjoy some of the lowest tariffs in the world, and customers can purchase the amount they can afford and there are no penalties for periods of non-usage, but the off-grid RETs sector does not enjoy these benefits. Though SHS customers in the Eskom-Shell joint venture project in the Eastern Cape have pre-payment meters, they have to purchase monthly cards at a fixed rate. These off-grid customers have to commit to using the systems throughout the year and pay the monthly fee even when they are not using the system. There are many such examples highlighting inequalities. In Botswana the up-front connection fees for grid have been eliminated but no equivalent action has been extended to off-grid RETs electrification. In Kenya the grid connection fees have been reduced to US$40 and a meter charge of US$5, though the real utility costs are over US$1500 (WEC, 1999). This translates to a 97% subsidy. Subscribers for the SHS in Ghana paid a connection fee of US$16, while the grid customers paid US$1 in 1998 and this inequity still prevails (Ahiataku-Togobo, 2000).

The differences in mode of service between grid and off-grid RETs has raised concern and challenges the justification for levelling the playing fields. For example, the predominant RETs being promoted for off-grid electrification –SHSs – provide lower level of service than grid electrification. Needless to say, while RETs might have limitations, they offer an opportunity to increase access to the majority who will not be reached by the grid in the foreseeable future. However, support to RETs should be offered to enable acquisition of an energy package which meets the demand of the consumers. The Namibian government is working on levelling the playing field between grid with off-grid. The Sustainable Energy Advisory Facility (SEAF), an initiative launched by UNEP, will assist in designing strategies to facilitate this. Notably, subsidies for grid-electrification benefit only a minority, although the burden of repayment of loans to finance these subsidies is borne by the unelectrified majority. Providing financial support for RETs could facilitate making this situation more equitable.

2.2 Access to finance

Schemes to facilitate financing of RETs have been tried in various countries, although often on a small-scale basis. The typical financing schemes available offer short-term high-interest loans, which translate into high monthly payments unaffordable by most users. In most of southern Africa the hire-purchase method with a repayment period of two years is common. Other loan schemes include 'lay-by' method which require shorter periods.

Some micro-scale household RETs have, after some teething financial problems, managed to grow in terms of market share. Most of the success is in the biomass sector. The Kenya ceramic jiko and its replicas in Tanzania, Uganda, and Ethiopia have penetrated into even low-income households. The relatively low capital requirements for these stoves, the institutionalised promotion at the onset of dissemination, and easy accessibility of the technology may have contributed to their success (Karekezi, 1997). The PV systems have not had the same level of penetration, although the smaller SHSs (less than 15 W) are purchased by the lower category of mid-income households. In Swaziland, offering a variety of system sizes has enabled a wider spectrum of the population along income lines to access systems than where only one size was offered (Subisiso, 2001). Some 20 000 Kenyan rural households have purchased SHSs, through the private sector and predominantly on cash basis (WEC, 1999). The solar cooker, on the other hand, has not taken off, for a variety of

reasons including incompatibilities with the social and cultural practices of communities. The GTZ Solar cooker project in South Africa is currently investigating the potential for commercialisation of these cookers. It is expected that the findings from this work will benefit promotion of solar cookers in Africa.

2.3 Duties and levies

Inconsistent and contradictory levels of support for RETs with respect to duties and levies makes it difficult to attract and sustain RET entrepreneurs, which keeps the costs high. Taxes and levies can increase the price of RETs by as much as 100%. In Egypt high tariffs and taxes have been identified as key barriers to the use of PV systems for rural electrification (UCCEEa, 2000). It is not uncommon to have some parts of a RET system taxed while other parts are exempted; this mainly due to lack of awareness among the policy makers of the components of RET systems as well as the fact that some of components (such as batteries) can be used for other purposes. In addition, tax exemption initiatives are often not integrated into the overall policy and normally change with change in personnel. Establishment of a sustainable policy is complicated by lack of information on which to base policy decisions. An analytical overview of the implications of restructuring RETs tax and levy systems at a macro level is often lacking.

In Zimbabwe, the government waived duties for PV technologies acquired through the GEF/PV project but lifted this duty exemption when the project ended. As a result the prices went up to market levels and the demand fell. Most of the companies that had emerged under the auspices of the project folded (Maya et al, 2000).

2.4 Technical support

The scale of the RET projects varies. Household solar electrification projects provide small systems to dispersed consumers across remote areas. The demand for these technologies is typically spatially located away from the supply. Accessibility to these areas is difficult and there are no skilled personnel to install, repair and maintain systems. The dispersed and remote nature of the settlements makes it difficult to establish and sustain technical support to users. This applies to other RETs including PV and wind for water pumping. Consumers or residents in these areas do not have the skills to undertake this work. So transaction costs tend to be rather high, and response times to technical problems lengthy. Lack of technical support within reasonable distances has been the main cause for failure of many RETs projects (Hankins, 1994); consumers stop paying for systems if as a result of technical failure they are unable to enjoy the service. Access to technical support and motivation among the beneficiaries was cited as the key to satisfactory operation of the PV pumps in Mali.

The performance of the RETs has direct implications on the sustainability of financing institutions. Since end-users will only pay if they are satisfied with the service, the financing institutions have vested interests in ensuring product reliability. Poor quality systems and lack of technical support have resulted in technical problems which deter many potential users from acquiring RETs, as observed in the use of solar water heaters in Egypt (UCCEEa, 2000). RETs may be mature technologies, but this maturity is only experienced under conducive environments. Without proper technical support to carry out even basic maintenance, the maturity edge is of little worth. The biogas technologies have been major culprits in this aspect. Complexity, high costs and involvement for maintenance, as well as lack of skilled personnel near point of use, has resulted in malfunctioning of most biogas plants. However, the potential for this technology still high. Poor planning which does not take into account regular availability of raw material and spare parts has affects sustainability of RETs. For example, in Ghana, seasonal availability of cow dung may have contributed to failure of biogas projects there (Edjekumhene et al, 2000).

Limited technical expertise, coupled with poor understanding of system operation by users, has indirectly encouraged tampering and damaging of the RETs by users who resort to using unqualified technicians. In a Ghanaian PV electrification project, these “technicians” were responsible for damaging over forty batteries through by-passing the charge controllers to allow longer use of batteries (Ahiataku-Togobo, 2000). Some countries have invested in training technicians, normally with donor funding and within a project framework. However, as noted in Lesotho, Uganda and Namibia, these technicians are afterwards not employed to continue disseminating and maintaining systems (Kanetsi and Phuroe, 1994; Turyahikayo, 1994; Muller, per. comm. 1999). Despite significant investment in training of biogas technology technicians in Lesotho by FAO-funded project, none of the 25 technicians were absorbed by the projects. Overall, retention of RETs technical experts has been poor, mainly because the field is not financially attractive and does not receive adequate political attention. As such, the attention given to RETs promotion tends to be ad-hoc.

2.5 Market constraints

RETs suffer from various market constraints. Unreliable data and lack of experience in this business makes estimation of market size difficult and growth unpredictable. Investment planning is thus ad-hoc. This has often lead to uncertainties in scale of investment and heavy losses which has led to low investor confidence. At the early stages of the solar water heater projects in Botswana or the PV system projects in Zimbabwe and Kenya, the number of RETs entrepreneurs was larger than today. Small market sizes have negative implications on cost, with the limited economy of scale keeping prices high.

The lack of reliable information on the market has curtailed entry into the RETs market. Most work provides some information, but often insufficient for attracting investors. A study on the potential for electricity generation from biomass in Kenya, while indicating high potential, does not estimate practical and economic feasibility – which is of particular importance to an investor (Senelwa and Sims, 1999). Obviously, such information is only available through detailed assessment of respective consumer and production base. Resources are normally unavailable to undertake such work.

Externally driven RETs projects influence the sustainability of the industry. The upsurge of the market, resulting from an influx of resources directed at RETs often followed by regression when resource flow stops, does not provide a conducive environment for consumers to develop confidence in the technology. Due to lack of infrastructure to control the industry, this process tends to attract 'fly-by-night' entrepreneurs who dump RETs on consumers without back-up service.

Complicating the market dynamics further is the shortage of accessible financing possibilities. Conventional financing schemes through commercial institutions are unsuitable for RETs. Most financing institutions are reluctant to enter the RETs business due to the high risks associated with it. The customers tend to be located far from the lending institution networks. Unavailability of reliable information on the user base exacerbates this problem. An important, often unacknowledged barrier, is the fact that most of the RETs are used in circumstances where they only provide consumer goods such as lighting and communal 'free' water. By themselves these products/services do not result in generation of income which can be used towards loan repayment. For the banker, cash-flow analysis of an investment is typically a pre-condition for qualifying for a loan. In Ghana, the difficulty in quantifying benefits of solar water heaters was mentioned as an important barrier to potential end-users (Edjekumhene et al, 2000). The interest rates provided by the commercial institutions are prohibitive, especially where there is no guaranteed income from the RETs. Inability to develop 'bankable' proposals for RETs under conventional bank terms has hindered access to loans from commercial banks. This has also contributed to the perception among bankers that RETs are poor investments. Consequently, commercial banks lack experience in lending for RETs business. This lack of experience means that the typical fallback to information used in conventional energy investment decisions is not feasible. Levelling of what Usher (2000) refers to as an 'information planning' field is needed. This can only be attained through experiences and their documentation.

Depending on the scale of operation, RETS can be environmentally harmful. Large hydro power dams displace people and destroy natural habitats. Communities, especially in the north, have protested against large wind farms on the basis that they are unattractive and would kill birds. The last allegation has rarely been substantiated in most areas where wind farms were established though it is a common reason cited by those opposed to them. However, small decentralised RETs systems, such as SHSs, are generally more environmentally friendly than conventional technologies.

2.6 Lack of awareness

The level of awareness on capabilities, sources, opportunities and limits of RETs among stakeholders is limited. Policy makers lack sufficient information on which to base favourable decisions and formulate relevant RETs policies. One of the consequences of this is inefficient expenditure of government resources on energy consumption. For example, although the long-run costs of PV pumps are lower than for diesel-powered pumps, the Namibian government budgeting does not allow for acquisition of the PV pumps but favours diesel pumps (UNDP/GEF, 2000). However, awareness campaign on RETS are being launched in a number of African countries, although most of these initiatives are ad-hoc and short term. The problem is not just the lack of information per se, but the lack of a framework for information dissemination (UCCEEa, 2000).

The majority of potential users of the technologies do not know about them or are misinformed about costs and benefits. A phobia about the high costs paralyses the process of creating and maintaining interest among users. A UNDP/GEF project (2000) in Namibia identifies lack of awareness of the technology, its source, and misconceptions as important barriers to penetration of most RETs. The FINESSE work in various SADC countries including Lesotho, Ma-

lawi, Namibia and South Africa also cites lack of awareness and misinformation as major hindrances.

2.7 Standards and quality control

Many countries lack relevant norms, standards and codes of practice for RETs. Where these exist, they are archaic and not adequately developed or enforced. Lack of independent agencies to monitor quality of the RETs affects the market. The PV industry is generally more advanced in development of standards than the biomass industry, especially the small-scale biomass energy sector. Lack of resources and low priority accorded to the renewable energy sector by government has contributed to the poor or lack of standards. In addition, the sources of some of the RETs makes monitoring and enforcement of standards difficult; for example, the biomass stoves are produced by the informal sector where the producers are widely dispersed and may not have formal addresses.

2.8 Institutional problems

Lack of clarity among the relevant institutions on their respective roles and how these roles interact or complement those of other institutions is a barrier to adoption of RETs. In many countries government activities in the energy sector are dispersed, with various aspects being the mandate of different agencies. As a result, decision making on the RETs is not cohesive. For example, the forestry sector in Botswana, which is tacked under the Ministry of Agriculture, does not effectively coordinate its fuelwood activities with the Energy Affairs Division (which is under the Ministry of Minerals, Energy and Water Affairs). In Zimbabwe this problem has been identified by the Danida-funded project, District Environmental Action Plan, which has subsequently proposed to increase representation of the Department of Energy at local levels.

In many countries, the energy sector is being restructured, with government energy agencies retaining core planning and management activities and implementation being transferred to the private sector. Out-sourcing is expected to be the conventional approach for those activities that the agencies do not have the capacity to undertake. Lack of experience, among others reasons, creates some reluctance to out-source. Due to shortage of in-house expertise on RETs, attention given to these areas is likely to decrease with restructuring.

The shadow under which renewable energy is normally placed in relation to other energy sub-sectors, is worsened by the absence of powerful players compared to conventional technologies, which receive substantial financial and technical investments and institutional support from international organisations and private mega-companies. In addition, collusion among international players to keep RETs at bay is not uncommon. The Malawi case, where unwillingness among multinational companies to increase the proportion of ethanol in gasohol has limited its use (Karekezi and Ranja, 1997) is an example of such influence. However, social support for RETs emanating from climate change debates has shifted thinking among mega-oil companies: to avoid surprises and ensure that they lead the process, these companies are investing in RETs. BP-Solar and Shell are some of the lead players.

Various government institutions, such as schools and healthcare facilities, are potential users of RETs but are unaware of the technologies. Poor coordination and collaboration between the relevant energy agency and these other agencies means there is no forum for relevant energy advice to such agencies.

Absence of an institutional structure to promote RETs has hurt their demand. In some countries, like Kenya, this has been left to the private sector. In Namibia the Ministry of Mines and Energy has taken the lead in promoting SHSs and intends to add other technologies to the list. The large-scale rural electrification government-led initiative in South Africa, which aims to use SHSs has raised the RET profile, but such initiatives are not common in the continent and are normally not institutionalised.

Most governments lack clear policy on RET promotion and use. Whenever such policies exist, they are add-on and are often not translated into concrete measures and activities by the relevant government agencies. The emphasis is still on the petroleum fuels and conventional electricity sectors. Some policies have actively hindered penetration of RETs. The Kenyan electricity sector is a good example where government policy prevents independent generators from distributing electricity. Thus, though the sugar industry might generate more than its requirements, it is obliged to sell the balance to Kenya Power and Lighting Company. Communities capable of generating electricity from wind for household use are unable to do so since this would involve distribution (Gitonga, pers comm, 2000). In some countries, the electricity Act gives one utility a monopoly for generation, transmission and distribution. This was the case under the South African 1987 Electricity Act where Eskom had the monopoly. The Electricity Act in Uganda has in the past given the Uganda Electricity Board, the national utility, similar powers (Turyahikato et al, 1995), but under the Act passed in 1999 the Board has lost its monopoly.

RETs projects and programmes have suffered from lack of involvement of key stakeholders in planning and implementation. Despite wide-

spread acknowledgement that participatory approaches yield more sustainable benefits, the 'top-down' approach is prevalent partly due to lack of frameworks on how to implement participatory approaches. This is further aggravated by implementation of 'microwave recipes' (plans that are already completed without input of local stakeholders). The Ugandan UNDP PV project started in 1998 with the aim of facilitating access to solar home system in rural areas has been a victim of such approaches. The project consultant provided the bank with a ready-made project, leaving little room for the bank or other local inputs to the project financing structure. As a result, after seven months, only one end-user has benefited from the loan scheme.

Most of the activity on development and use of RETs has been limited to donor-funded projects and programmes. The majority of these are not planned in an integrated sustainable manner and tend to disappear once donor funding ends. Local communities targeted as beneficiaries from these projects rarely identify with it. As a result the communities has minimal participation in the critical aspects of the project like technical maintenance – although this is slowly changing. Performance of RETs is sensitive to use patterns. A PV system will only survive its lifetime if used and maintained correctly. Hence consumers need to be trained on how to use these technologies. Most projects have neglected this aspect, while, in other cases, the training has been inadequate. As a result systems are misused and, so, often malfunction.

3 Options and strategies for increasing use of renewable energy

3.1 Institutional frameworks

In order to level the playing fields between RETs and conventional technologies, the key stakeholders, in particular government, need to articulate what type of activities would be entailed and what policies are needed to support their implementation. This would highlight the level of commitment needed. With respect to subsidies, actions could involve removal of subsidies from the conventional systems, or subsidy provision for RETs. Identifying the appropriate least-cost option requires some in-depth analysis. In recognition of this analytical need as a basis for smart decision making, the UCCEE will, through SEAF, provide assistance to the Namibian government in facilitating balancing grid and off-grid electrification.

Awareness and acknowledgement of the need to complement grid with off-grid technologies in addressing national electrification goals is increasing. To facilitate this technological intermarriage coherent and focused policy on RETs needs to be designed. Some countries, Cameroon and Namibia, for example, are developing masterplans for rural electrification which take into account the possibility of using RETs, and Botswana is undertaking a masterplan study on PV rural electrification. Other strategies to promote use of RETs include allocation of special funding for off-grid electrification with a percentage dedicated to RETs, an approach that has been adopted in Namibia and South Africa.

Sustainable development and integration of RETs requires that the associated policy be given the same level of sustained attention as policy on conventional technologies and should be informed by experience with RETs. Needless to say, this policy needs to be complemented by long-term action-oriented programmes with committed resources. Given the increased role of the private sector in energy provision, the RETs policy should aim at creating a conducive environment for private sector and conventional utility investment. There is growing interest among traditional utilities in using RETs, especially where these technologies enjoy political support. In South Africa, Eskom, the main utility, has formed a joint venture with Shell South Africa to supply solar home systems to rural areas, and the Zimbabwe Electricity Supply Authority was an implementing agency in the GEF solar project aimed at electrifying rural households using solar home systems.

Notwithstanding, RETs differ from conventional technologies, and for sustainable penetration need a specifically tailored regulatory framework. Regulation is essential, especially in the face of reform in the energy sector characterised by high privatisation and commercialisation of energy service provision. Given the diverse number of stakeholders and the dispersed nature of the common off-grid electrification system, this regulation will have to be participatory and light- rather than heavy-handed. In addition, the regulation approach should reflect the dynamism in the sector. The National Electricity Regulator in South Africa has recently developed such a regulatory framework through a consultative process, providing transparency in the process and a conducive environment for private sector participation.

Although globally the costs of RETs have been decreasing, they remain quite high for most potential African consumers. They can be brought down through creating financial institutions targeting RETs or establishing windows within existing institutions which provide funding on concessionary terms. The SADC-Finesse study of Lesotho (1997), for example, recom-

mended establishing a conducive financing institution as a necessary precursor for successful dissemination of RETs. Most of the financing schemes, however, have been based on a project and closed down when the project came to an end; the Zimbabwe UNDP/GEF SHS project was one such example. In Namibia, the management of a revolving fund administered by the national cooperative bank is under review and it is likely that the management responsibility will shift to the private sector. Creating a sustainable institution for management of RETs promotion is challenging, especially since there are few experiences to draw on. The UCCEE through SEAF is supporting restructuring and development of an efficient management structure for the Botswana national PV project which has been experiencing some institutional problems.

An important challenge for the sustainability of RETs is the short-term development planning cycles practised by government. The high investment costs, coupled with the involvement of the private sector, call for long-term strategic plans for RETs promotion for sustainable development. The Kenyan electricity crisis in October-November 2000, resulting in US$2 million a day economic losses due to power rationing, demonstrated the danger of not having a diversified range of sources of electricity. The measures taken by the World Bank will address the short-term needs. This US$72 million for the Kenya Emergency Power Supply Project will support contracts for supply of 105 MW of emergency power needed to bridge a prolonged shortfall in energy supply from conventional sources. The credit will be used to finance electric power purchases from three independent power producers who have been contracted by the government of Kenya. It will also finance the fuel costs of these emergency plants and facilitate supply of incremental fuel to Kenya Electricity Generating Company's thermal power generation plants (World Bank, 2000).

Overall, most RETs initiatives are designed and managed as projects isolated from the national development plan and are often donor funded. As a result, where they survive, they tend to remain as projects with minimal influence on policy. For RETs projects to have a sustainable impact on development, they should be integrated into the permanent government planning structures, providing an opportunity for elevation into programmes ultimately influencing policy. The Mali Aqua Viva solar water pumping project, started in 1974, is an example of a project that influenced the government to undertake a wider-scale government programme in 1980. The structuring of such a programme can provide useful lessons.

3.2 Public-private partnerships to promote RETs

Global market trends are shifting. Reform, often in the shape of privatisation and commercialisation of previously government-owned utilities, is common. Independent power producers and management contracts by the private sector for public facilities are emerging. Although the private sector has always been active in the RETs sector, in most cases this has been uncoordinated and often unstructured and, except for select cases, resulting in minimal impact. The investment environment has not been conducive to private sector involvement. The most common RETs, solar systems, are needed in remote high-risk areas often unattractive to the private sector. Thus, partnerships within public institutions and between public and private sector are required to design attractive packages for meeting energy needs and fulfilling energy national goals in a sustainable manner.

To effectively promote RETs, partnerships need to acknowledge the special circumstances associated with these technologies. Specific legal, regulatory and fiscal frameworks have to be created. These will have to be developed by government. Consumers need incentives to choose RETs. In recognition of this need, the South African government is contemplating providing subsidies to private companies to electrify rural areas via off-grid RETs.

3.3 Capacity building

Lack of technical support to install and maintain RETs has hindered their penetration. This problem can be addressed through training of technicians. Various countries including Zimbabwe, Malawi, South Africa, Morocco, and Ghana have some experience in this approach. The Namibian government with assistance from GTZ trained about 100 technicians between 1996-1999 on installation, repairs and maintenance of SHSs. The aim was to provide technical support to the Home Power! Programme initiated by the government to facilitate solar electrification of rural households. Today, less than 10% of these technologies are operating, although the programme is still operating. This can be attributed to inadequate incentives, slow pace in the growth of installations, the dispersed and remote location of the consumers, as well as commitment to other alternative activities.

Incentives are needed to retain technicians in the RETs sector. To serve the remote areas, it might be better to train local residents in order to minimise response periods in addressing consumer queries. However, this in itself does not guarantee sustainable technical support. In 1998 the UNICEF programme in Namibia trained two local residents as technicians to maintain the

systems in a solar village, but these technicians left the village for the urban area after a short period.

This demonstrates a need for an alternative strategy. A two-pronged approach in meeting technical support needs is needed, where end-users are trained in basic maintenance and technicians are equipped with more specialised skills. Training of older, less mobile residents should be considered, while recognising the limitations in their capabilities. Easily accessible training guides could be useful complements to the more structured training whereby a certain level of education and skills are available. With the increased role of the private sector in the energy sector, RETs projects could be designed to incorporate long-term maintenance contracts where the service is provided by private entrepreneurs. Guarantees on RETs systems could also be on longer terms and more enforceable. Peer pressure among the manufacturers and installers of RETs through code of practice agreements can reduce the risk of technical failure.

Technicians need tools and spare parts to operate. The majority, however, lack the capital to purchase them and cannot access loans from commercial lending institutions. The amounts involved are relatively small and the technicians normally lack collateral. Mechanisms to extend credit to technicians for establishment of this enterprise are needed.

Capacity in government to handle RETs issues is limited. In some cases the renewable energy section is subsumed under other energy divisions and not provided with adequate dedicated staff. As a result the staff working in this area are overworked and cannot give RETs the attention it deserves. To compound the problem, some of these officers are not trained in RETs. Though some governments have established a renewable energy sub-division, only in a few cases does the section have adequately elevated status to effectively address the RETs issues. Government staff need to be capacitated to develop good policies for RETs. Obviously, good policies are not an end in themselves – they have to be implemented. More important is the need for the implementers to understand the rationale for the policy, for only then will it be implemented as intended and enhance sustainable development. Capacity building of implementers would facilitate this.

Sharing of experience is a relatively unexploited useful approach to capacity building. Benefits from RETs are not well known due to limited monitoring and evaluation as well as poor information dissemination of cases documented (Wamukonya and Davis, 1999; James et al, 1999; Ahiataku-Togobo, 2000 (draft)). For example, though many countries have PV projects, the experiences generated from older projects do not seem to be informing new projects across country borders. To address the lack of information problem UCCEE has embarked on development of a publication on Africa PV experiences which will be used as reference for future projects hence contribute to sustainable energy development.

More research and development (R&D) is needed to push RETs over the threshold. In the face of dwindling funding for RETs R&D due to reforms and focus on commercial gains, the need for targeted, applied R&D is underscored. Thus, what is important for Africa is strategic research and development whereby Africa forms symbiotic partnerships with the North, the main developers of RETs.

3.4 Awareness raising

Promotion of RETs should be done through existing national programmes to ensure sustainability. It would also be important to couple these with other, more sexy, national issues to increase attention.

Government has many opportunities for raising awareness and increasing user confidence in RETs, including taking a lead in the use of RETs in government buildings. These activities should be coupled with research and development on assessing costs and benefits of RETs and documenting this information in accessible formats to potential consumers.

Experiences on RETs should be shared through structured information dissemination strategies to avoid repetition of past mistakes and misuse of resources and disillusionment in RETs. UCCEE' publication on African PV experiences to inform policy should contribute to this goal.

3.5 Direct policy initiative: target setting

Allocating quotas for RETs in the national energy balance promotes their penetration. In a study conducted in Zimbabwe, RETs stakeholders identified setting national targets for RETs as a measure to promote these technologies. Under target setting, otherwise refereed to as renewable portfolio standard (RPS), is more commonly used in the US electricity sector where a specified amount of electricity from renewables is included in the suppliers' portfolio. The suppliers are offered the flexibility of meeting their obligations through generation or purchasing renewable energy credits from brokers. RPS has been used to lower the cost of the generation of energy using RETs by spreading these costs across all users. The Non Fossil Fuel Obligation in Britain is another example of a market-enabling strategy where a goal of 3% of total electricity to come from renewables was set. An agency pays a premium fee to the renewables generator. The

difference between this fee and the market price is financed by fossil fuel levy, a tax from electricity paid by electricity suppliers and passed on to the customers (Wohlgemuth, 1999). Are such strategies realistic for Africa? The general approach - somewhat modified - is being used in some African countries, and Namibia is considering allocating specific funding for off-grid RETs.

Target setting is however only effective if complemented by implementable resource commitments. This is already happening in the electricity sectors of a few countries. However, the level of funding commitment, for example, is still very low compared to the funding allocated to the petroleum or conventional technologies. The case of Botswana highlights this disparity: in the National Development Plan 7, the Botswana government set aside US$1.3 million for RETs, accounting for 6% of the energy sector budget, which was far below the amount allocated to conventional energy technologies (Mosimanyane et al, 1995).

Active national support for RETs in form of directives by the government can facilitate penetration of these technologies. In Zimbabwe, the policy obliging the national oil company to buy power alcohol from the producers has contributed significantly to the survival of this industry (Karekezi and Ranja, 1997).

3.6 Financing

In principle, funding for RETs needed to meet African energy demand is available. Various financing mechanisms have been established in the 1990's. The dilemma is why the funding is not reaching the majority most needing it.

Innovative financial arrangements facilitating access to loans for RETs are emerging. Loan schemes based on the establishment of revolving funds administered by conventional and new financial institutions are being used to enable acquisition of SHSs by rural households. However, some of these schemes have failed due to institutional problems, poor understanding of the markets and lack of commitment among key stakeholders. Better understanding of the factors contributing to success or failure of the financing schemes is needed to ensure sustainable RETs penetration. While provision of guarantee on loans for RETs has provided an incentive for involvement by commercial banks, it is clear that this needs to be coupled with clear guidelines, action plans and commitment by the institutions on how to implement.

UNEP is implementing a project, the African Renewable Energy Enterprise Development, aimed at promoting RETs through providing financial assistance to small-scale entrepreneurs, but this project is still in its initial phase and it is too soon to evaluate its performance.

The utility model where the consumers pay for the service rather than own the technology is being explored as a way to address the high investment barrier. The Eskom-Shell joint venture in South Africa has installed SHSs where consumers are paying about US$10 per month for the service. The fee-for-service option is one of the options offered in the Morocco rural electrification programme.

3.7 Limits of RETs for sustainable development in Africa

RETs include biomass, solar, hydro, wind and geothermal technologies. However, in Africa today, the use of the term has become synonymous with solar PV systems for electrification, and to a lesser extent for telecommunication, water pumping and heating.

Biomass energy is the predominant energy source for rural and peri-urban Africa. In some countries like Uganda biomass accounts for over 90% of the total energy used. Biomass is mainly used as a 'traditional energy carrier', as fuelwood. In the form it is conventionally used, biomass has little promise for facilitating economic growth unless converted to modern carriers such as electricity or gas. The predominant intervention in the biomass energy sector, the improved stoves, uses biomass in the 'traditional carrier' form. Though technologies for biomass gasification exist, the cost remains prohibitive. The use of biomass for fuel cells is being explored but its accessibility to rural areas is likely to be hindered by the same barrier. Biogas digesters have been installed in various African countries but the success rates have been rather low. The high demand for water and labour are some of the barriers to wide usage of biogas technologies.

Hydropower and geothermal technologies provide modern energy carriers, but are site-specific. Only a few areas have financially viable hydro and geothermal resources.

Solar PV systems are widely promoted in Africa, mainly for rural electrification. The typical household system is 50W or less. These systems can only meet very limited energy services and are mainly for lighting and operating black and white TV; they cannot provide mechanical power for operating the equipment often used in income-generating activities, nor provide adequate power for thermal purposes such as cooking, though this accounts for significant energy demand in households and food processing enterprises. As such, for the majority, the systems mainly provide energy as a consumer good. While the improved quality of lighting has enabled some households to extend their evenings and employ the time for income-generating activities, it is important to note that this has only been feasible where such activities already exist.

Lighting in its own right has not triggered development of income-generating activities. For this to occur, the complementary factors, such as finance and markets, have to be available. Solar systems should thus be offered as part of a package comprising all the factors necessary for establishment of entrepreneurial activities as well as other energy demands unmet by the system. The bundling of energy services where a gas cooking system is offered together with the solar system has been tested in some countries. However, the financing facilities offered for the solar system are normally not extended to the gas system, so few potential beneficiaries are able to access the gas systems.

4 The role of regional and international cooperation

Promotion of RETs in Africa has been hampered by various barriers including high capital costs, lack of capacity to install and maintain systems, lack of awareness among users, lack of standards, etc. While some parts of the RETs systems might be made in Africa, the bulk of the systems and components are imported. Cross border trade of RETs is common especially in Eastern and Southern Africa regions. Regional structures and international cooperation could thus play an important role in eliminating barriers and promotion of RETs.

Use of common regional standards could facilitate promotion of RETs and limit dumping of technologies across borders. Common policies on RETs, such as taxes, could improve trade across countries and hence increase market size to a financially viable level, where this is a barrier. These economics of scale would enable lowering of costs and enhance sustainable penetration.

Regional cooperation could use the emerging and existing institutions such as Common Monetary East and Southern Africa, West African Power Pool, Southern Africa Common Customs Union, SADC regional regulator etc, to implement regionally beneficial policies.

Developed countries have established mechanisms to transfer technologies to Africa, such as export credit agencies. An example is the Spanish government which used its agent to provide assistance to the government of Ghana for installation of solar PV systems in ten rural communities in 1998 (Ahiataku-Togobo, 2000). These credit agencies offer an opportunity for influencing RETs agenda for Africa in developed countries. However, to achieve this goal cooperation among African as RETs recipients is necessary.

5 Conclusions

Problems associated with adoption of RETs appear chronic if evaluated in isolation without due attention to the prevailing economic conditions. RETs do have a niche within Africa's energy mix but do not meet all energy needs for sustainable development. As such, promotion of RETS should follow an integrated approach taking into account ways in which the energy service can be used to foster development goals.

There are many experiences with RETs which remain unknown to potential users, resulting in repetition of mistakes. The information-sharing infrastructure needs to be improved.

References

Ahiataku-Togobo Wisdom,2000. MME/Spanish project on off-grid rural electrification. Ministry of Mines and Energy, Ghana, EDG and Sechaba Consultants, 1997. Lesotho alternative energy factbook.

Hankins, M. 1994. Solar electrification in developing countries. Case Study:Kenya, Solar electric light fund, Washington DC.

Karekezi Stephen and Donella Mutiso, 2000. Power Sector reform: A Kenyan Case Study in *Power Sector reform in Subsaharan africa*, John Turkson eds. MacMillan.

Karekezi S. and Ranja T. 1997 renewable energy technologies in Africa, Zed Books, London.

Kanetsi B. and Phuroe T., 1994 in Karekezi S. and T. Ranja (ed), 1997. *Renewable Energy Technologies in Africa,* Zed Books.

Mosimanyane M.T., Zhou P.P. and Kgathi, D.L. 1995 in Karekezi S. and T. Ranja (ed), 1997. *Renewable Energy Technologies in Africa*, Zed Books.

Muller, Hansjorg, 1999. Personal communication. GTZ energy Advisor, Ministry of Mines and Energy, Namibia.

Senelwa K. and Sims E.E. 1999. Opportunities for small scale biomass electricity systems in Kenya. Biomass and Bioenergy 17: 239-255.

Subisiso N. Dlamini, 2001. Solar PV systems: Insights from Swaziland, Summary in *PV experiences in Africa*, N. Wamukonya (ed), UCCEE, Denmark.

TuryahikatoG.R, Hatanga E.S, Otiti T and Kebirungi P., 1995 in Karekezi S. and T. Ranja (ed), 1997. *Renewable Energy Technologies in Africa,* Zed Books.

UCCEEa, 2000. Implementation of renewable energy technologies- Opportunities and Barriers- draft report.

Usher Erik, 2000. RET/EE Investment Advisory Facility-draft report, UNEP.

Wamukonya Njeri and Mark Davis, 1999. Socio-economic impacts of rural electrification in Namibia. EDRC, Cape Town South Africa.

Wohlgemuth, Norbert, 1999. Renewable energy production in competitive electricity markets. Paper presented at the Solar Energy Society UK section conference in Quality Hotel, Brighton UK. UCCEE, Denmark.

World Bank, 2000. World Bank Board Approves $72 million for Kenya. News Release No: 2001/105/ AFR. http://wbln0018.worldbank.org/news/ pressrelease.nsf/

ACCESS TO ENERGY

Rural electrification: A challenge for improving access to energy by the poor

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1. Introduction

Access to energy can be defined in various ways. One of the most commonly used definitions is that access to electricity is the availability of electrical energy infrastructure in rural areas. Efforts to increase access in rural areas seem to end at providing infrastructure for electrical energy delivery. The rural poor are therefore left without the means to use this energy, hence their access to useful energy is not significantly improved.

Another preconception is that access to electrical energy is the ability of rural communities or households to have electric light, television and radio powered by photovoltaic (PV) systems. This definition has seen the expenditure of large volumes of money to install PV lighting systems in rural households and businesses. The household suddenly has a higher bill for lighting. Where it used to cost a few dollars a month for kerosene or candles the loan repayments for the lighting system cost much more. The systems are installed on request from the household, hence the argument may be raised that the supplier is meeting a demand for services. In this case access is restricted to those able to pay for the energy, and the rural poor may still remain without access to electrical energy. The provision of PV lighting presents an additional demand for limited financial resources, yet it does not add to the household income: the availability of increased working hours is not sufficient for increased income (and might also translate into inefficiency the following day).

A definition for access to electricity that will be used in this paper is the ability to connect to and use electrical energy for sustainable development in rural areas – sustainable development being the use of resources to maximum lifespan and for the good of the local communities and their environment. In the absence of income generation and improved environmental conditions there cannot be a good basis for arguing for improved access to electricity by the rural poor.

Utilities currently shun rural electrification and prefer to define it as a social responsibility of government, the reasons being the high risk involved, and low load demand resulting in poor returns on investment. The utility also has a defined business which excludes involvement beyond the supply of electrical energy. Obviously, the rural household is not able to meet the real cost of electrification on receiving the connection. Also, in the long term only some households are able to obtain the necessary appliances to use the electricity for income generation. The business mandate for energy utilities seems to restrict them to trading energy. The disadvantage is that the volume of business in energy sales is dependent on the success of the end-use applications. The utility is a reservoir of technical expertise which by design is meant to provide the engineering and business skills to the utility. On the other hand, users are generally deprived of technical expertise and so end up making incorrect judgements about electrical energy applications In most cases the communities cannot afford expertise and often do not have the complementary factors that would enable them to use the energy appliances productively – even if they acquired them.

The government rationale for rural electrification has mainly been political. The capital cost of electrification can be justified by the social benefits of access to electrical energy by the majority of the population. The power utilities are in most cases public enterprises, and so are viewed as the responsible entities to spearhead electrification of rural areas. Given the disparities in the level of development between urban and rural areas, the provision of electrical energy is seen as a major step in closing the gap. However, access to electrical energy by the poor is not possible in the absence of measurers for providing cheaper end-use devices. Policies for utilities to extend the grid into the remote areas are not matched with policies for increasing productivity by the beneficiaries so as to enable them to pay for the energy used. Agricultural extension services, business incubators and infrastructure development have in some instances been used to stimulate development, but are rarely linked to the provision of electricity in rural areas. The Zimbabwe Electricity Supply Authority, for example, has a rural electrification fund which is fed by a levy on each electricity bill. The fund has successfully extended the grid to several rural households by contributing towards the initial capital investment. There is, however, no complementary funding to support energy use in the electrified areas, such as irrigation development, small scale enterprise development or water supply, or another fund supporting development in the electrified areas so as to support the uptake of the electricity. Another example is the GEF-PV pilot project that was implemented in Zimbabwe. The project supported the delivery of PV systems in rural homes but did not provide for the addition of value to the local economy through use of PV power. The project therefore supplied a consumption need. Decision-makers remain, however, sensitive to the need to provide for a base load for rural electrification to gain political profile.

In Zimbabwe the Rural Electrification Masterplan prioritises electrification projects by: economic base in the target area, a population that would benefit from the electrification, and distance from the nearest supply point. This means a high population area with a strong economic base is highest priority, although if a potential site is close to a power line it may end up being high priority due to the low incremental cost of supplying power to the site. When these criteria were applied in Zimbabwe it ended up with a priority list for projects as given in Table 1.

Table 1: Electrification and characteristics of growth centres in Zimbabwe

Priority	*Characteristics of site*	*Remarks*
Group 1A	High population, high productivity, close to supply point	Mostly electrified
Group 1B	High population, low productivity, close to supply point	Generally electrified
Group 2B	Low population, low productivity, close to supply point	Generally not electrified
Group 3A	High population, low productivity, close to supply point	Generally not electrified
Group 3B	Low population, low productivity, far from supply point	Not electrified

It was, however, found that most areas within 30 km of a supply point were electrified or due for electrification. Each time a new supply point was installed there would be a shift in the priority list by other sites as the distance to nearest supply point would change. This means the electrification process is dynamic and parameters cannot continue to hold true as the programme continues. It may not even be possible to iterate between plan and work on the ground as some of the connections are fait accompli.

Historical information also showed that the high population and high productivity sites exhibited highest growth in demand for electricity. Sites nearest to major centres tended to have highly competitive markets for goods and services and so did not grow as expected. Figure 1

shows some of the electrified centres and the growth in number of connections over time. Gokwe exhibits the highest growth and is in a highly productive agricultural region and has a large population within its influence zone. Murombedzi is in a productive zone with high population but faces competition from established towns within 40 km: hence it exhibits very slow growth. The graph basically supports the use of population served by the site and productivity as joint criteria in prioritising electrification projects.

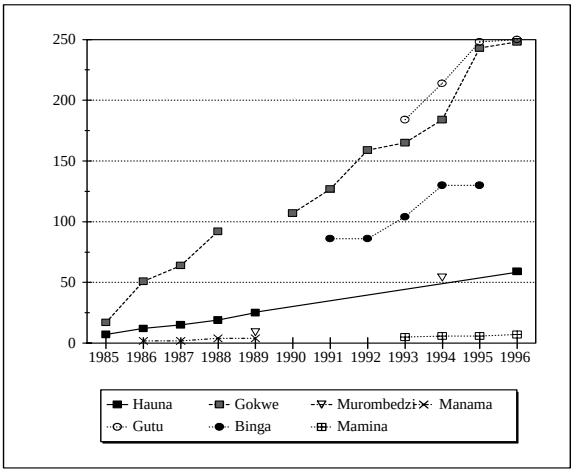

Figure 1: Number of electricity connections over time
Source: Southern Centre Survey: Rural electrification Masterplan

2 Energy and development

The main observation on rural development in Africa is the exclusion of the rural population from mainstream economic activity. Several factors contribute to this, one of them being technology. Hard and soft technologies enable the delivery of goods and services to a wider majority by a small production unit. Technology development trends have so far focused on the production of technologies for the supply of high quality and lower cost products to the market. Most of this technology is dependent on the availability of electricity, fossil fuels and human skills. In the absence of conventional modern energy the rural population has to rely on low productive technologies that in most cases cannot meet the demands of a modern market. Rural areas are therefore restricted to agriculture – and in most cases subsistence agriculture. Addition of value to local raw materials is very limited in the absence of commercial energy, since all modern technology is designed with commercial energy in mind. The rural technology base in most countries in Southern Africa comprises agricultural extension services, health delivery services, primary and secondary education, and technology retailers. Apart from agriculture there are no extension services for production in rural areas. The target for most training institutions is the job market in urban centres and large-scale commercial agriculture. Health services are mostly interested in safe drinking water, good public health systems and general household hygiene in addition to the delivery of health care. Their perspective on energy is, therefore, the delivery of these basic needs. Given this perspective, it is not surprising that energy is generally viewed as the primary need for upgrading the social needs of rural communities.

Elevation of incomes is recognised as an important component but there are no provisions for large-scale upgrades of rural enterprise. It is this limitation that attracts more support for "social energy" such as home PV systems, small-scale biogas plants, efficient cook stoves, solar cookers and solar water heaters. Even when programmes target the commercial application of energy, such as crop drying, the scale of such initiatives is normally for the subsistence farmer – with the irony being that the subsistence farmer is not able to pay for the technology. On the other hand the priorities for rural households may not rank electricity highly. In a survey carried out in Zimbabwe electricity was sixth on the priority list, as shown in Table 2. The higher ranking needs have a common requirement as money with money itself being ranked second on the list. What is evident from this is the fact that energy is a service useful for income generation and should be provided in this context..

Table 2: Priority needs of rural households

Rank	*General needs*	*Energy source*
1	Food	PV power
2	Money	Firewood
3	Water	Paraffin oil
4	Health	Grid electricity
5	Education	Own generator elec.
6	Electricity	

Source: Southern Centre – JICA, Zimbabwe Field Survey (1997)

Even grid electricity is ranked fourth on the energy preference list. The main reason given was the monthly bill, whereas rural households prefer to pay a fixed amount or one large payment. Given the seasonal nature of rural incomes it is understandable that rural households would prefer PV power with a fixed capital cost and low operational cost, as opposed to grid electricity with a monthly bill computed after electricity consumption. If electricity would yield higher incomes then the priority list would be headed by grid electricity.

Barriers to rural electrification

The above discussion has highlighted some of the difficulties with the current views of rural electrification in Southern Africa. There are, however, barriers to the successful implementation of rural electrification projects in the region which are additional to the programming or technology support barriers already cited.

Development funding is useful in creating an enabling environment for the local communities to take more strategic decisions for their development. It is, however, limited to activities that remove barriers without necessarily creating wealth within specific groups. In the absence of complementary programmes to receive the products of development activities and convert them to tangible value addition or wealth, the initiatives of development agencies tend to fall short of the target objectives.

The migration of skills from rural to urban areas is the major limitation of technology delivery to rural areas. Too much emphasis is placed on use of skills in employment as opposed to employment creation, so that most of the basic skills emanating from rural areas migrate to seek employment in urban areas. It then appears an objective of the government education programmes to train for employment as the curriculum is structured to deliver the traditional academic and vocational training.

Utilities are normally put in the centre of rural electrification programmes. They select technologies and in some cases design the programmes themselves. Utilities are, however, limited as development agencies, hence they omit the end-use component as a programme for rural electrification. The absence of agriculture extension services, ministries of mining, of industry, of health and of finance from rural electrification planning results in lowered commitment and insufficient guidance to the utilities.

3 Elements of successful electrification

The traditional rule for electrical energy supply is that the end user pays a tariff that enables the utility to recover the cost of supplying the service. (This principle does not take into account the cost of not supplying the electricity – in most cases unelectrified areas would be dominated by unsustainable fuelwood use.) As a result rural electrification has been viewed as non-viable with the main factors being:

- low load density;
- long transmission lines-rather high cost of grid extension;
- inability of rural populations to pay for service;
- lack of appropriate rural electrification technology; and
- lack of finance.

If a broader view of electrification is adopted, it will be realised that the stakeholder base is wider than the utility and the prevailing end-user. Benefits of rural electrification accrue to other stakeholders who are currently not included in the execution of the programmes. Some of the impacts of absence of rural electrification include:

- unsustainable use of biomass fuels;
- low productivity of the agricultural sector;
- poor population distribution (urban migration);
- limited demand for electrical devices in rural areas;
- poorer health delivery services;
- limited availability or retention of skilled manpower in rural institutions.

These impacts of non-electrification of rural areas highlight the unsustainable development that results from lack of commercial energy in rural areas which would enable extension services for agricultural production to be provided. These impacts are cross-cutting, so they affect other sectors as well as the energy sector. An example is the unsustainable use of biomass fuels which can reduce the available hydro resources through silting. Loss of surface water reservoirs will also affect potential irrigation, commercial livestock breeding or rearing, and also the use of alternative energy types such as biogas. The cross-cutting nature of the impacts of non-electrification justifies the participation of a wider spectrum of stakeholders in rural electrification than is currently involved.

Levies on electricity bills and development levies on taxation may be used as methods for sharing the rural electrification burden but the interaction of stakeholders is lost in such a process. Integrated planning of rural energy supply and rural development may answer some of these questions, but the involvement of private sector and public sector decision makers in rural development planning is still a concept for the future. Acceleration of the process to include the private sector in development planning may take initiatives outside the energy sector but a strong involvement of the energy sector can assist such things such as the establishment of agricultural estates with smallholder units that benefit from a corporate management input.

The Rural District Environment Action Plan (DEAP) process in Zimbabwe acknowledges the role of energy planning in rural development. Whilst the district administrative structures have capacity to respond to local development plan-

ning needs they have limited capacity to respond to energy planning. This results in energy planning being left to the utility or others – who in most instances are called into the process towards the end of the planning cycle. Basic guidance such as criteria for energy technology selection and estimation of energy needs is often lacking. If energy provision is to be demystified there is need to build capacity within the rural planning structures themselves to handle the basic drafting needs for energy planning. Once the local communities are able to request electrical energy supply and are able to account for it in terms of financial, social and other benefits, it will be possible to set performance targets for rural electrification projects. Where urban electrification projects may balance energy supplied and revenue received, rural electrification projects need to account for social and economic factors that would make the current and future electrification projects successful. The following is a list of some of the factors that need to be accounted for.

A responsive tariff Tariffs are generally designed to recover the cost of energy supplied and to influence the decision of the energy user to a pattern that suits the capacity of installed energy equipment. Rarely do utilities account for end-use products in tariff design. In a rural setting a tariff structure that allows for increased revenue collection at the start and at the end of a cropping season would allow for the farmer to plan for the inputs at the same time and to make budget allocations for energy at the same time as other agriculture inputs. In another case a tariff that charges per unit of water used may receive a better response from a rural user than a tariff that charges for demand and energy supplied. If the utility would supply water then the demand pattern for the electricity could be regulated by installation of reservoirs so that during peak load times when the utility is unable to supply power the community can draw water from the reservoir, thereby reducing the cost of supplying electricity during high demand periods.

Integration of electrification and end-use finance Utilities are reluctant to connect rural customers due to low load densities. If the utility would bring finance for the end use of electricity into the electrification programme the demand would be relatively high at the time of connection , compared with when the customer is funding the connection as well as the end-use devices.

End-use extension services Electricity use in a rural setting can be a costly exercise for the user. The perceived cost could be a result of device inefficiency, operating habits, poor maintenance of devices, and poor energy choices. The utility could secure a better client by providing extension services that allow the user to make electricity the energy of choice. Utilities have been known to include in their service experts in the agricultural application of electricity for purposes such as irrigation and heating. These services may also be extended to other customer groups.

Reliability of service There is a tendency to equate reliable service with uninterrupted service. In a rural setting, however, electricity could be required for a few hours a day to pump water. The user may not be sensitive to the actual time of supply as long as the service does not result in a shortage of water. This may result in the utility being able to reduce line load during peak hours and increase it during off-peak periods. This would reduce cost for the user and utility and allow the utility to provide a more reliable service for the whole system.

Increased production If electricity supply in rural areas is to be sustainable, then it should add

Table 3: Impacts of rural energy use

	Environmental and social contact point				
Activity	*Air*	*Soil*	*Water*	*Quality of Life*	*Gender Balance*
Fuel collection	Pollution from kilns	Erosion	Increased run-off	Labour-intensive	Women and children affected most
Fuel transport	Air pollution from poor vehicles	Erosion from poor vehicle use	Silting	Labour-intensive	Women and children carry wood
Fuel use	Indoor air quality	Acid rain		Eye and chest infection	Women and children affected most
	Global climate Poor health	Silting of rivers	Reduced storage Poor quality	Poor health Poor quality of life	Women and children exposed Reduced participation of women in economy
			Environmental and social effect		

to increased production or better delivery of service. Without increasing production, electricity supply would just be a cost. There is limited justification for better performance of consumer goods in rural areas where the availability of income to support such services is limited. In other words, electricity cannot be supplied for non-income generating activities such as household lighting and cooking. It is arguable that in a case where electricity is a lower cost alternative to the current energy in use it would be justified to supply electricity. However procurement methods would have to be the same unless income generation is included as part of the electrification package.

4. Rural electrification and the environment

It is generally agreed that electrification can potentially mitigate environmental damage in rural areas, the major cause of which is loss of tree and grass cover. Table 3 shows the impact of non-electrification on the environment. Energy use is a major contributor to tree loss, through demand for fuelwood. Studies have, however, revealed that *urban* populations, with a significant proportion of households using fuelwood, pose a major threat to woodlands: large volumes of wood have to be transported to urban areas for sale and the wood collection process has to rely on tree felling since collection of dry branches cannot meet the demand. It is this intensity of use that promotes loss of tree cover around urban centres and in areas remote from urban centres but with low security for forests. Charcoal use has an even greater impact on the environment than use of firewood, because of the losses inherent in the charcoal production process. In Zambia studies have found that 50% of forest accessible to charcoal producers is lost due to initial tree felling followed by forest fires which destroy the trees and new shoots.

Loss of forest cover forms the beginning of a wider environmental degradation in rural Southern Africa. The major impact is increased run-off which results in lowered water tables and depleted aquifers. The frequent droughts experienced in the region take a bigger toll on the surface water resources and land degradation, which in turn affect the energy sector in terms of reduced hydro resources and reduced tree growth. (It is also clear that reduced surface water quality which results from increased silting of rivers has an impact on public health in the rural communities.)

Table 4 shows the levels of household electrification in some Southern African countries. Successful electrification allows rural communities to switch from biomass fuels to electricity (so long as this includes delivery of devices and increased incomes for rural communities to be able to pay for the electricity). The environmental impact of non-electrification is not only a problem for rural communities. In Southern Africa the electrification of urban communities has not reached saturation. It is urban households which have higher incomes and a higher ability to purchase the firewood that causes more degradation of forest areas.

Table 4: Household access to electricity in Southern Africa

	Botswana	*Malawi*	*Mozambique*	*Zambia*	*Zimbabwe*
Urban	26	19	28	37	~55*
Rural	4	1	<1	2	3-5
Total	10	4	5	18	14

* This figure includes rural growth centres as urban areas.

Source: EDG – CIDA, Access to Electricity in Southern Africa

Major urban centres have higher levels of electrification than the smaller centres. The city of Bulawayo for example has a nearly 100% level of household electrification due to a policy of connecting all new municipal houses to the grid. Bulawayo is also in a low rainfall area that would be affected drastically by deforestation.

The environmental impact of non-electrification is dependent on the alternative fuel used – in most cases fuelwood or charcoal. In Zambia electrification of households is seen as a way of reducing environmental damage in the forest areas where tree-felling for charcoal production is rampant. The impacts of fuelwood use are related to the collection process as well as the transportation of the wood to site of use. Use of poorly maintained vehicles is common, as well as use of animal-drawn carts or sledges which damage unpaved roads and expose them to erosion. The effects shown in the Table 3 are increased by fuelwood use. The results of deforestation are well understood in the region, with large tracts of forest cover having been lost to agriculture and fuel wood use. Further analysis of the effects of deforestation will show that they reach all sectors of the regional economy, since agriculture is a major activity.

Gender balance is a often a key element of energy use analysis, especially in rural communities in Southern Africa. Women are the custodians of the household energy budget, and in most cases are traditionally responsible for collection of fuels – although the critical shortage of firewood in some districts has seen men being responsible for the identification of sources further

from home. Men also arrange for the transport of the wood by animal-drawn cart or other hired vehicles. This is a switching of roles which helps in spreading the responsibility for energy supply to the household, but women remain responsible for managing the fuelwood once collected.

If rural electrification is implemented, the assumption is that women would be freed of the task of collecting wood. There are, however, several issues that would need to be addressed to make this a reality. Electricity use for cooking will continue to be an unaffordable luxury until rural households can generate sufficient income to meet the monthly bill. In addition, if rural communities continue to be subsistence, or at least semi-commercial, farmers, they will continue to have a low value for time and will opt for wood collection over buying electricity. Even though electricity provides for a cleaner indoor environment, men, who in most cases have overall responsibility over the household budget, are not affected by smoke of the indoor wood fires to the same extent as women and children since they do not have to sit through the smoke whilst making a meal. The men as heads of households do, however, have to provide for medical care, and so get involved at a stage where the effects of the poor indoor air quality might be more easily recognised – although chest infections or sore eyes are not usually explained to the families as caused by smoke.

In surveys carried out by Southern Centre rural households indicated that they would upgrade their house first, before requesting electricity. This priority indicates the need for improved incomes for rural electrification to be sustainable.

Rural electrification allows for an improved management of the impacts of the energy sector on the environment. Electrical energy, especially in Southern Africa, has a major impact on the environment through use of fossil fuels. Combustion of coal is responsible for 98% of the emissions of carbon dioxide in the region, but reduction of deforestation would increase the rate of carbon sequestration and provide a cancellation effect for the environmental impacts of increased coal use in electricity production.

5 Elements of a rural electrification strategy

A successful electrification programme will be accompanied by increasing income levels. Rural electrification should therefore be an option for increasing production as opposed to answering the energy problems of households. If income generation were to be the priority, some of the capital investment problems of rural electrification would be reduced. Given the agricultural nature of the economies of Southern Africa, the following are the key factors for consideration in a rural electrification programme:

- baseline economic activity in the rural area;
- potential economic activity in the area;
- available human and technical resources;
- potential market for products;
- effectiveness of local authority governance; and
- local technology support for rural investment.

If the utility alone is left to manage rural electrification it is possible that future policies will emphasise levies and grants as a means of electrifying rural areas as opposed to mobilisation of local capital.

Industry in Southern Africa is dependent on raw material from agriculture. In some cases industry has contractual agreements with the rural agriculture sector for the supply of agricultural inputs and the delivery of raw materials. Typical examples are production of spices, cotton farming, oil seed production and potatoes. These agreements could extend to the provision of energy services so as to achieve higher yields.

The flexibility required in energy supply to rural areas is sometimes not available in the public sector. If energy companies were to sell services as opposed to energy the public sector utility would have to seek a new mandate from the responsible authorities. Private companies could, however, supply the energy under a new tariff arrangements as a new opportunity for business.

Apart from cooperating in the electrification of border areas, South African Development Community (SADC) states could implement a common rural electrification programme in terms of technology and standards. With similar equipment standards, equipment suppliers would have a greater interest in supplying rural electrification equipment to the region. If the integration of electrification and food security was taken as a regional initiative there would be greater scope for resource sharing, as the food security programme is already running as a regional project but without the component of increasing production through electrification.

The regional environment programme which is run through SADC-ELMS would also benefit from a regional electrification programme. The reduction in use of fuelwood and the conservation of the rest of the natural environment will help in optimising the use of other natural resources such as water and land. The environmental problems being faced by SADC are related to poor production methods in agriculture which can be reduced by electrification. Higher incomes would then allow for a better capacity to

respond to environmental conservation initiatives. If the exercise is carried out on a country-by-country basis, the market size for technologies, extension services as well as investment may not be sufficiently large to attract the attention of large international investors.

Even though private sector participation may provide the key operational capital, the development of basic infrastructure and the removal of barriers to technology diffusion are best addressed by public sector funding. The development of rural electrification networks and the introduction of technical cooperation programmes are best suited to development agencies whose financial support is for public benefit. The sponsorship of end-use activities is also outside the electricity sector, and would be better implemented by development agencies and agricultural finance. However, since the majority of the clients would be small-scale producers, there would be a need to develop specific programmes for funding small enterprises.

Rural electrification has the potential to generate global climate benefits, because use of electricity can result in an increase in standing biomass. At the same time use of electricity reduces indoor air pollution resulting in a better living environment for rural families. The improved public health benefits and the potential climate benefits can be used to support rural electrification. Public sector and private sector funding can be used to buy the benefits of electrification activities given the limited progress that utility-funded programmes make.

Bibliography

1. Southern Centre, SADC FINESSE – Zimbabwe Country Study
2. Energy and Development Group, Access to Electricity in Southern Africa.
3. The Institute of Energy Economics Japan, Study on the Promotion of Photovoltaic Rural Electrification in Zimbabwe
4. Southern Centre, Survey results – Household Income and Expenditure and Energy Consumption for Assessing Feasibility of PV for Rural Electrification in Zimbabwe.
5. SADC Energy Sector TAU, SADC Energy Cooperation Policy and Strategy.
6. Government of Zimbabwe, Rural Electrification Masterplan.

Rural electrification reform and programme in Cameroon

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1 Introduction

Rural development in general, and rural electrification in particular, are important political issues which deeply concern Cameroon's authorities. Owing to the low access to electricity in the country and to poor performances of the National Electricity Corporation that was assigned the mission of electrifying the whole country, in 1998 the government of Cameroon decided to restructure its electricity sector to improve its contribution to the social and economic development of the country and to help combating poverty in the country as a whole and in rural areas in particular.

This paper outlines the major restructuring options chosen by the government of Cameroon in the framework of the reform of its electricity sector, and analyses the potential of this reform to properly address the issues and challenges at the heart of the power sector and rural electrification development in Cameroon. One of these challenges is to provide at least minimum energy services, to allow the rural population to achieve a decent standard of living.

After an overview of major issues confronting the electricity sector and rural electrification development in Cameroon, the paper analyses the reform of the electricity sector and other actions taken by the government to address these issues, and suggests a few options and strategies that may allow for increased access to electricity in rural areas.

2 Background information

2.1 General information

The Republic of Cameroon is located in sub-Saharan Africa, surrounded on the west by the Republic of Nigeria, the Republic of Chad in the north, Central Africa Republic in the east and Congo, Gabon and Equatorial Guinea to the south. The estimated population in 1998 was 14,400,000. The land area is 475,000 km². An estimated two thirds of the total population live in rural areas.

2.2 Economic situation

Cameroon's economic situation has improved considerably following the structural adjustment programme engaged by the government under the guidance of IMF and the World Bank and the devaluation of the CFA franc[1] in 1994. The growth of the GDP has been stabilised at around 5% per annum since 1996 and annual average inflation contained within reasonable limits (under 2,8% in 1998 against 13,9% in 1995). The deficit on balance of payments was brought to 2,4% of GDP in 1998.

Cameroon was recently elected to the Heavily Indebted Poor Countries (HIPC) facility and saw its heavy external debt considerably reduced.

2.3 Energy production and consumption profile

Cameroon is a marginal oil-producing country, with an annual production of about five million tons. Proven natural gas reserves are about 110 billion cubic metres but are not yet exploited. Cameroon is also well endowed with renewable energy resources but, except for some biomass fuels, this potential has not yet been maximally exploited. Energy consumption in 1994 was about 3,744,600 tons of oil equivalent, of which biomass energy accounted for 67%, petroleum products for 18% and electricity for 15%. Biomass therefore remains the main source of energy for most households, as well as for many small- and medium-scale industries.

2.4 Institutional set up of the electricity sector

Until 1998, Cameroon's electricity sector was composed of units that were fragmented

[1] The CFA franc is the currency unit used in Central and West Africa. In January 1994, it was devaluated against the French franc (F.F) from a parity of 1 FF: 50 CFA F to a parity 1 F.F for 100 CFA F.

between various ministries. These include the Ministry of Mines, Water Resources and Energy responsible for policy and planning and co-ordination; the Ministry of Finance responsible for financing and for economic control, the Ministry of Industrial and Commercial Development responsible for tariffs setting, the Ministry of Scientific and Technical Research responsible for applied research, the Presidency of the Republic and the Prime Minister's Services responsible for co-ordination.

Although a few small-scale self-power generators exist in the country, electricity generation and supply is mainly undertaken by the National Electricity Corporation (NEC), a state-owned enterprise whose primary mission was to electrify the whole country. The NEC enjoys a *de facto* monopoly status in power production and supply in the whole country.

3 State of the electricity sector and the need for restructuring

The Republic of Cameroon is one of the richest countries in the world in terms of hydroelectric resources. It has significant reserves to develop the hydro-based energy and renewable resource for energy production. The gross hydroelectric potential is estimated at 55,2 GW (not including small hydroelectric sites), of which 19,7 GW can technically be harnessed. In addition, the technical potential for small hydroelectric schemes is about 1,115 TWh/an.

Despite this favourable situation, access to electricity is still very limited. Hydroelectric power development, initiated in the late 1970s, is now at an installed capacity of 723 MW, while diesel capacity is about 140 MW.

Only 25% of the total population has access to power provided by the NEC. In rural areas, this rate is about 6%. Because of the difficult terrain conditions and the low levels of consumption, it is not economically viable to extend the grid to most rural and remote areas. Thus, the population of these areas will necessarily depend on decentralised energy provision solutions, such as solar diesel or small-scale hydroelectric schemes.

Electricity demand is growing at an average rate of 5% per annum, leading to a continually growing peak demand (actual peak demand is about 475 MW) and making it difficult for the NEC to provide its customers with good quality and reliable electricity supplies. In addition, the high dependence on hydropower makes the electric systems sensitive to variations in rainfall.

Poor management performances by the NEC (linked to inefficient billing) and an adverse economic and political environment (linked to economic recession, consequences of the devaluation of the CFA franc, inappropriate electricity tariffs fixing by government, increased oil prices, severe taxation policy) could no longer allow it to effectively achieve its mission of providing access to electricity to all the communities. The NEC is heavily indebted and its revenues are low, and this inhibits its ability to properly plan and execute its preventive maintenance programmes, and to expand its capacity to meet the continually growing electricity demand in the country.

During the period 1997 to 1999, in the dry season, shortfalls of water inflow in the reservoirs considerably reduced energy production. As a consequence of this and of the ageing production equipment, blackouts and frequent shortages in electricity supplies occurred, forcing the NEC to carry out load shedding in many regions in the country.

4 Major issues confronting rural electrification

As it has been mentioned earlier, Cameroon's rural electrification rate is low. Only about 6% of households have access to electricity in rural areas. In terms of number of villages, only about 2,000 out of over 13,000 villages are connected to the grid. Various reasons can be advanced to explain this poor performance; some of these are reviewed in the following sections.

4.1 Technical choice

The biggest stumbling block is the choice of, and the anchoring to, a centralised grid extension supply strategy by the NEC. No commitment to develop small-scale decentralised rural electrification technologies has been demonstrated by the NEC on grounds that they do not incur economies of scale.

Centralised grid extension has been shown to have severe limitations given the demand characteristics in rural areas, where population density is low and consumers dispersed. The grid is often extended over very long distances to capture a few consumers. On the other hand, the load factor is low. According to the NEC and various surveys, in villages already connected to the grid, the average electricity consumption varies between 300 and 800 kWh per annum. This situation impairs the internal rate of return of many rural electrification projects.

Even though the NEC has been aware of the lack of financial viability in most of their rural electrification programmes, it has been forced to pursue its rural electrification efforts for a variety of reasons stemming from political motivations,

development goals, to its own institutional expansion and growth.

4.2 Limited paying capacity

The limited purchasing power of the rural population to pay for electricity supply and electric appliances is also a major problem. In some rural areas where electric grid has been constructed at high capital costs to the detriment of other development services, and free connections have been granted to households, people cannot afford to buy electric appliances. Moreover, there have been reports from the NEC billing personnel of some people not being able to afford to pay their electricity bills.

4.3 Insufficient financial resources

There is a critical need for funding to carry out rural electrification programmes given the low level of access to electricity in rural areas. In the past, conventional financing for rural electrification programmes was an integral part of power sector financing and relied mainly on bilateral and multilateral financing institutions. During the last ten years, funding from these sources has received a setback, mainly due to the high level of state indebtedness.

Meanwhile, local commercial banks have not developed appropriate credit schemes capable of meeting the needs of rural people and local businessmen and organisations willing to be involved in rural electrification.

Although some innovative funding possibilities to develop decentralised rural electrification programmes based on small-scale technologies are being explored by the government with the support of its development partners (World Bank, Agence Française de Développement, UNDP), the lending policies of financial institutions are strongly based on economies of scale and their project evaluation procedures, based on strict application of risk assessment criteria, do not favour the qualification of such small scale decentralised rural electrification technologies.

4.4 Planning approach

Rural electrification planning in Cameroon has often been supply-oriented, taking little cognisance of rural environment and demand features. Programmes are basically designed and implemented based on the hypothesis that once the grid is brought to a community, many connections will follow. Thus, demand forecast is overlooked and, as a consequence, in most grid-connected villages the rate of connection has not reached expected levels. According to data provided by the NEC, the maximum average rate of connection in grid-connected villages in rural areas seldom reaches the level of 30% of total households.

4.5 Linkages with rural development process

Rural electrification and rural development fall within the responsibility of different ministries and organisations. Thus, rural electrification and rural development programmes are often planned separately. There is little, if any, detailed co-ordination between the entities involved. As a consequence of this lack of synergy, rural electrification programmes fail to produce significant impacts on rural development.

4.6 Lack of local capacity

Lack of capacity for the selection, adaptation to local conditions, and local manufacturing of decentralised power supply equipment, and decentralised electrification systems in general, is also a major constraint. Furthermore, the administrative and management capability is also needed to appropriately operate these systems.

This poor state of the electricity sector and the importance of investments required to sustain this sector's growth brought the government to a decision to reform the sector and privatise the NEC.

5 Electricity sector reform and prospects for increased access

5.1 Restructuring objectives

The main objective pursued by the government in the reform of the electricity sector and the privatisation of the NEC is to reduce the financial burden of this sector on the state budget and to improve its contribution in the social and economic development of the country. The reform is characterised by regulatory measures that would encourage private participation in electricity sector development and would enable this sector to recover its costs and contribute to its future investment needs. It aims at attracting investments, increasing efficiency in the supply, and improving reliability and performance of the electricity sector, increasing access of the population to electricity, and holding electricity tariffs within reasonable and competitive limits.

5.2 Options and prospects

Given the above reviewed shortcomings, the government was faced with the challenge of setting a realistic framework whereby increased access to electric services can be achieved and adequate, sustainable, socially acceptable and environment-friendly energy provided at acceptable costs to meet the needs of people and to

boost economic growth. The reform rests on the "law no 98/022 of the 24th December 1998 regulating the electricity sector". This act has further been completed, among others, by the "Decree no 2000/464/PM of the 30th June 2000 regulating electricity sector activities". Following are the key features of the reform:

- ***Stimulation of capital flows and channelling of technology requisite to develop energy resources and expand the electricity sector***

By deregulating the sector and privatising the NEC, the government seeks to send a signal to foreign investors, capital markets and the local population that it is committed to market-led policies and, in particular, to private participation. This could stimulate private sector investments to meet the investment requirements needed to expand the electricity sector.

The government also expects that private electricity projects would give the country access to new technologies and management expertise needed to efficiently run the electricity sector.

- ***Minimisation of government interference***

The reform has fundamentally changed the role of the government in the electricity sector. It no longer has the role of the direct operator in electricity generation and supply, but is rather becoming the setter of the legal and regulatory framework in which private sector enterprises are the energy suppliers. Under the new legal environment, the electricity tariff will no longer be set by the government but by the suppliers. However, the government will continue to deal with major energy-related policy issues, which include environmental protection, safety, energy availability and accessibility, energy poverty alleviation issues, as well as co-ordination between the actors.

Under the restructured electricity sector, most of the previously fragmented policy and co-ordinating powers have been concentrated within the Ministry of Mines, Water Resources and Energy.

An independent regulatory agency was created with the responsibility to enforce the regulation, to promote competition in the sector, to ensure the economic and the financial viability of the electricity sector, and to guarantee the interests of electricity suppliers and consumers.

The option taken by the government to create an independent regulatory body constitutes another strong signal to investors that it is committed to respecting the rules of the game.

Promoting private sector participation is seen as a means of reducing the cost and institutional burden placed on the government by rural electrification programmes. Private participation in the utility is expected to increase profitability and autonomy. The private sector should also be able to respond faster to shortages in the supplies, and it may be able to construct new plant faster than the public sector (once the necessary approvals are in place). In addition, the private sector offers the possibility of developing small projects that are viewed as too small by the public utility.

- ***Creation of a specific rural electrification agency***

Given the low access to electricity and the fact that market mechanisms are not always efficient in ensuring that all energy needs are met, a specific agency responsible for promoting the development of rural electrification was also created, in support of the policy of the government to combat poverty all over the country and specifically in rural areas. Among other things, this agency has been assigned the mission to mobilise funding and to develop local capability (within rural community organisations and local businessmen) to establish, operate and manage small scale decentralised rural electrification systems.

- ***Promotion of commercial profitability and encouragement of private power generation and supply***

The basic preconditions needed for the utility to pursue its commercial objective and for independent power producers (IPPs) involvement in electricity generation have been included in the new legal and regulatory environment. The new regulatory framework provides clear policy directives to promote commercial profitability, encourage private power generation and supply, and give the utility's management the requisite mandate and powers to achieve its commercial objective. It allows for the establishment of clear licensing of IPPs, protection against changes in taxes and duties, indexing of power purchase terms to protect against inflation and exchange rate changes, guaranteed convertibility of currency, etc.

- ***Establishment of transparent procedures for granting concessions and IPP licenses***

Under the new legal framework, the set of rules and the criteria for handling concessionaires and IPP proposals are clear and transparent.

- ***Promotion of non-utility power generation and supply***

Under the former electricity act of 1982, although self-power generation was authorised, self-electricity generators did not have the right to distribute (that is, to sell) electricity to consumers

or to the NEC. Thus, those self-power generators which are mainly wood and agricultural based industries located in remote areas that had established substantial installed capacity could not distribute their surpluses to the neighbouring population. This drawback has been corrected in the new legal framework by providing any electricity producers other than the utility with the right to distribute electricity in areas out of the utility acting perimeter and to sell power to the utility. This provision is specifically intended to increase access to electricity supplies in areas which would otherwise not be able to be electrified within a reasonable delay. However, these legal provisions need to be backed with adequate policy instruments, such as credit schemes or tax preferences, to produce sizeable impacts on rural electrification.

Simplified procurement procedures for off-grid electrification projects

Under the new legal and regulatory framework, procurement procedures for off-grid electrification (this means electrification of all villages outside the incumbent utility's concession) have been simplified. All operators interested in supplying electricity in remote areas or areas outside the utility's concession are only bound to an authorisation involving limited administrative procedures and obligations , as against relatively complex procedures of tendering for concessions and licenses to establish and exploit larger generation and supply activities. This provision is particularly intended to favour the development of decentralised rural electrification using small-scale technologies such as solar photovoltaic systems, small hydroelectric systems, small diesel units, etc.

- ***Introduction of competition to stimulate the provision of energy to domestic consumers and industries at reasonable tariffs***

Two types of competition have been introduced in order to maximise the market forces in the power sector: competition *for* the market that involves competitive bidding for concessions and licenses and competition *in* the market that provides large customers with the right to switch from on supplier to another.

For this purpose, third-party access to the transmission networks is allowed to eligible customers (mainly industrial customers) whose consumption is above a certain level, to purchase their power directly from IPPs. However, this market-opening process is bound to the protection of the utility's interest and will be implemented gradually. Hence, the threshold to be considered an eligible customer, presently set at 1 MW, is subject to changes in accordance with demand conditions.

As regards electricity tariffs and the quality of service, the government expects that cost reductions as a result of the introduction of new technologies and improvement in the management by private operators and the new competitive environment will allow for reasonable tariffs and better quality of service to consumers.

6 On-going rural electrification initiatives

6.1 The Rural Electrification Master Plan

In respect of the low access to electricity in the country and of the various constraints faced by rural electrification programmes, as part of the national sustainable development policy and strategy to combat poverty, in the beginning of year 2000, the government of Cameroon with the assistance of the African Development Bank (ADB), engaged in a Rural Electrification Master Plan. This plan which has not yet been completed, seeks:

- in the first phase, to gather information on the real situation of the regions to be electrified, starting with an inventory of rural development targets and local power generating resources up to establishing of the reference costs;
- in the second phase, to determine the long term target plan, the optimum electricity supply programme which consists of various solutions combining decentralised, isolated, grouped or interconnected productions which are stable in all demand and costs scenarios;
- in the last phase, to develop a sequential dynamic master plan which guarantees the division of the electrification programme in successive sequences, satisfying the strategic targets of rural development as well as minimising the costs while managing the available financial resources.

The Rural Electrification Master Plan is also expected to establish technical standards and design criteria that are appropriate for the level and quality of service needed for rural electrification and to propose sound institutional and financial mechanisms for the allocation of investment and recurrent costs to the parties involved (government, rural electrification recipients, non-rural electrification consumers, etc).

6.2 Other initiatives

Since 1998, the government of Cameroon, with the support of the World Bank, has been carrying out studies to establish a financial

mechanism to help develop decentralised electrification in rural areas by local businessmen, grassroots organisation, co-operatives, etc. Another such proposal has recently been received from the Agence Française de Developpement (AFD).

In addition, in support of the government strategy to boost rural electrification and combat poverty through the encouragement of the development of decentralised electrification schemes in the country, the government of Japan has funded the feasibility studies and the establishment of business plans for the development of three small-scale hydro power plants in rural areas in Cameroon. The preliminary studies have been completed and the development phase is to start soon.

7 Ensuring access in rural areas

Notwithstanding the efforts achieved so far, more input is required to increase access to electricity to the rural population. Ensuring widespread access to electricity in rural areas requires efforts from internal sources as well as from the community of donors. Following are some suggestions for consideration by decision-makers and rural electrification actors:

- Electricity is critical to the improvement of healthcare services, water, education, and many other key aspects of welfare, and there is evidence that grid-based electrification alone will not meet the challenge of providing minimum energy services to allow the rural population to achieve a decent standard of living. Hence, the decision-makers should recognise that the provision of modern, reliable and affordable electricity supply can also operationally rely on other sources of energy which are not necessarily grid-based, such as stand-alone energy sources, renewable energy sources and other forms of distributed generation.
- The promotion of the use of electricity: in grid-connected rural areas, many people believe that electricity is extremely expensive and are afraid to use it once they have a supply. Electricity can be extremely good value for money in many uses. Even if there is high unit charge, promotion of the use of electricity could be done in various ways, for example, through demonstrations of appliances and equipment, distribution of leaflets showing the cost of using different appliances in the home (as has been done lately by the NEC). As well, appliances could be sold on interest-free loans or easy credit terms to encourage their wider use.
- The promotion of renewable and decentralised electrification technologies in rural areas to overcome the current perception that grid electricity is the only viable solution to bringing electricity to rural communities, by the provision of public information on these technologies and their uses to enhance users' confidence. The centralised electricity option is well established in Cameroon and enjoys political and institutional backing. In rural areas, whenever decentralised electrification technologies are submitted for appraisal by communities , there is a strong belief that 'it's just a way to divert people from the real thing', namely grid electricity. Rural population do not always associate these technologies, particularly renewable ones, with the environmental and social benefits that they produce.
- The priority recourse should be to labour- and local input-intensive technologies, reduction of high maintenance components where possible, not simply adoption of donors' or urban electrification standards. As it has been demonstrated in other countries where renewable technologies have worked best, reliance has been on commercially proven technology and has involved technology adaptation to local conditions. For example, recently in Cameroon, in their bid to find solutions to their energy needs, a few local private businesses and rural communities have developed small hydro-power schemes, operated either on community or private management basis to power their activities and to provide lighting to rural households. An example of such schemes is the small hydro power plant of Bapi, a village located in the west province of the country. This plant, completely built by local entrepreneurs with local material, was built with the technical and financial assistance of the Institut de l'Energie et de l'Environnement de la Francophonie (IEPF), an Implementing Agency of the Organisation Internationale de la Francophonie. Similarly in Nepal, firms that manufactured traditional water-driven grindings wheels have converted production to modern and efficient designs. Use of local designs, materials, and fabrication were the primary factor in holding down costs to an affordable level. Similarly, the successful experience of the Kijito wind machine in Kenya also illustrates the need for support systems. In this case, a local entrepreneur was provided with a technology design and continuing technical assistance. He was able to market independently with reliable equipment which he then backed by a service

guarantee. The choice of an entrepreneur with sufficient capital, a reputation for service, and good technical capability was a key factor. (Ashworth, 1985 and AID, 1984).

- Donors should also initiate specific programmes to transfer the technology for the development of local capability to manufacture and maintain equipment to utilise local sources of energy such as small hydro resources either as specific programmes or as an integral part of rural electrification programme packages.
- There should be the establishment and the promotion of sound and sufficient financing schemes in support of the development of renewable decentralised rural electrification technologies by the government, with the support of donors and financial institutions. As was mentioned earlier, conventional financing schemes are often not adapted to deal with decentralised power systems.
- Simplification of implementation procedures and promotion of the instruments established by donors and designed to meet the needs of renewable decentralised energy technologies are needed: although some financial tools have been established by donors, availing of these funding opportunities is often constrained by lack of information, and the lengthy and complex procedures and project cycles adopted by the implementing agencies. These financing schemes should also take into account the need to meet basic requirements of low-income consumers, which may include subsidising part of the fixed costs.
- Owing to the limited paying capacity of low-income consumers, a systematic policy for the promotion of rational use of electricity should be included in rural electrification programmes. This may include some subsidy, or interest-free loans or easy credit terms to accelerate the penetration of efficient electric appliances.
- Credit policies should be designed and implemented to encourage rural co-operatives, municipalities and local businessmen (including self-power-generating enterprises) wishing to develop their own power supply or to sell their power surpluses to surrounding population, rural enterprises wishing to expand or purchase new and efficient energy equipment and households for either initial hook-up or efficient electric appliances.
- Import and tax privileges should be provided to non-utility electricity providers and suppliers of electricity-using devices, especially if intended for productive uses, and efficient appliances: they should enjoy reduced taxes and custom duties.
- Individual decentralised power projects should be incorporated into broad programmes, both for economies of scale in planning, design, equipment and associated technical services, and to provide better organisational or manpower development support.
- Recipients must participate in project cycles from design to implementation: the task should not simply be to bring electricity supply to the rural areas, but to ensure that rural populations are involved in the planning and implementation of programmes and are encouraged to use electricity in ways which are beneficial for them. Project staff should therefore be able to communicate with the rural population.

8 Conclusion

As has been presented above, rural electrification reform in Cameroon was part of the overall reform of the electricity sector. It is yet to early to make any judgement on the outcome of the measures taken by the government of Cameroon. However, as the backbone of the reform was the introduction of market forces in the electricity sector, much still has to be done for the provision of reliable and affordable energy services to all. In the context of reliance on market forces, complementary policies and strategies or policy instruments specifically targeted to meeting the needs of the poor need to be established. The establishment of an appropriate financing mechanism and tax and import duty-based instruments to help develop decentralised rural electrification and to promote rational and productive utilisation energy should play a key role in this prospect.

References

AID Bureau for Africa (1984), Renewable Energy Technologies in Africa, Washington, D.C. April 1984, p. B-5.

Foley, G. (1992), Alternative Institutional Approaches to Rural Electrification, in Saunier, G.(1992), *Rural Electrification Guidebook for Asia and the Pacific*, Bangkok, Thailand, 1992.

John H. Ashworth (1985), Renewable Energy Systems Installed in Asia, Burlington, Vermont: Associates for Rural Development, Inc., 1985, pp. 5-1 to 5-15.

Ramani, K.V. (1992), Rural Electrification and Rural Development, in Saunier, G. (1992), *Rural Electrification Guidebook for Asia and the Pacific*, Bangkok, Thailand, 1992.

République du Cameroun, Ministère des Mines, de l'Eau et de l'Energie (1990), Projet de Politique et de Plan Energétiques pour le Cameroun.

République du Cameroun, Loi n° 98/022 du 24 décembre 1998 régissant le secteur de l'électricité.

République du Cameroun, Décret n° 2000/464/PM du 30 juin 2000 régissant les activités du secteur de l'électricité.

Saunier, G. (1992), *Rural Electrification Guidebook for Asia and the Pacific*, Bangkok, Thailand, 1992.

The South African non-grid programme process

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1. Introduction

A concerted effort to extend the grid to the poor majority began in South Africa in 1991. Upon coming to power in 1994, the African National Congress government, through the Reconstruction and Development Programme, highlighted its commitment to increase access to electricity to previously disadvantaged populations. The target was to connect 2.5 million homes from 1994-1999 (RDP 1994). This target was surpassed. By the end of 1999 about two thirds of households in South Africa had access to grid electricity (DME 2000), compared to an estimated 44% (40% of the population)[1] at the end of 1994 (Thom et al 1995). However, electrification in the rural areas still lags far behind, with only 46% of houses electrified at the end of 1999 (NER 2000).

The South African government has committed ZAR86 million[2] of the 2001 fiscal budget to subsidies in the rural non-grid electrification programme in an effort to increase the level of electrification and achieve the goal of universal access.[3] The programme plans to supply approximately 30 000 houses with solar home systems in 2001, all of which will be in rural areas. Electrification during the Reconstruction and Development Programme was mainly via grid connections in urban areas. The majority of the unconnected are in areas where grid extension is uneconomical, and the subsidies will improve the competitiveness of non-grid electrification and hence widen the reach to the grid-marginalised rural communities. Government support for this approach is indicated by the inclusion of this year's non-grid connections in the national electrification programme projections.[4]

As the clock ticks by, it remains unclear whether the year 2000 non-grid targets will be realised. The original plan was to give rural concession areas to private entrepreneurs, who would receive capital subsidies over a limited period, to electrify the areas using non-grid technologies. As discussed in this paper, this thinking has somewhat shifted.

In early 1999 the Department of Minerals and Energy (DME) called for tenders for rural electrification via solar technologies. The call noted that the winners would be selected based on their technical and financial competence. Despite the fact that there was not much information provided on what was being offered,[5] the magnitude of the response was unexpectedly overwhelming: 28 proposals were submitted, six of which were selected. Although the general areas to be electrified had been identified, the criteria on which awards were made had not been established. The preliminary business plans presented to the DME were thus quite theoretical and largely assumptive, as they were not based on specific areas. With the establishment of the National Electrification Co-ordinating Committee (NECC), the process was incorporated into its activities. DME, in consultation with the NECC, expects more comprehensive and realistic business plans, on the basis of which it will set subsidy levels, once the implementation phase of the programme starts. The broad target areas are Northern province, Kwazulu Natal and Eastern Cape, and the programme goal is to electrify

1 South Africa's population was about 46 million in 1999.

2 In 1999 ZAR64 had been pledged but never used. In August 2000 the National Electricity Regulator (NER) pledged an additional ZAR20 million for electrification via mini-grids.

3 The Energy White Paper (1998) stipulates achieving universal household access to electricity as a government objective.

4 NER, July 2000 Electricity Regulatory Journal provides the year 2000 electrification targets.23000 of the total 403000 connections will be via non-grid PV systems.

5 For example, the subsidy levels had not been disclosed.

250 000 households within three years. The DME tender was preceded by the initiation of a project in Eastern Cape by the Eskom-Shell Joint Venture in 1998, aiming to electrify 50 000 rural households with solar home systems within five years. The launch of this project was highly publicised and politicised, and this may have influenced the schedule of the DME's non-grid programme. Pressure from various interest groups, including political ones, has been – and is still – instrumental in the programme's pace.

Implementation of the new non-grid electrification programme was planned to commence in June 1999. This is however yet to happen. Except for the Eskom-Shell Programme, which has since the end of 1999 supplied solar home systems to approximately 6000 households, there is no other large-scale non-grid project in operation. No concessionaires are likely to start work in 2000. Over the past year or so, various stakeholders through the NECC have been involved in activities aimed at gearing the implementation to a start. This work presents the authors' interpretation of the occurrences and how these may have influenced the process.

2. Rationale for the utility route

The provision of services to a large number of people in South Africa is conventionally done via public or privately owned utilities. It was thus envisaged that the difficulties of planning, funding, maintenance and affordability pertaining to the large-scale dissemination of solar home systems could be overcome by following a similar route. The utility will procure, install, maintain and own systems and sell a service to end-users at an appropriate monthly tariff. The utility route would thus ensure low costs through bulk buying where necessary, carry the hardware as assets, which should facilitate access to bulk financing from financial institutions, and engage the local authorities. Efficiency associated with private industry participation would thus enable accelerated provision of services to the majority yet to be electrified.

While households are the primary consideration, it is expected that the utilities will integrate all local and regional electrification requirements within their areas of operation, including community facilities like schools and clinics. In recognition of the deficiencies of solar home systems in meeting all energy needs, service providers are required to also provide access to thermal fuels such as illuminating paraffin and LP gas in their areas of operation so as to cater for cooking and water heating needs.

3 The stakeholders and institutional developments

Discussions on implementing the non-grid electrification programme have been ongoing among stakeholders for over a year. The stakeholders have been represented as affiliated groups as well as individual entities. They include the DME, National Electricity Regulator (NER), (the Non-Grid Task team is one of the four NECC task teams, the others being Strategy Task Team, Fund and Levy Task Team and the Planning Task Team), Eskom, Development Bank of Southern Africa (DBSA), the concessionaires, and local authorities.[6] What do these groups have at stake and how have they interacted with the process?

3.1 The DME, NER and SALGA

The idea of rural electrification via non-grid concessions emerged within the DME, and the department has led the non-grid programme development process. The national electrification strategy, as developed by DME, provides for the full integration of the grid and non-grid technologies into a single electrification programme, as complementary supply options. The rationale for supporting the programme was electrifying more people through levelling the playing field between non-grid and grid technologies. In addition, there was a school of thought that believed that enabling private entrepreneurs to enter areas normally shunned by investors because of their high risk status would increase investor confidence in general and attract investment-creating, income-generating opportunities.

The DME has the overall responsibility for developing policy, strategies and guidelines that will facilitate the implementation of the programme and overseeing its implementation. One of its important direct responsibilities is to create a conducive investment environment, which involves developing the regulatory framework within which the programme will operate.

The NER is the agent responsible for regulating electricity nationally. Amongst other things, the Regulator is responsible for establishing electrification and service authority licensing conditions. Legally it would appear that, since the concessionaires do not need a license to operate,[7] they would be beyond the Regulator's reach, although the fact that the programme will

[6] So far Durban Metro is the only municipality has expressed interest in being active players. Other local authorities may not have the capacity to engage effectively.

[7] Section 6(1) of the Electricity Act denotes that a supply license is only required if sales exceed 5 GWh per annum.

use public funds is a central argument to support the NER's involvement. In addition, the novelty of the approach, as well as the technologies used, demand attention for regulation. Regulation will also ensure harmonisation between the grid and non-grid technologies. In the absence of an appropriate government agency to administer the subsidies, the NER seems best positioned for this role. Currently it is administrating the electrification fund earmarked for use by municipalities mainly for similar purposes, although the consolidated electrification fund will most likely not be administered by the NER in the future.

The South African Local Government Association (SALGA) was launched in November 1996 as a body that would represent the interests of various local governments. In line with this, SALGA has interests in electrification, especially since the electrification approach could potentially affect the roles of local authorities and revenue accruing to municipalities. One of the ways of safeguarding these interests has been through representation in the National Electrification Coordinating Committee and the non-grid task team.

3.2 The non-grid task team and its dynamics

The NECC was formed in April 1999. Its main objective is to integrate electrification with other development initiatives in order to maximise the benefits for the communities earmarked for electrification. As part of their mandate, the NECC advises the Minister of Minerals and Energy on issues such as facilitation of the integration of grid and non-grid electrification with other infrastructure development activities.

In order to carry out its work efficiently, the NECC formed a number of task teams which comprise technical people. The Non-Grid Task Team is one such team that meets at least twice a month to deliberate on issues and make recommendations to the NECC. The NECC is comprised of a number of stakeholders that have either direct or indirect interest in electrification issues (some of those stakeholders are discussed below).

The Non-Grid Task Team was constituted by the NECC in August 1999, with the mandate to advise this committee on facilitating implementation of the non-grid programme. The team's membership is drawn from DME (the chair), SALGA, Eskom, NER and the Development Bank of South Africa. The team has been having regular meetings to discuss progress and problems, and to map the way forward for the programme's implementation. Initial meetings were limited to the team members, but later on researchers were invited to make relevant presentations on the proposed regulatory framework and contractual agreements. The first meeting attended by researchers was held in 19th January 2000. A recent and notable development was the extension of the invitation to include concessionaires to attend part of a meeting held on 26th July 2000. Some important events appear to have motivated this change from the traditionally exclusive to an inclusive approach into government policy forums.

Since the beginning of this year, the concessionaires have significantly increased their efforts and level of involvement and actively embarked on initiatives to help speed up the process. They have provided timely written feedback on the contractual agreement drafts. They have drafted some add-on issues focusing on the areas where there were deadlocks, such as a 'proposal on compensation in case grid comes'. The most visible effort was organising a meeting of stakeholders to discuss the problematic issues in the contracts, to which members of the non-grid task team were invited. The mood and trend of discussions at that meeting were evidence that the stakeholders had more in common than they had differences. The fact that the concessionaires supported having Eskom as a concendante meant that the issue was now of modalities rather than approaches. Key issues, especially those needing to be addressed by Eskom, were thrashed out at the meeting and on most issues there was a high level of agreement. The Eskom representative was tasked with consulting with the company's strategic board and providing blueprints on most of these issues at the Non-Grid Task Team meeting. Thus, it would seem that it would certainly be more efficient and effective to have concessionaires present at this meeting. However this seems to have been a once-off arrangement, as concessionaires were not invited to subsequent meetings.

3.3 Eskom

Eskom is the principal electricity generator, transmitter and distributor in the country. The utility is being corporatised and split into different entities, and in the meantime a holding company is being proposed to manage the transition. Eskom's core business has been grid electrification. Its involvement in non-grid electrification has been limited to institutional programmes, mainly schools and clinics.

In 1999 Eskom formed a joint venture with Shell South Africa to undertake rural electrification with solar home systems in Eastern Cape, which so far has installed approximately 6 000 systems. However, at the onset of the non-grid rural electrification programme, Eskom did not express particular interest in further involvement. Almost a year after the programme was launched, Eskom's stance seems to have changed

and the utility has been persuaded to participate as the party contracting concessionaires, because it is assumed it holds licences for most of these areas, as they are rural. For those rural areas that they do not have licenses, the NER will issue Eskom with licences to implement non-grid electrification. This role would ideally have been undertaken by local authorities. One of the main concerns among the concessionaires has been the threat of penetration of grid into the concession areas without ample warning and thus negatively affecting the commercial viability of the project. Having Eskom involved helps to remove this threat.

3.4 The concessionaires and their activities

The programme attracted both national and international companies, most of who have had no experience in non-grid concessions. All six concessionaires are consortiums; BP SA-Emtateni-Eskom,[8] Solar Vision and Partners, Renewable Energy Africa and Partners, Electricité de France-Total, Spescom,[9] and NUON-RAPS.

The interest of private investors in rural non-grid electrification, an area that would normally be considered highly risky and unattractive to profit seekers, has raised some speculation among sceptics. Questions about whether the concessionaires have hidden motives or if there is more market-related information than is publicly available are being asked. Are the concessionaires enticed by the capital subsidies which have been rumoured to be in the order of approximately 85%? It has been mooted that the concessionaires are rather strategically positioning themselves to venture into the more profitable area of grid-electrification in the future. Notwithstanding, as investors obviously motivated by seeking a profit, the concessionaires have been rather patient. Notably, for all the concessionaires, this is only one of their multiple business ventures and obviously not the most financially important one.

After winning the tenders, the concessionaires had undoubtedly expected to soon embark on implementation. However, though the concessionaires were selected and announced by May 1999, they have not formally entered into any contract with DME or any other relevant body, and hence the terms of appointment remain unclear. Whether the concessionaires will eventually be able to fulfil the obligations laid out in such a contract is subject to debate. Since they were selected the basic thinking on the programme's institutional structure and implementation plan has shifted significantly. Although, the concessionaires may have kept abreast with the developments, it is questionable whether the terms on which they were selected still apply, and hence if they still qualify to meet the terms that are eventually adopted.

Eskom Distribution and Durban Metro Electricity have subsequently formally agreed to include non-grid in their supply options and to jointly act as 'concedante' to the selected consortia in their respective distribution licence areas. Eskom will be granted a licence by the NER, before the end of 2000, to provide non-grid electrification in suitable demarcated areas, with Eskom's preference being to act as an agent for the DME in this matter. Eskom will thus enter into an agency agreement with DME. In anticipation of the above, Eskom has undertaken to set aside the non-grid areas as specified in previous agreements between DME and the concessionaires. Eskom will thus enter into a Memorandum of Understanding with concessionaires based on their business plans. It is expected that the Memorandum will be signed before the business plans are presented to the NER on 15 January 2001.

Another dimension has been added to the concession program. The German government, through the German Development Bank, KfW, has donated DM31 million to finance non-grid electrification in the Eastern Cape Province. The delegation from KfW appraising the non-grid electrification project expressed concern regarding the financial viability of the area identified. In response, DME agreed to extend the area to a second province, North West Province.

4. Implementing the programme-contractual agreements development process

When DME published the call for tenders for rural electrification in April 1999, little had been done towards designing a regulatory framework to enable implementation of the programme. The six consortia winning the tenders were selected within the same month. The plan was to have them start implementation in June 1999, but it soon became evident that procedures and regulations on some principal issues needed to be formulated before the project could begin. The modalities of subsidy provision, allocation of concession areas and terms under which the concessionaires would operate were some of the preliminary aspects that had to be defined. The

[8] This concessionaire consortium has since withdrawn.

[9] Spescom has since withdrawn mainly because the main area that had been identified for non-grid which they were to operate in received international funding for grid electrification.

institutional structure within which the programme would operate had not been sufficiently mapped out. Involvement, roles and capabilities of key stakeholders such as local authorities and to a lesser extent Eskom, had not been adequately explored. Discussions among stakeholders raised critical unanswered questions.

Some of the main questions and grey areas relating directly to the concessions were: Who would be responsible for ensuring that the concessionaires deliver? Were the concessionaires capable of delivering? Who would administer subsidies? What would be the level of subsidies? Should the technologies be restricted? How long should the contractual agreements last? What would be the size of concession areas? What would happen if grid came to the concession area? To whom do the assets belong – government, concessionaires or customers?

There have been other overarching concerns: Should rural communities be electrified with small-scale DC solar systems or should the subsidies be provided to extend grid to these areas? Would non-grid electrification jeopardise the chances of these communities getting grid? Should public funds be used to support private entrepreneurs whose objective is to make profits?

The best-articulated and comprehensive concerns emanated from SALGA in the form of a letter to DME in December 1999. The main issues raised by SALGA related to the contract period, the implications of expected regional demarcation, grid extension into the concession areas, ownership of assets, regulatory framework, choice of delivery mode and uniformity in service provision. As a member of the Non-Grid Task Team, it is unclear why SALGA had not expressed its concerns sooner. However, SALGAs approach had the effect of slowing down the process. In response to SALGA's concerns, the efforts to implement the programme intensified, particularly through increased forums for discussion. The concessionaires, who had up till then been relatively passive recipients awaiting direction from DME, started being more proactive and engaging more with the process.

The emergence of concerns, the content, and the response by DME raised the issue of DME's preparedness for implementation of the programme. The paths that can be adopted in the non-grid programme are varied and promise different outcomes in terms of level and quality of service, efficiency of investments and sustainability of the initiative. In view of this, background studies and analysis, especially on the short- and long-term implications of various scenarios should have been done. From the identified options, the most acceptable path would have been selected. An immediate and important outcome of SALGA's concerns was that they highlighted the need for developing contractual agreements between concessionaires and relevant government agencies as a basis for solutions to these concerns. Previously DBSA had been requested to draw up a concession agreement, and had submitted a draft for comment to the Non-Grid Task Team in July 1999. However little progress had been made. The Energy and Development Research Centre (EDRC), a not-for-profit research institution, had in the last quarter of 1999 secured funding from the Shell Foundation for monitoring and evaluation the concession programme. EDRC was requested to develop the contractual agreements using a share of these funds. The process of designing these agreements was long, very interactive and dynamic. The contracts provided a basis for progressive discussions and an outlet for a process which had appeared deadlocked. Changes to the original drafts have been extensive, both in content and format. The most important, interesting and perhaps quite thought provoking changes were

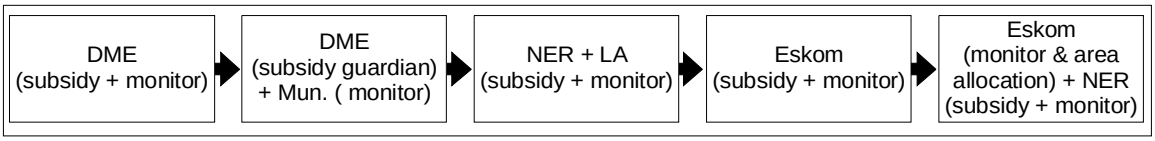

Figure 1: The evolution of contracting parties

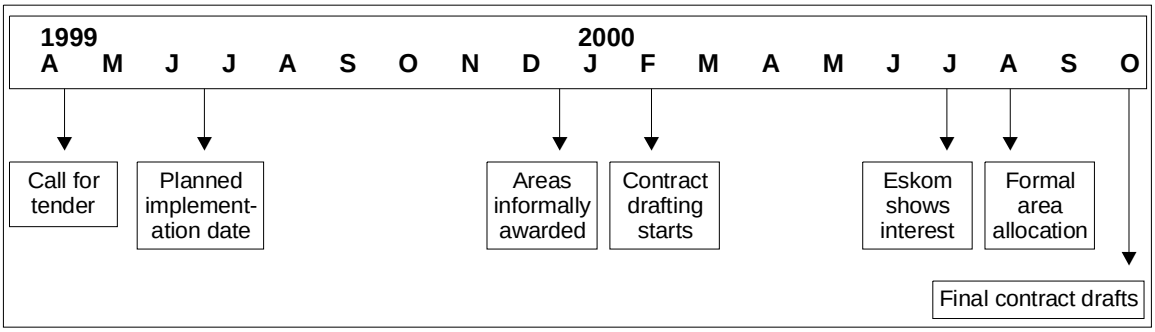

Figure 2: Key aspects of the process to date

on the parties to the agreements. This evolution is presented in Figure 1. Also notable has been the shift in thinking on the types of agreements needed.

When the idea of having concessions for non-grid electrification started unfolding, it was envisaged that the concessionaires would enter into one contractual agreement with local authorities covering both subsidy administration and service provision. The assumption was that DME would be the guardian for the subsidies, which it would periodically transfer to the local authorities, who would in turn distribute it to the concessionaires. In this case it was deemed that there would be no need for a contractual agreement between DME and local authorities. The local authorities would be responsible for ensuring that the concessionaires meet electrification obligations. The rationale behind this was that local authorities have the constitutional right to provide services to their subjects. However, it was noted that the DME does not have the capacity to administer subsidies. In addition, such activities could potentially hinder the DME from effectively performing in its principal mandate of overseeing energy policy development and implementation on a national level, as there would be possibilities for conflict of interest. On the other hand, SALGA raised concern about the lack of capacity in local authorities to undertake the duties expected of them.

It was thus proposed that the NER undertake the role of handling both the subsidy issues and also service issues in those areas where local authorities lacked the capacity to operationalise the concessions. As such, two contractual agreements were developed: one on subsidies and the other on service provision – otherwise referred to as 'concession contract'. The fact that the NER has been involved in administration of the electrification fund in the absence of a legitimate body was seen as placing it in a technically favourable position to administer the subsidies. However some felt that such a role would be in conflict with the regulatory duties of the NER. In addition, although ensuring that electricity providers adhere to agreements is one of the main functions of the NER, there were some reservations about its ability to effectively monitor the dispersed concessions with its current limited capacity. Arguably, presently the NER does not have the necessary networks in the rural areas which could be drawn upon to conduct such monitoring activities. Ways in which the NER could serve this role without there being a conflict of interest were explored. Having it act as an agent for local authorities seemed to be the most acceptable option. The contractual agreements were thus modified to incorporate the NER.

While the discussions on the adoption of the NER as the concendante were underway, SALGA was engaged in discussions with Eskom with the intention of persuading it to jointly (with SALGA) provide electricity to the rural areas.

Hence, in the next proposal Eskom was proposed as the concendante, whereby Eskom would receive subsidies from government and disburse these to the concessionaires upon proof of adequate performance. Thus Eskom would enter into a subsidy agreement and a concession agreement with the concessionaire. Eskom would also be responsible for monitoring the process and ensuring that goals are met – for example, that the number of customers connected are as per agreement. Such an arrangement would effectively mean that Eskom would evaluate and approve the concessionaires' business plans. This arrangement threatens to nullify the selection of the concessionaires by the DME. As a potential competitor with the concessionaires, access to confidential business plan information would also place Eskom in an advantaged position at the expense of the concessionaires. Eskom is already providing non-grid electricity in one of the areas and would be interested in extending this service to other areas, and could use the concessionaire's business plans as a basis for developing a more competitive plan. This potential conflict was resolved through a compromise which unbundled the functions of the concendante into commercially sensitive and general monitoring roles. Eskom would undertake the later and NER the former.

With Eskom coming on board, the idea of concessions as originally envisioned has changed. Initially, the zoning approach, whereby service providers would be given 'areas of operation', was to be used. In this case, the service providers would be responsible for serving all the customers. Eskom has instead stated that the non-grid service providers will operate in 'permission areas' which will exist within a concession area where Eskom will provide grid where viable. The contracts are yet to be finalised, as Eskom has to commit itself to a particular approach. Apparently it is waiting for the go-ahead signal from the government since the utility views its role as that of an agent acting on behalf of the government. Figure 2 presents the key aspects of the process until November, 2000.[10]

[10] All the finalised documents such as Regulatory Framework, Business Plans directive, Claim Procedure and Concedante/Concessionaire Agreement for non-grid electrification are obtainable from the NER website at www.ner.org.za.

5. Allocating the concessions

Though the tendering companies were expected to follow the concession model, the initial call for tenders did not invite entrepreneurs to submit their proposals based on specific areas. This either assumes similarity in level of effort and expertise needed across regions or high flexibility of the entrepreneurs should the areas turn out to be different from what their preliminary analysis revealed. It may, however, also be an indication of the DME's flexibility in allowing the selected companies to modify their approaches or in shifting its goals.

The concession areas were not allocated until mid December 1999, and then only informally. Eager to at least start some preliminary analysis of the concession areas, the concessionaires urged the DME to allocate the areas, but it had not developed criteria for this process. Caught unawares, it sought to follow a transparent all-inclusive process whereby all the concessionaires participated in the decision making process, which culminated in a meeting. While the concessionaires may not have anticipated such an approach, it was apparent they had discussed the allocations themselves and this proved quite worthwhile. The allocations fitted their wishes. However, this allocation was informal, awaiting acknowledgement by the NECC. The formalisation of the concession areas only occurred in October 2000, and with significant changes from the original pattern.

The inclusion of the Durban Metro municipality as a local authority capable of implementing the programme threatened to upset the allocation of concessions. After expressing its wish to implement the programme, the municipality started informal negotiations with some of the concessionaires. However, it was later noted that its area of jurisdiction fell within an area already allocated to a different concessionaire. This issue was temporarily resolved without changes to the original allocation pattern. Durban Metro later met with the concerned concessionaires. At the meeting the municipality was encouraged to select one concessionaire but it chose not to.

6. Gender in non-grid programme

The non-grid programme has so far not directly addressed any gender and energy dynamics. The main stakeholders are mainly men; none of the concessionaires is managed or owned by women. Notably, some of the decision makers in DME are women. From an access to electricity perspective, women are likely to constitute majority customers. It is unclear whether the concessionaires will design gender-differentiated strategies in electricity provision to facilitate gender equity. There are no policies in place requiring such an approach.

7. Implications for renewables

The problems encountered in the non-grid programme raise important questions for the renewable energy sector. Globally, promotion of renewable energy technologies as potential strategies to reduce greenhouse gas emissions is receiving increasing attention. For those intimately involved in these technologies, a successful project amidst many failed initiatives would be useful in promoting a cause. Levelling of playing fields between grid and non-grid electrification has been on the agendas of various governments for a long time, but few governments have translated them into implementable action plans and fewer still have attempted to implement the action plans. The stagnation facing the implementation of the non-grid programme in South Africa should not be interpreted as a problem with renewable energy technologies or even as a problem with the off-grid utility type approach, but should rather be seen as an institutional encumbrance. A comment from the chairperson of the Energy Intensive User's Group indicates that non-grid programme experience might have hurt the possibilities for getting subsidies for the electricity sector from industry (NER 2000). On the other hand, the relatively large investments by the German government into this programme provide a more promising signal.

8. Some lessons and conclusions

It is almost two years since the process of integrating grid with non-grid electrification commenced. Notwithstanding the fact that the programme is yet to start, the experience gained so far can provide useful lessons for future initiatives. It is hoped that the implementation process would start in early 2001. The experience gained by the Eskom-Shell joint venture that started operating two years ago will be worthwhile.

From the process, it is evident that the novelty of the non-grid concession electrification approach warranted a higher level of preparedness than was achieved. Nevertheless, the importance of initiating the programme, and in particular supporting non-grid electrification, and the progressive approach adopted by DME, must be recognised.

The attitude adopted by the stakeholders in the face of bottlenecks was generally optimistic and solution-oriented. The difficulties in the programme led to an interactive process among the stakeholders and this has resulted in the development of relatively close public-private relations.

In an environment where public-private partnerships are viewed as the route to prosperity, this development is definitely a positive outcome.

Clearly, the importance of developing a regulatory framework prior to commencing a relatively new programme cannot be overstated. Extensive consultations with the stakeholders should also be done and in a timely fashion. During the project planning stage, adequate time and resources should be allocated to research, especially on key determining elements of the project. This programme has demonstrated the importance of smart relationships between research community and policy makers and implementers. Energy programmes can benefit ignorantly through partnerships between planners, policy makers and research institutions.

Levelling the playing field between grid and off-grid electrification is a challenge that requires long term commitment from the interested parties. A consultative and participatory approach starting at the commencement of the process and involving all the stakeholders is necessary for realising intended goals. This approach removes the threat of suspicion likely to arise when entering unfamiliar territory such as non-grid electrification via public-private partnerships.

References

Department of Minerals and Energy (DME) 2000. The national electrification programme. Presentation to the Parliamentary Portfolio Committee on Minerals and Energy in March 2000. Pretoria: Department of Minerals and Energy (DME).

National Electricity Regulator (NER) 2000. Electrifying South Africa for Prosperity and Development. *Electricity Regulatory Journal*, July 2000. National Electricity Regulator, South Africa.

Thom C, Davis M & Borchers M 1995. Review of South African experience in rural electrification. Cape Town: Energy and Development Research Centre.

Reconstruction and Development Programme (RDP). 1994. *The Reconstruction and Development Programme*. ANC, South Africa.

Financing frameworks to facilitate sustainable development: Experiences in the AREED project

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1 Introduction

From the standpoint of rural energy service provision, financing has great potential as a catalyst of sustainable development. In terms of definition, sustainable development should entail progress in areas of environment, economy and society [1]. The path of sustainable development chosen should aim at meeting the needs of the present population without compromising the ability of future African generations to meet their own needs.

It is generally accepted that meeting the needs of Africa's poor, the overwhelming majority of whom live in rural areas on less than US$1 per day, is the greatest challenge most African governments face in the 21st Century. Not surprisingly, virtually all governments in Africa have embarked on poverty reduction programmes.

For these programmes to be successful, it is imperative that the status quo of "energy consumption patterns of poor people relying on traditional fuels and without access to electricity" be altered. Lack of electricity in particular has resulted in the rural areas being deprived of opportunities for education and other income-generating activities. It is only through income-generating activities that poverty reduction can start having an impact.

It is for these reasons that Africa should establish and expand rural energy systems [2] that provide energy services necessary to uplift the economic status of rural areas of Africa. To achieve these objectives requires formulation of financing frameworks and strategies that take account of the following elements:

- identification of opportunities;
- information and technology needs;
- identification of barriers;
- availability of innovative financing mechanisms;
- conducive institutional and regulatory arrangements.

2 Elements of financing frameworks/strategies

2.1 Opportunities

The biggest irony in Africa is the existence of abundant natural resources within the precincts of the rural areas, which unfortunately cannot be exploited to the advantage of rural areas. Exploitation of such natural resources, which can go a long way towards poverty reduction can be realised through the introduction of income-generating activities. The nature of the economic set-up in most rural parts of Africa is that virtually all income-generating activities will be promoted by individuals or small-scale private sector entities.

This potential can be realised by encouraging the promotion of sustainable businesses from two perspectives: one based on an energy supplier or provider, and the other based on renewable energy to produce a product or service. The range and level of business opportunities can vary from small to medium scale systems, and can be classified as follows [3].

Renewable energy supplier or provider (energy services enterprises)

Provision of power supply using photovoltaic cells, wind energy, mini- and micro-hydropower, biomass-based electric generating entities for

- electricity provision for household application on an individual/community basis;
- electricity provision for commercial/industrial applications such as battery charging, water pumping for both domestic and irrigation purposes, mortuary refrigeration, etc;
- energy provision from biogas for cooking, lighting at community level.

Renewable energy user as part of an enterprise entity

- Water pumping for irrigation purposes;
- poultry rearing;
- localised power supply to petrol stations;

- localised power supply to entertainment and grocery business enterprises;
- localised power supply to cold room facilities for provision of refrigeration for fish and vegetables;
- localised power supply for battery charging;
- localised power supply to tailoring enterprises.

Manufacturing/production of energy products for sale

- Manufacture of low-cost electric cooking stoves;
- manufacture of more efficient biomass based cooking stoves;
- production of charcoal and briquettes using more efficient carbonisation technologies;
- distribution/sale of LPG for use as a domestic fuel;
- manufacture of LPG cooking stoves;
- manufacture of solar dryers;
- manufacture of solar water heaters.

Process/manufacturing enterprises

- Honey processing;
- hot water for dairy processing;
- firing of pottery;
- beer brewing;
- knitting;
- processing of hides.

Currently, these activities are being hampered by lack of cost-effective appropriate energy supply for both lighting, commercial and industrial applications. Such activities require energy input in the range of 5 – 1000 kW for commercial application and 50 – 100 Wp for domestic lighting.

2.2 Information and technology needs

Opportunities which have been elaborated in the previous section require identification and application of the most convenient, efficient form of energy appropriate to the task at hand (site- and project-specific) on the supply side. Over the years, significant technological advances have been made and are being applied in various forms and configurations such as:

- PV –systems;
- wind systems;
- PV – Diesel hybrid systems;
- wind – diesel hybrid systems;
- biomass combustion/gasification systems;
- anaerobic (bio-gas) systems;
- micro- and mini-hydro systems.

These technologies are typically modular, small-scale and decentralised, characteristics which make them more suited to the generally small-scale African businesses [4].

PV and wind systems are well suited for irrigation purposes for enhanced agricultural production. A well-designed PV system can be cost-effective to provide irrigation water supply up to 15 hectares of land [5]. In view of inadequate insolation during some seasons, and also relatively low speeds in inland Africa, typically 3.0 m/s, PV-diesel and wind-diesel hybrid systems, respectively, are recommended.

In view of the abundant biomass resources in Africa in the form of agricultural and forest wastes, which currently go to waste, biomass combustion/gasification systems come handy and appropriate. Proven technologies, are now available on the market, typically in the range between 30 and 1500 kWe of electrical output. Such systems are suitable for wide range of applications, which cover especially, biomass combustion, biomass gasification and biomass anaerobic (bio-gas).

In view of the abundant water resources in most parts of Africa, micro- and mini-hydro systems are equally suitable for electricity generation in the range 5 kW – 3000 kW. As part of infrastructure development, dams and weirs on perennial rivers can be constructed for multi-purpose functions, especially for irrigation and processing through use of excess water for electricity generation.

The technologies identified above are often ignored in the development projects because people do not understand their capabilities, benefits and costs. Given in Table 1 is the current status and potential, future costs of such renewable energy technologies for turnkey investment costs (US$/kW), and current and potential energy costs (c/kWh).

2.3 Identification of barriers

In the process of formulating financing frameworks to facilitate sustainable development, it is essential that the question of barriers is articulated beforehand. In the case of African Rural Energy Enterprise Development (AREED), preliminary work was undertaken to identify barriers, which are classified as financing and associated financing barriers.

Financing barriers are initial investment capital, collateral and security, and affordability. Initial investment capital for start-up business is one of the greatest barriers to both small- and medium-scale, and individual small businesses. Even if traditional financing becomes available, such business cannot access such funds due to conditionalities of collateral and security. Energy services companies (ESCOs), which deliver solar

Table 1: Current status and potential future costs of renewable energy technologies

Technology	*Turnkey investment costs (US$/kW)*	*Current energy cost*	*Potential future energy cost*
Biomass energy	900-3000		
Electricity	250-750	5-15 c/kWh	4-10 c/kWh
Heat		1-5 c/kWh	1-5 c/kWh
Ethanol		8-25 $/GJ	6-10 $/GJ
Wind electricity	1100-1700	5-13 c/kWh	3-10 c/kWh
Solar photovoltaic electricity	5000-10000	25-125 c/kWh	5 or 6-25 c/kWh
Solar thermal electricity	3000-4000	12-18 c/kWh	4-10 c/kWh
Low-temperature solar heat	500-1700	3-20 c/kWh	2 or 3-10 c/kWh
Hydroelectricity			
Large	1000-3500	2-8 c/kWh	2-8 c/kWh
Small	1200-3000	4-10 c/kWh	3-10 c/kWh
Geothermal energy			
Electricity	800-3000	2-10 c/kWh	1 or 2-8 c/kWh
Heat	200-2000	0.5-5 c/kWh	0.5-5 c/kWh
Marine energy			
Tidal	1700-2500	8-15 c/kWh	8-15 c/kWh
Wave	1500-3000	8-20 c/kWh	Unclear
Current	2000-3000	8-15 c/kWh	5-7 c/KWh
OTEC	Unclear	Unclear	Unclear

Source: World Energy Assessment Report, UNDP, UNDESA, World Energy Council 2000

home systems, are not able to recover fully their costs due to lack of affordability by their clients. Most of them depend on some form of subsidy or grant [4]. The question of affordability in such areas can only be solved if income-generating activities are enhanced.

Associated financing barriers are the capacity to produce bankable proposals, the knowledge base on available appropriate technologies, and system design and technology choice. Even if financing was made available, the level of entrepreneur capacity in most rural areas is not so advanced to expect them to produce bankable proposals, select appropriate technology and undertake system design.

2.4 Availability of innovative institutional financing mechanisms

Sustainable energy development requires affordable credit financing. In view of the relatively large initial investment, very few rural-based entrepreneurs can afford outright purchase. In addition, traditional banks are unable to lend to such clients due to lack of collateral and security; also the amounts being requested fall below their minimum levels. Therefore, any financing mechanism to be put in place for such purposes should take account of the following:

- risks (both financial and technical);
- collateral and security issues;
- revolving funds with start-up capital; and
- support for bankable proposal preparations, including system design and technology choice.

Whilst forestalling some of the issues raised above, it is essential that thorough work goes into preparation of bankable proposals which would ensure success of such businesses.

2.5 Conducive institutional and regulatory arrangements and investment environment

Successful implementation of energy sustainable enterprises will largely depend on a favourable policy framework which considers the following at national, regional and international levels:

- the existence of energy policy on renewable energy;
- participation of independent power producers (IPP) through existence of policy on independent power production;
- policy on tax rebate on plant and machinery, and tax exemption on profit for at least for the first five years;
- energy and related policies that enhance removal of subsidies on conventional energy supplies, and application of marginal pricing of electrical supply systems;
- incentives on setting up businesses in rural areas (tax relief on profit for first five years);
- policy on infrastructure development in rural areas such as roads, dams, and weirs, which can serve as bases for micro/mini-hydro construction;
- synergy of various development programmes with energy input to enhance production;

- micro-credit;
- investor confidence;
- free movement of capital;
- repatriation of dividends.

3 African Rural Energy Enterprise Development

Availability of accessible financing is key to overcoming some of the barriers earlier identified such as initial capital, risks, collateral and security, and preparation of bankable proposals. To date, there have been few of such financing models in rural Africa. For this reason, the newly introduced African Rural Energy Enterprise Development (AREED) initiative has the potential of addressing some of the identified barriers for establishment of sustainable businesses in rural areas.

The United Nations Environmental Programme (UNEP), with financial support from the United Nations Foundation, has initiated AREED. The AREED initiative being implemented by E & Co seeks to develop new sustainable enterprises that use clean, efficient, and renewable energy technologies to meet the energy needs of the poor, thereby reducing the environmental and health consequences of existing energy use patterns.

The main objectives of AREED are to create rural energy enterprise and to build the capacity of NGOs and institutions to facilitate enterprise development; to provide early stage funding and enterprise development services to entrepreneurs; and to build capacity in African NGOs to work with clean energy enterprises and work with financial institutions to assess the rural energy business sector and integrate enterprise investments into their portfolios

To achieve the above objectives, AREED has the following components in its portfolio:

- training and tools to help entrepreneurs start and develop energy businesses;
- enterprise start-up support in areas such as business planning, structuring and financing;
- seed capital for early stage enterprise development;
- assistance in sourcing second stage financing;
- partnerships with banks and NGOs involved in rural energy development.

Figure 1 shows the linkages between the parties under the AREED initiative.

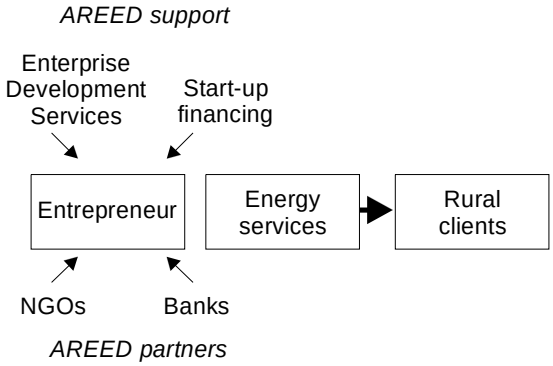

Figure 1: Linkages between the parties under the AREED initiative

3.1 Training and tools, and enterprise start-up support

The AREED approach offers rural energy entrepreneurs a combination of enterprise development 'hand-holding' and start-up support. The enterprise development involves training and tools through use of a toolkit, which has been designed to assist entrepreneurs in planning and implementing their projects and enterprises. The toolkit assists entrepreneurs with special tools to bring an idea to implementation through fact-finding, feasibility analysis, and business planning. Figure 2 shows the stages of the toolkit process [6].

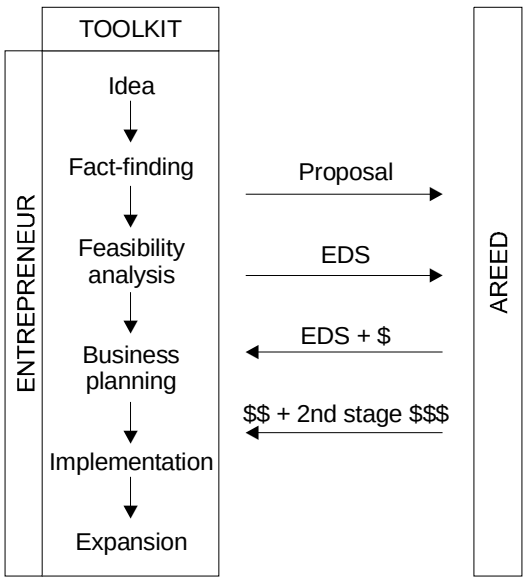

Figure 2: Stages of the toolkit process.

(i)

An enterprise *idea* is a short and precise description which tells you and others the following:

- What product or service your enterprise will produce and sell.

- What technology will be used to produce your product or service.
- Where the enterprise will be located.
- Who your enterprise is going to sell the product or service to.
- How your enterprise is going to sell its products or services.
- Which energy need your enterprise will fulfil for the customers.

(ii)

Fact-finding is designed to help an entrepreneur to define a project, gather the basic information required to later evaluate the project feasibility and prepare an introductory memorandum and work plan. It consists of the following:

- Introduction.
- Project description.
- Entrepreneur objectives.
- Technology and business relationships.
- Skills inventory.
- Customers and local market conditions.
- General market conditions.
- Preparing an introductory memorandum and work plan.

(iii)

Feasibility analysis reviews the main characteristics that determine the feasibility and help translate the information gathered during the fact-finding phase into a completed feasibility analysis, and thereby set the stage for preparing a business plan. It consists of the following:

- Introduction.
- Natural resources.
- Contracts for fuel.
- Land.
- Permits.
- Technology.
- Customers.
- Local and national energy plans.
- Macroeconomic, political and social setting.
- Project team.
- Contractors and suppliers.
- Estimates of revenue, capital cost, operating costs.
- Financial analysis (profit and loss, balance sheet, working capital requirements, financial indicators (IRR, payback period, return on investment)).
- Source of financing.
- work plan presentation

(iv)

Business plan: A good business plan is undertaken to achieve the following:

- • Shows that a proposed energy project is a serious initiative, undertaken by capable entrepreneurs who understand and have control of the essential elements that will assure success.
- • Increases the chances that an entrepreneur will be able to attract investors. Lenders, partners, strategic allies, supplier and key staff.
- • Forces the entrepreneur to collect, in one place, all of the thinking and research that has gone into the development of a proposed project.

A good business plan is built on solid information. That information can be recognised in many different ways but the essential ingredients remain the same:

- Location and technology.
- Agreements.
- Sponsors and advisors.
- Market.
- Implementation.
- Finance.
- Impacts.
- Risks.

Enterprise start-up support include the following services:

- Financial analysis.
- Market analysis.
- Refinement of concept.
- Contracts and opened doors.
- Negotiations.
- Board member and financial advisor.
- Recruiter and promoter.

Providing such services helps new enterprises develop as businesses. The result is that entrepreneurs can plan and structure their companies in a manner that prepares them for growth and makes eventual investments by mainstream financial partners less risky.

3.2 Seed capital and second-stage financing

AREED provides early-stage funding and enterprise development services to entrepreneurs [7], helping build successful businesses that supply clean energy technologies and services to rural African customers. Services include training, hands-on business development assistance and, for promising businesses, early-stage investment and assistance in securing financing.

AREED applies a particular hands-on form of enterprise development used by E & Co, whose mission is to support viable energy enterprises to deliver reliable and affordable energy by bringing together people technology and funding. This is similar to venture capital on a smaller scale and with social/environmental ends. The approach is best explained by example. The first AREED support to an energy entrepreneur might be a modest loan (e.g. $15 000) to support preparation of a business plan. If this looks promising, a second financing package could be arranged to assist in the company's start-up – this time usually the purchase of an equity share in the company/or provision of a loan.

Once the business is operating, a working capital loan might be provided on a cost-sharing basis with the owner(s). In this initial period, significant in-kind support is provided, including an AREED representative working closely with the company's management. The support increases the probability that a more "bankable" project can eventually be presented to financial investors and partners. Total AREED support to a company typically ranges from $50 000 to $100 000, although it can reach $250 000. Once other partners are committed to a new company, AREED's role diminishes. The intervention is considered successful once experience is no longer needed and the enterprise has either reached sustainability, or is capable of representing itself to outside investors.

3.3 Partnership with banks and NGOs

The AREED initiative also works to broaden the skills of organisations and people involved in the energy and investment sectors to nurture energy entrepreneurs [7]. Specifically, AREED is partnering with local development organisations and financial institutions to create an enabling environment for rural energy development and growth.

AREED works with African NGOs and development organisations on clean energy enterprise development. This helps prepare NGOs to identify potential energy projects and to provide follow-up business support services to entrepreneurs. Resource tools are also developed and disseminated that focus on business planning, management structuring, and financial planning.

AREED works with financial institutions to assess the rural business sector and integrate it into their portfolios. This is accomplished through workshops and specific hands-on tools, centred on rural energy markets and enterprises, appropriate project finance models, financial analysis and risk management issues. Opportunities for co-financing are also explored.

4 Implementation of AREED

The AREED initiative has now begun operations in Senegal, Ghana, Botswana and Zambia. AREED is working in-country with a number of local partners, including ENDA in Senegal, KITE in Ghana, CEEEZ in Lusaka and the Mali Folkcentre.

4.1 Methodological approach for implementation

The methodological approach for implementation involves the following steps:

- Identification of stakeholders involving government ministries and departments, financial institutions, NGO development consultants and entrepreneurs.
- Initiation workshop to introduce the AREED programme and introduce some aspects of the toolkit.
- Initial proposal preparations by entrepreneurs.
- Training on the toolkit for all the stakeholders, in particular entrepreneurs.
- Final projects preparations and submission based on AREED proposal guidelines.
- Selection of projects which meet the AREED guidelines.
- Enterprise development services for feasibility analysis and business planning.
- Financing if project found feasible.
- Implementation.
- Monitoring and implementation.

4.2 Identified projects for Zambia

Since the inception of AREED in April 2000, several projects, still in their proposal preparatory stage, have been identified, and these are given below.

Project: Improved household energy stove
Institution: Enviro-care
Objectives/action: Intends to formalise and increase the production of improved charcoal stoves from 150 to 1000 per month. AREED to assist with business plan and SUSAC to assist with environmental assessment to attract CDM investment.

Project: Improved household, commercial and institutional energy stove
Institution: Rasmas Engineering
Objectives/action: A small-scale manufacturer of bakery and catering equipment intends to produce a variety of household and commercial and institutional stoves.

Project: Mini-hydro
Institution: Lwakela Investments
Objectives/action: To replace diesel electric power stations with mini-hydro on Lunga River in Mwinilunga, North-western province.

Project: Mini-hydro
Institution: Kacholola Development Association (KDA)
Objectives/action: To develop new mini-hydro in Kacholola area, Eastern Province to supply electricity to neighbouring communities (Kacholola and Nyimba).

Project: Improved charcoal production
Institution: Zambia Wood Energy Association
Objectives/action: Intends to develop sustainable charcoal production business using improved carbonisation technologies in the form of metal/brick kilns.

Project: Coal briquetting
Institution: Zincorous Limited
Objectives/action: Intends to produce coal briquettes of up to 100, 000 tons per annum aimed at replacing charcoal utilisation.

Project: Vegetable/fruit drying
Institution: Red Ribbon, Solar Tech, Dr I N Simate
Objectives/action: Currently involved in drying and marketing fruit and vegetables as a cottage industry. Wishes to go into large scale drying and marketing of the same to meet local and export demands

Project: Solar home systems
Institution: Nyimba ESCO, Chipata ESCO, Lundazi
Objectives/action: With support from the Ministry of Energy and Water Development and SIDA (Sweden), Nyimba, Chpata and Lundazi are currently installing 100, 150 and 150 solar home systems, respectively. AREED considering support to increase the number of solar home systems to sustainable levels.

Project: Storage and ice-making facilities
Institution: Coolwell Systems Limited, Peasant Farmers and Small Scale Farmers Association
Objectives/action: Intend to install storage and ice-making facilities at fishing camps, for milk and vegetable preservation.

Project: Tailoring / Saloons / Irrigation
Institution: WEDAZ
Objectives/action: Established in 1995. membership of 924 spread all over Zambia. Main activities. Intends to enhance production for its members in tailoring, saloon and tailoring activities.

Project: Poultry rearing
Institution: ANED Investments Limited
Objectives/action: Intends, with the use of PV solar energy, to go into commercial poultry rearing of up to 4000 birds per annum and irrigation of High Value Crops

4 Lessons and experiences learnt, and recommendations

(i) AREED initiative once fully implemented will go a long way in addressing some of the barriers addressed in this report in that it will:
- begin small, build to large;
- demonstrate that renewable energy and energy efficiency projects are commercially viable;
- establish a pipeline of projects and investment opportunities for the new capital flows;
- use small, staged, high risk investment;
- use leverage investment from others, especially the private sector.

(ii) Although ideally AREED expects that, as far as possible, fact-finding, and to some extent, feasibility analysis be undertaken by entrepreneurs themselves, experience on the ground reveals that the level of entrepreneur capacity in most cases is not sufficiently advanced for them to fully undertake such assignments. There is therefore need to ensure participation of more NGO development consultants to provide additional assistance.

(iii) Establishment of synergy between AREED and other developmental programmes is essential to ensure that energy input is incorporated in the latter to enhance production.

(iv) The question of gender disparity in the case of Zambia does not arise as evidenced by the entrepreneurs and financial institutions participating in AREED.

(v) Government policy on institutional and regulatory arrangements and investment environment, and support are essential for the successful implementation of AREED.

(vi) Cost-effective appropriate energy technologies are now readily available on the market and what is required is their transfer to support sustainable development in rural areas.

(vii) For sustainable development to be achieved in Africa, and in particular in the

rural areas, more financial resources will be required on the basis of AREED to support enterprise development.

References

1. Yamba, F. D. and Matsika, E.: Discussion Paper on Sustainable Development Goals and Indicators from Clean Development Mechanism (CDM) Perspectives, CDM SUSAC Project – November 2000.
2. Sokona, Y: Setting up Access to Energy Services in Rural Africa. Paper Presented at COP6 Side Event on African Rural Energy Enterprise Development. A hands on Approach to Climate Change Mitigation, November 2000.
3. Yamba, F. D.: African Rural Energy Enterprise Development (AREED) Initiative Report – March 2000.
4. Farinelli, U: Energy as a tool for Sustainable Development for African Carribean and Pacific Countries, ISBN 92 1126 112 81, 1999
5. Kaunga Solar Project Model Village – JICA, Luangwa – 1998.
6. Phil LaRocco: Toolkit for Energy Entrepreneurs, Version I, October 2000, AREED, UNEP and E & Co. Contact areed@energyhouse.com for more information for non-commercial use.
7. Christine Eibs Singer: African Rural Energy Enterprise Development- A Hands on Approach to Climate Change Mitigation, E & Co., CoP6 Side event, Hague, Netherlands, November 2000

Gender concerns in accessing energy for sustainable development

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Introduction

The role of energy in the pursuit of sustainable development agenda cannot be overemphasised. Sustainable development implies meeting the needs of the present without compromising the ability of the future generation to meet their own needs (WCED, 1987). It is a positive social-economic change that does not undermine the ecological and social systems upon which communities and society depend (Rees, 1989). The major focus of sustainable development is human development, which addresses social, economic and environmental needs, such as reducing poverty, expanding access to health and education services, ensuring a clean environment and promoting intergenerational equity.

Energy is an essential tool for human development and is critical to world economic and social development. Energy needs are directly linked to people's social and economic lives; they will vary greatly between different social groups. Understanding the basic needs of men and women and providing energy to meet these needs is key to improving their social and economic well-being and is essential for sustainable development.

Energy is necessary for survival, and is directly related to the most pressing social issues, which affect sustainable development, such as poverty, jobs and income levels, gender disparity, access to social services and health (Reddy, et al., 1997). In terms of energy, poverty means, among other things, limited access to energy services. It is the inability to afford alternative sources of energy when one's own supply or own provision is exhausted (Burn, 2000). People living in poverty lack sufficient choice in accessing adequate, affordable, reliable, quality, safe and environmentally benign energy sources to support economic and human development. Any attempt to alleviate poverty, therefore, must address improving access of the poor, especially women, to energy services as well as the level and quality of these services. The services provided must be affordable to the user, in terms of both initial investment costs and daily running costs (Anderson, et al., 1999).

Access to energy is important and necessary for the achievement of social, economic and environmental objectives of sustainable development. Widening access to reliable and affordable energy supplies is, therefore, one of the critical issues which need to be addressed for sustainable development. Such issues, however, must be addressed within a gender perspective because women and men have different needs, interests, roles and different degrees of access to energy resources and services. This paper addresses gender concerns in accessing energy and suggests approaches and actions to address them.

The energy situation in Africa

The energy sector in Africa, particularly sub-Saharan Africa is afflicted by severe problems that adversely affect economic growth and its benefits. These include: frequent power black-outs and brown-outs, poor access to modern fuels and electricity, bankrupt energy utilities, and inadequate investment infrastructure. Those mostly affected by poor availability of energy services are the rural areas where the majority of the population lives and poor households who cannot afford the high costs of modern energy. Modern energy refers to manufactured or processed fuels with sophisticated conversion equipment and includes electricity, solar photovoltaic, biogas and liquefied petroleum gas (Rogner and Popescu, 2000). Traditional energy, on the other hand, means unprocessed fuels and low conversion technology devices (or no technology).

Africa is rich in energy resources because of the massive reserves of both renewable and non-renewable energy resources. In 1997, proven oil reserves amounted to 9.3 billion tonnes and natural gas reserves to 9.9 trillion cubic metres, representing 6.7% and 6.8% of global reserves, respectively (UNDP, 1999). The region also possessed 17% of the world's untapped hydropower potential. Yet despite these vast energy

resources, most of them remain under-exploited, primarily because most countries lack both the capital resources and favourable political and economic environments for private investment.

In many countries, the energy sector is still driven primarily by issues of supply instead of demand, with provision of energy services, to a large extent, being supply-oriented (Davidson and Karekezi, 1993). A major focus is on conventional systems (petroleum, grid electricity and coal) with relatively few actors and large supply-side structures, to the neglect of the renewable energy sources which are appropriate for rural areas, given the low load density and low income (hence inability to pay for energy services) in these areas. However, such conventional energy strategies that rely on supply-focused, fossil-intensive, large-scale approaches do not address the needs of the poor, the majority of whom live in rural areas.

The tendency to support conventional energy systems versus renewable energy systems has limited the choice/opportunities for energy services in rural areas. Energy policies in most countries have focused on the industrial sector and urban centres while rural energy, households, agriculture and small-scale production (including the informal sector) are given the least priority. Urban areas have attracted energy service infrastructure, for example electricity, because of higher energy demand and higher disposable income of urban households (Smith, 1998) compared to rural areas. Consequently, few affordable and viable energy options have been developed for the domestic and informal sectors in which much of the women's work occurs. This has forced women and the poor to continue to rely on their own labour and traditional biomass fuels for energy.

Traditional biomass energy, mainly firewood, charcoal and crop residues, still dominates the energy sector in many African countries despite technological developments and advances made in the sector. It represents about 70% of the final energy consumption in sub-Saharan Africa and over 84% if South Africa is excluded (UNDP, 1999). In 1990, only 8% of rural people and 38% or urban populations in sub-Saharan Africa had electricity connections (UNDP, 1999). Today, the situation has not changed much, with only 30% of the population, mainly those in urban areas, having access (Amadi-Njoku, 2000). Although many low-income households have potential access to electricity, they cannot afford the cost of electricity installation (Smith, 1998). However, because they are more dependent on commercial energy, especially kerosene, than those in rural areas, they end up paying a high price for their fuels (Clancy, 2000). In Kenya, poor rural and urban households spend at least between 5% and 10% of their income on securing fuel (Muchiri, 2000).

The annual per capita consumption of modern forms of energy in Africa has been the lowest in the world (Davidson and Karekezi, 1993); less than 10% of that of North America (Rogner and Popescu, 2000) mainly due to poor availability and accessibility. This implies that most Africans have no access to commercial energy. Although the magnitude of accessibility problem varies from one country to another, some similarities can be identified within the region and sub-regions. There is generally a problem of inadequate supply and affordability of modern energy services for the rural people, especially the poor and women. Consequently, many women and children spend several hours every day in the drudgery of gathering firewood and carrying water often for considerable distances for household needs. In some situations, men do assist in such activities.

Although affordable and viable renewable energy options, such as biogas, solar photovoltaic and liquefied petroleum gas have been developed worldwide, the technologies have not been widely disseminated to the rural poor. Renewable energy development and utilisation is still given low priority in national energy planning and policy development. In addition, market forces do not orient economic actors toward socially and economically optimal solutions like renewable energy systems. Experiences in Kenya, Uganda and Zimbabwe have shown that currency devaluation has affected affordability of imported renewable energy technologies (Clancy, 2000). Other factors that confront renewable energy development and utilisation include energy pricing policies and subsidies that favour the conventional energy sources, lack of a supportive institutional framework, high initial cost of renewable energy systems, as well as lack of financing and credit arrangements.

Given the current energy situation in Africa, the majority of the people in Africa, particularly those in the rural areas, will continue to live without energy that can sustain their basic livelihoods in this 21st Century. This implies that traditional biomass energy will continue to be important for the poor, given their low income levels and the high cost of alternatives. This will have severe adverse impacts on environment and health. Compared to men, women would be the most affected group because they are frequently the primary users and providers of energy.

Gender concerns in accessing energy

Accessibility of energy can be seen in terms of affordability (Muchiri, 2000) and having a supply of quality fuels. It is important to recognise that women and men have different degrees of access to energy resources and services. This recognition is urgently needed in energy policy in order to reduce the suffering of women, which is intimately linked with current patterns of rural energy use (Kartha and Larson, 2000). In the rural areas, women are extensively involved with the provision and use of energy service in order to meet their families' basic needs through their subsistence and income-generating activities (Cecelski, 1996). Therefore, their daily lives are greatly influenced by energy access and use. Women do most of the subsistence activities that rely on energy (both traditional and modern fuels), such as cooking, heating and water hauling. They also use energy in small-scale income-earning activities in the informal sector, many of which are energy-intensive, for example, beer brewing, fish smoking, shea butter and palm oil extraction, tea shops etc. Men, however, dominate in productive activities, defined as income-generating commercial or entrepreneurial activities (Muchiri, 2000).

Women and children are primary collectors of firewood and other household fuels both for household consumption and sell to urban markets. They head-load firewood while travelling long distances on foot or they use non-motorised transport, such as animal carts. With higher incomes and reliable access to fuel supplies, both men and women in the rural and urban areas can switch to more modern stoves and cleaner fuels such as kerosene, liquefied petroleum gas, electricity and modern biomass.

As users and providers of energy, women are the most vulnerable to changes in energy availability and environmental damage. In the absence of alternative energy sources, and as the biomass resource base becomes degraded, many households experience energy scarcity and women are forced to spend more time and effort to meet the minimum household energy needs. Such scarcity severely impinges on women's valuable time that could have effectively been spent on productive activities. The drudgery that is associated with lack of, or inadequate, energy to meet requirements in the various household and productive activities also impacts on women's health. Their nutritional status may be worsened because they tend to expend more energy in work than men. Where women are involved in the production of palm oil and other oils, they become exposed to burns and smoke because of lifting and moving heavy containers of hot liquids (Reddy, et al., 1997). At a household level, use of solid fuel, such as biomass for cooking and heating has significant impacts. It causes indoor air pollution from the incomplete combustion products

Despite women's role as energy users and providers, their access to modern energy services is limited. Many of the large-scale energy projects located in rural areas neglect the energy needs of rural communities. In most cases, development of these projects cause negative environmental impacts to local communities leaving them more energy poor than they previously were. Women are particularly vulnerable to adverse impacts from these energy projects (Kartha and Larson, 2000).

Women's access to modern energy sources and technologies is limited by a number of factors, including:

- Limited financial and credit facilities for women. Micro-credit schemes and financial institutions tend to favour men and only provide short-term finance to women.
- Insufficient knowledge on the improved technologies or alternative energy technologies that is necessary to make informed decisions on technology use.
- Lack of integration by policy makers and planners of the special energy needs of grass-root women and men. This is due to lack of gender sensitivity in energy planning processes and policies.
- Lack of consultation on women's energy needs and requirements during technology design resulting in poor technical skills or solving specific technology problems. The energy sector is characterised by top-down planning, with inadequate consultation of the stakeholders. The lack of frameworks for the implementation of participatory approaches may partly be responsible for this.

These have been identified as the key issues of concern that need to be addressed in order to increase and improve access to energy services particularly by women (Karlsson, 2000; Karanja, 2000). One cannot, however, neglect asking the following question: are these problems restricted to women or do they afflict the poor at large? Although these constraints may seem specific to women, poor men, particularly in the rural areas, are equally affected by more or less the same factors. A gender approach needs to be adopted in addressing these issues. More attention, however, will need to be paid to women's energy problems and for more involvement of women themselves in solving their energy problems. In particular, policy frameworks intended to widen access to modern energy services and remove

gender disparities in such access are needed in order to develop sustainable energy strategies.

What needs to be done?

Although lack of energy services impacts heavily on women compared to men, the challenge for developing sustainable energy strategies transcends a woman-only focus, and requires the incorporation of gender as an integral part of equity-led planning for sustainable development. Paying more attention to women's energy problems, especially in rural areas, and more involvement of women in solving their own problems, can only be effectively done if gender energy issues are integrated in energy planning. It is not enough to have women represented in decision-making bodies. What is required is to have frameworks for increasing women's participation/involvement in energy planning and development and within which gender energy issues can be integrated in energy planning so that policy decisions on energy can be made that will benefit women.

Practical approaches for integration of gender in energy planning and policies and increasing women's participation include:

- **Gender analysis in planning, implementation, monitoring and evaluation of energy policies, projects and programmes.** This involves analysing and understanding the ways in which women and men and their energy needs, activities and utilisation approaches are structured. The focus should be on the different situations of men and women in relation to issues of access to and control of energy resources and benefits, division of labour, the type of work they are engaged in, influencing factors, condition and position, practical and strategic needs, levels of participation and potential for transformation
- **Empowerment approach.** This approach calls for the provision of education and training to build the capacity of both men and women to effectively participate in energy planning and decision-making and to make informed decisions. Developing the technical and managerial capability of women to install and operate energy systems, for example, will increase women's participation in energy development and empower them to participate in income generating activities. The information packages should raise the awareness of both men and women about available technologies.
- **Lobbying and advocacy with policy makers.** There is need for lobbying for improved energy access to rural areas and advocate for collaboration across ministries. Lobbying to have private sector address gender concerns in service provision is also necessary.
- **Mainstreaming gender.** This calls for the adoption of a gender approach in energy proposals and energy planning. More attention should be directed towards the integration of gender and energy issues in national energy planning.

In addition to the above, it is necessary to remove all bottlenecks that constrain the poor, especially women, in energy. The recommended actions that need to be taken include:

- Listening to the practitioners: the energy sector is male dominated. It is imperative to understand their views on how the gender equitable energy status can be achieved.
- Provide micro-credit schemes for small-scale enterprises and project implementation in order to increase access of women and the poor to credit and financial facilities. This will assist women to acquire energy technologies and invest in productive enterprises
- Reforming and modifying national energy policies to make them gender sensitive as well as expand and improve national energy plans in order to cater for the energy needs of both men and women as well as all sectors of development.
- Coordinate energy needs with other entrepreneurial activities and hence provide micro-credit schemes for small-scale enterprises and project implementation in order to increase access of women and the poor to credit and financial facilities. This will assist women to acquire energy technologies and invest in productive enterprises.
- Dissemination of information through seminars, mass media, flyers and other avenues in order to provide sufficient and accessible information on energy options so that the stakeholders can make informed choices.
- Make women attractive energy consumers to the emerging private sector as the energy provider.
- Networking: establishment of national and regional energy networks will strengthen capacities and capabilities to implement gender sensitive policies because of the opportunity for sharing information and experiences.

Conclusion

Because of disparities in economic and social status and hence in access to, and reliance on energy, women face different energy needs and

constraints compared to men. There is no doubt that the lack of access to affordable modern energy services is constraining the options and opportunities available to women. Merely providing an energy technology will not solve women's energy problems. The technology has to be provided in an environment where it can be effectively and efficiently used for economic and social empowerment if it is to foster sustainable development. Women must be seen not as merely beneficiaries of targeted welfare improvements but as agents of change in their own right – no less, and perhaps more so, than men.

References

Amadi-Njoku, R. (2000) Implications of renewable energy for women in Africa: challenges and opportunities. **Energia News** 3(3):1-2

Anderson, T., Doig, A, Rees, D. and Khennas, S. (1999) **Rural Energy Services: A Handbook for Sustainable Energy Development.** IT Publications, London.

Burn, N. (2000) The Multifunctional Platform: decentralised energy for gender-aware poverty reduction in Rural West Africa. **Energia News** 3(3) : 15-17.

Cecelski, E. (1996) From Rio to Beijing: engendering the energy debate. **Energia News** 1(1) http://www.energia.com/

Clancy, J. (2000) **Policies, Projects and the Market: Empowering Women.** Working Paper 104. Technology and Development Group, University of Twente, Enschede.

Davidson, O. and S. Karekezi (1993) A new, environmentally sound energy strategy for the development of Sub-Saharan Africa. *In* Karekezi S. and G.A. Mackenzie (Ed.) **Energy Options for Africa: Environmentally Sustainable Alternatives**. Zed Books, London, Pp. 9-22

Goldemberg, J., T.B. Johansson, A.K.N.Reddy and R.H. Williams (1987) **Energy for a Sustainable World.** World Resources Institute, New York.

Karanja, L. (2000) Building gender issues into sustainable energy use in Africa: a regional workshop for NGOs, Research Institutions and governments. **Energia News** 3(3):6-7

Karlsson, G. (2000) UNDP project on energy aand women: generating opportunities for development. **Energia News** 3(3): 5-6.

Kartha, S. and E.D. Larson (2000) **Bioenergy Primer: Modernised Biomass Energy for Sustainable Development.** UNDP, New York.

Muchiri, L. (2000) Gender and Household energy technology in East Africa. **Energia News** 3(4):11-13, www.energia.com.

Reddy, A.K.N., R.H. Williams and T.B. Johansson (1997) **Energy After Rio: Prospects and Challenges.** UNDP, New York.

Rees, W.E. (1989) **Defining Sustainable Development.** Research Bulletin, Centre for Human Settlements, University of British Columbia, Vancouver.

Rogner, H. and Popescu, A. (2000) An introduction to energy. *In* UNDP, UNDESA and WEC ed. (2000) **World Energy Assessment: Energy and the Challenge of Sustainability.** UNDP, New York. Pp. 30-60.

Smith, N. (1998) **Low Cost Electrification: Affordable Electricity for Low-income Households in Developing Countries.** Intermediate Technology Publications Ltd., London.

UNDP (1999) **Energy as a Tool for Sustainable Development for African, Caribbean and Pacific Countries.** European Commission and UNDP, New York.

WCED, (1987) **Our Common Future.** Oxford University Press, Oxford.

RENEWABLE ENERGY: PROSPECTS AND LIMITS

Sustainable development in Africa through renewable energy

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Introduction

Africa, home to more than 720 million people distributed among 54 countries, holds the deplorable record of the lowest per capita income and also includes some of the planet's poorest countries. Three African subregions can be distinguished: North Africa, separated from the rest by the Sahara desert; sub-Saharan Africa; and South Africa, at the southern tip of the continent.

The three sub regions are significantly different in terms of economic development, energy endowment and demography, but in all three, rapid and continuous population and urbanisation increases impose growing constraints on social and economic development accompanied by a rise in energy demands.

Sub-Saharan Africa is widely acknowledged as representing the staunchest challenge in global development: two-thirds of the population live in a rural environment with no access to commercial energy, and 40% must eke out a living on a daily income of less than $1. In South Africa, despite the steady progress of political and economic reforms, energy supplies remain drastically insufficient in the rural areas. The sustained development of North Africa should target the diversification of its economy with a view to reducing its dependence on oil and natural gas exports in some countries. Moreover, there is diverse potential to develop local energy resources: hydrocarbon fuel, hydroelectricity (coupled with the extension of the inter-regional network), biomass and other renewable energies.

1 The energy situation in Africa

Yearly per capita energy consumption is an indicator of development in a country or region and therefore of people's living standards. With a yearly average value of 0.6 toe per capita, the African continent, compared with Asia (excluding China and the OECD countries), has the lowest consumption level on the planet, while one North American consumes 8 toe per year and one Japanese 4 toe. Furthermore, there are great inequalities among the African countries,

depending on whether they dispose of fossil energy sources (Libya: 2.9 toe/cap/yr; South Africa: 2.6) or not (Ethiopia: 2.8 toe/cap/yr; Mali: 0.23)

Energy production

Petroleum oil is at the top of the list, covering 48% of overall energy production on the continent, which was estimated at 794 million toe (ton of oil equivalent) in 1997. The main producers are located in North Africa (Algeria, Libya and Egypt) and in sub-Saharan Africa (Nigeria, Angola and Gabon) with equal contribution from these two regions.

Next is biomass fuel (24%), charcoal (16%) and natural gas (11%). Nuclear energy, with a production of 3 million toe in 1997, remains insignificant and is restricted to South Africa. Hydroelectricity is also limited (5 million toe in 1997), despite enormous untapped potential (about 1300 TWh per year – 20 times current production).

Oil, gas and coal reserves represented about 7% of the world's proven reserves in late 1997. Out of a total production of 593 M toe of fossil fuels in 1997, only 38% was consumed in Africa, the rest being exported in the following export/production ratios: oil – 74%; natural gas – 53%; coal – 30%.

Final energy consumption

The fact that most of the fossil energy produced in Africa is exported can be explained by the low indigenous buying power and the restricted development of industry and transport. This results in three distinctive features in energy consumption on the whole:

- predominance of biomass fuels (60% of total primary energy consumption);
- predominance of the domestic tertiary sector (66% of total);
- low electricity consumption.

Biomass remains the main component of final energy consumption, even if there is uncertainty in determining each country's precise share. Biomass consumed in rural areas is mostly collected directly by the villagers, while in urban zones, charcoal and most of fuelwood is marketed. This activity entailing charcoal production and fuelwood supply is an important provider of jobs and income for the rural populations. Another characteristic of biomass consumption is that it is used in an unsophisticated manner with very low yields (15% for three-stone cook stoves) and that it is designated for cooking and water heating, hence essentially for domestic use.

In the final energy consumption by sector, the **tertiary domestic sector** retains the lion's share on the continent as a whole (66% in 1996), with industry (19%) and transport (15%) holding markedly less. This is the result of a predominantly rural economy in sub-Saharan Africa. Another reason can be found in the low efficiency of biomass utilisation. In North Africa, however, the energy consumption pattern is more similar to that of industrialised countries with 33% for industry, 25% for transport and 42% for the tertiary domestic sector in 1996.

	Part of biomass in the domestic tertiary, agricultural sector	*Electricity consumption (kWh/cap/year)*
North	16%	899
Sub-Saharan	93%	131
South	35%	5 260
TOTAL	**83%**	**537**

Source: IEA. 1999 Annual Energy Review

Moreover, Africa is distinguished by the **lowest per capita electricity consumption rate** in the world: 537 kWh/year, which reflects the extremely low electrification rate in many countries. Only one-quarter of African homes have access to electricity. Here too, there are huge differences between the regions and between rural and urban areas: in South Africa, for example, more than 60% of the population enjoys electricity and accounts for half of the African production with a high per capita yearly rate of 5260 kWh.

The inescapable conclusion is that energy is grossly underdeveloped in Africa and that reform is inevitable if social and economic development is to be achieved. The current energy situation reveals several priority areas to be delineated:

- efficient use of biomass and regeneration by fast-growing species;
- exploitation of the hydroelectric potential, coupled with the extension of interconnected networks;
- exploitation of the other renewable energies: photovoltaic and wind-powered electricity, solar water heaters, solar cooking stoves, biogas, etc.;
- efficient use of fossil energy;
- prospecting for new oil wells.

2 Energy and sustainable development

Immediately after the 1992 Rio Summit, having recognised that energy was an essential and inescapable factor in development, the international community urged countries to develop energy strategies with a view to sustainable de-

velopment. Components of these strategies were identified by UNDP in a recent report on energy that summarises the lessons learned in the last decades of the Twentieth Century.[1]

Current patterns of energy production and consumption around the world cannot lead to sustainable development. The earth cannot indefinitely sustain the imbalances caused by these patterns: excessive discrepancies in social and economic development amongst the different regions of the world, an excessive gap between the poor majority and the wealthy minority in Third World countries, excessive discrepancies between the consumption rate for natural resources and the regeneration rate, excessive discrepancies between nature's evolutive cycles and those imposed by the human action.

Where does the African continent stand in this international background of intense imbalance?

After nearly half a century of political independence and various development experiences, the average energy consumption rate per head in Africa remains the lowest in the world (1.50 koe/ca/day versus 25 koe/ca/day in North America). This clearly indicates that the methods employed up to now to solve energy problems in Africa have only brought inappropriate solutions. People persist in resorting to biomass in such a fashion that its sustainability is seriously threatened. The utilisation of fossil energy, which serves as a basis of economic development, remains insufficient. Furthermore, its energy and ecological yields are low.

It is evident that African countries have huge energy needs if they are to develop. Their consumption must increase tenfold in due course. According to the International Energy Agency, 70% of final energy demand between 1997 and 2020 will originate from the developing countries. But the needs of developing countries, particularly those in Africa, must be expressed in terms of sustainability, not just of quantity. It is therefore the sustainability of energy and subsequently of development in its economic, social and environmental aspects, which should serve as guides in providing solutions to the needs and changes to be made in energy policies. The environmental dimension implies not only that countries observe the conditions for sustainability individually but also on a global scale. The transition from the present energy systems to sustainable systems is therefore a long-term matter.

Moreover, the energy needs for development should no longer be assessed in terms of energy but of service provided by an energy system. Likewise, national energy programmes should cease to be designed as isolated schemes or in such a way that they focus only on economic considerations. The implications of the methods of producing, distributing and consuming energy should also be taken into account – both social (poverty and wealth distribution, women's advancement, the creation of jobs, etc), and environmental (soil degradation, deforestation, the greenhouse effect, etc).

In order to face its energy needs in terms of sustainability, African countries should mobilise all their natural and human resources in a rational manner. The mobilisation and exploitation of resources require technologies that both perform well and are environment-friendly. Today's new energy technologies are mature and available. Fortified with a new vision of the essential development needs, these new energy technologies can be used to find adequate solutions. They will need to focus on renewable energy use, improving yields of final energy utilisation, and increasing efficiency of fossil fuels transformation and utilisation.

These technologies should be more widely used in Africa, but many obstacles hinder broad-scale dissemination, including the necessity to adapt them to the specific contexts of regions or countries. Indeed, whether the purpose is to produce energy (combined cycles, CHP generation, wind turbines, fuel cells, etc) or to utilise it (separation by membranes, by hypercritical CO_2, heat pumps, bio-treatment, new materials, etc), considerable progress has been achieved or is about to be made. This means that there is a supply of clean and efficient technology.

This should not obscure the fact that the biggest challenge that Africa must face before it attains truly sustainable development is to eradicate poverty. There are considerable gaps in development levels between African countries.[2] But even where there is significant growth, improvement in living conditions is far from homogeneous. In most African countries the majority of the population is peripheral to development and often lives below poverty levels. Moreover, they live in rural areas or on the outskirts of urban centres, which further worsens their lot.

Yet, as Baltivala stresses,[3] poverty and scarcity of energy services go hand in hand in a synergetic relation. It is well established that the poor have to pay much more for energy services

[1] Reddy et al (1997). *Energy after Rio: Prospects and challenges.* UNDP, New York.

[2] IEA (1998). "CO_2 emission due to energy combustion". Paris.

[3] Baltivala S. (1997): " Energy as an obstacle to improved standards" in: *Energy after Rio*, UNDP, New York.

than the other social strata. They pay not only in monetary terms but also in work time, health, etc, especially women and children. Therefore, the main challenge faced by nearly all African countries is to gain access to energy for the poor, particularly in rural areas.

3 Renewable energy: prospects for development in Africa

It is no longer necessary to demonstrate the technical feasibility of the various types of renewable energy. Hundreds of pilot and demonstration projects have been implemented in different countries since the 1980s. The solar, wind and geothermal sources and the hydraulic and biomass potential are huge, whether assessed or not at the country or continental level. Aside from biomass fuel, which is overexploited, the use of other renewable energy sources reveals advantages that can build and develop sustainable energy systems, but each is also confronted with constraints that hamper its massive exploitation.

Biomass, which consists essentially of forest products and their residues, of residues from agriculture and livestock breeding, shrubs and other plants, is the most readily available and often the only accessible resource for African population, particularly in rural areas and in poor urban outskirts. These fuels are used primarily for cooking and water heating in households, with rudimentary techniques (15-20% yields). They are also utilised to a lesser extent in the arts and crafts (potteries, bakeries, foundries) and in collective operations (bread bakeries, Turkish baths in North Africa, etc), and also to produce charcoal for urban areas (with low yields of 30-45%).

These uses are common throughout in Africa, and have been the subjects of many studies and projects in numerous African countries (Morocco, Sudan, Burkina Faso, Niger and Kenya), their objective being to improve combustion yields. The dissemination of improved cookstoves, which made significant breakthroughs in a number of countries, is far from being generalised. The stoves would allow for substantial savings in biomass (decreasing the pressure exerted on forests and ground cover), but also lighten wood fetching chores for women in rural areas and alleviate the health problems inherent to the smoke produced by open stoves.

Several obstacles hinder the generalisation of improved techniques, including poorly informed users and the inability to finance the necessary tools.

Among the other conversion sectors of biomass fuels that utilise more elaborate technologies, some were included in pilot or demonstration projects in Africa. For instance: briquetting agricultural residues (peanut shells, sugar cane bagasse, cotton stalks, etc) in Sudan, gasification of wood and farming residues in Burkina Faso, or even methane production from livestock raising and agro-industrial residues in several African countries (Morocco, Burundi, Kenya, Tanzania, Uganda, etc). These technologies, which are well developed in the northern hemisphere, are promising for Africa. Gasification in particular allows for the integrated production of electricity from biomass (0.5-50 MWe installations) and is of specific interest for Africa, insofar as it can be combined with co-generation.

Biomass fuel is and will long remain the primary source of renewable energy in Africa to cover populations' energy service needs. Modern, advanced technologies to utilise this resource are available; other technologies should be developed or adapted to the numerous existing and untapped resources.

Under what conditions will Africa be able to profit from biomass conversion technology?

The initial focus should be on implementing a coherent policy for the sustainable management of the biomass-energy resource. The African Support Group (ASG) for the Regional Program on Traditional Energy and Substitutes (RPTES) has designated the main areas for such policy at the national, regional and international levels.[4]

Among the areas to focus upon in order to achieve sustainable forest management are:

- a global development policy that will take account of other components such as agriculture, animal husbandry, urban development, poverty reduction, etc;
- allowing the rural populations living near forest zones to manage local resources on their own;
- promotion of transparent and coherent information and planning policies;
- the establishment of a legal and financial framework involving the private sector and local communities to promote income-generating activities within the context of the sustainable management of biomass resources;
- the utilisation of financing mechanisms offered by international agreements.

The ASG also suggested action plans for the required regional and international collaboration.

[4] Dianka, M. (2000) "Vers une vision africaine de la gestion durable la biomasse-énergie". (Towards an African Vision of Sustainable Biomass Energy Management) LEF, N 47.

Hydroelectric energy

Hydroelectric energy has long been used in North Africa) for grinding grain (water mills) and "pumping" water from rivers for irrigation (norias). Nowadays, this energy is essentially utilised to produce electricity.

Africa, which abounds in potential in this area, produces less than 3% of the world's hydroelectric power (IEA, 1998). After the great dam construction period in Africa (Egypt, Ghana, Congo, Morocco, etc), with the search for appropriate solutions to decentralized rural electricity, we now witness to rising interest in mini-hydro (500 kW to 10 MW) and micro-hydro power stations (<100kW) in mountain zones where waterfalls exist. The potential varies from one region to the next, but there is obvious interest in this technology where favourable conditions exist. As evidenced by a few projects in Africa but mostly in Asia and Latin America, mini- and micro-hydro power generators can play a decisive role in the development of rural areas. The recent interest shown in this technology in Europe and North America points to the new technological developments that will contribute to improving costs and performances.

Wind energy

Although it was introduced in Africa by colonisers in the form of small isolated generators for pumping water or charging batteries, wind energy has not developed significantly. Yet, Africa has 20% of the world's wind energy resources, estimated at 53 000 TWh. It was only in the 1990s that an upsurge of interest in wind energy began to be noticed. This way of producing electricity is suitable for small power levels (10-100 kW), for isolated sites and/or for coupling with micro photovoltaic generators for rural areas. In the case of large power generators (500 kW to 1.5 MW modular generators), the electricity produced is injected into the electrical network. Some projects in this area have been conducted in Africa in recent years (Cape Verde, Mauritania and Morocco) and others are being studied.

This is the fastest developing form of renewable energy for electricity production in Europe and in the USA. According to one specialist,[5] producing 10% of the world's electricity by wind-powered sources in 2020 is quite possible, given the development of this technology, and the costs involved. Africa could benefit from such development to exploit its potential, provided a favourable context for investing in this sector can be set up.

[5] BTM Consult, Denmark.

Solar energy

Africa possesses considerable solar energy sources (1500 to 2500 hours of solar radiation per year, depending on the region). The first African experiences in solar energy go back to the mid-1970s. Photovoltaic conversion has inspired more projects than any other mode because of its immediate applications to rural population needs: pumping water, lighting in schools, lighting and refrigeration in health centres, lighting, radio and television in rural houses. All these projects implemented in many African countries contain an important social component that compensates for their costs.

The advantage of photovoltaic systems is that they require minimal maintenance, which is important in areas where technical expertise is limited. The most widespread thermal conversion is the one that uses solar panel systems for water heating. The dissemination of these systems in urban areas is relatively important, depending on the countries (South Africa and Tunisia). Some projects to disseminate these systems on a massive scale are being studied or even implemented (Morocco). Other types of applications such as solar drying of agricultural produce or the pasteurisation of liquid foodstuffs, solar cooking and heating have been addressed in studies or demonstration projects with very little dissemination. The findings of pilot laboratories in Morocco on photochemical conversion for the disinfection and detoxification of slightly contaminated water have not yet been disclosed.

Geothermal energy

The geothermal potential of some regions of Africa is relatively well known. Only South Africa (among twenty-some countries in the world) is using its potential in this area with a 45-MW plant. Further studies are still needed to shed some light on Africa's potential in this area.

One can see from this brief overview of renewable energy sources that the continent has great and diverse potential in this regard. Most of the technologies to exploit these sources have been perfected. The question is not to increase the utilisation rate of one source or another; it is, rather, to use this diversity to address development needs within specific local contexts. For instance, in one valley in the Moroccan High Atlas, as part of a project being conducted by a university team for the past 30 years, some villages have opted for a micro hydraulic generator, others for a solar PV power station with a 220V distribution network, others for a diesel generator, etc. This all falls within the scheme of an integrated development action that includes agriculture, forestry, livestock raising, aquaculture, schools, health, mosques, water, sanitation, etc.

It is the nature of these priorities expressed by the populations (development of tree farming using drip irrigation, for instance) and the assessment of local resources that will indicate the most appropriate solutions.

So, the prospects are highly promising for the development of renewable energies in Africa, if one wishes to be optimist, because the potential does exist. These prospects constitute a great opportunity for the sustainable development of African countries – but under what conditions? The areas identified by ASG for biomass energy also apply to the other renewable energies. For African countries, this entails the following:

1. *Develop and implement a global policy that will not consider energy as an isolated sector but as part and parcel of the other sectors of development.* The energy services to be established should target the development objectives set in the areas of agriculture, health, education, transport and so on. This is a different vision of energy planning and can be very complex.
2. *Promote participation by the people:* The needs of people are generally well known and have been expressed. The solutions proposed have often been inadequate because they do not take specific local conditions into account. The information provided to users about available technical opportunities, the constraints and costs, and including them in assessing the local resources in a context of sustainability, is the procedure that will give the best results. Sometimes this must be done through a demonstration project on a model site of the technical and socio-economical feasibility of a solution. Indeed, in rural areas, the decision by people to go ahead with a project is often made only after a neighbour has confirmed its success. This approach, which requires time and effort, calls for the involvement of the regional state institutions, local communities and civil society in a framework of consultation.
3. *Promote an ambitious policy of information, training, research and development in the various energy areas.* This is an essential component of the overall policy. It is the foundation for successful sustainability, transfer and integration of technology and for attracting financial resources. The design and elaboration of energy projects is an area where the deficit in training is particularly apparent. These activities are real insurance for tomorrow for the regions and countries. In order to implement this policy, all local, national and regional human and institutional resources should be involved; all the financial resources planned for that purpose in national programmes, and bilateral or international cooperation agreement should be utilised with maximum efficiency. (It is still common to see managerial staff trained in one sector yet allocated to another, or the funding of research and development projects that are not even remotely connected with local realities!)
4. *Create the legal, regulatory, institutional and financial framework that will lift the barriers blocking the way to the development of renewable energy as an essential factor of sustainable development, and to strengthen regional cooperation.* The tax and tariff policies on energy and equipment (often imported) are not always coherent with the decision to develop renewable energy. Incentive measures must be taken to encourage involvement by the private sector and remove the political and institutional barriers that impede the free propagation of innovative activities. But, at the same time, it is necessary to enact norms, standards and certification systems to protect users and limit the harm done to the image of renewable energies by unprofessional wheelers and dealers. Public authorities also must have a hand in the matter to reconcile trade investment incentives with the objectives of environmental protection.
5. *Prioritise regional cooperation.* This area, through presenting great difficulties in Africa, is nevertheless an essential aspect of global policy. How to benefit from the complementarity of resources – whether physical, human or institutional – and how to benefit from a neighbor's experience if there is no cooperation or dialogue between neighbouring countries?
6. *Strengthen African participation in international meetings and negotiations.* The voice of Africa is heard all too little. Who will defend African interests if not the Africans themselves? This emphasises the extreme importance of utilising and strengthening capacities, and of regional cooperation and consultation.

Conclusion

Renewable energy does indeed constitute a major asset for addressing sustainable development needs in Africa. The living standards of more than half of the continent's population depend on it. The policies that will be enacted over the next twenty years will depend on it as well.

The road to sustainable development in Africa is marked by challenges. The first of these is to integrate energy policies with the other sectors of development: agriculture, health, education,

transport, land development, etc. All actions should contribute to poverty eradication, gaining access to basic needs for the poor, and restoring dignity to all Africans. The energy policies should contribute to releasing rural women from wood-related chores, thereby enabling them to fully play their part as citizens. For this part of the rural population, the objective is to break the vicious circle that both makes it the victim of ,and holds it responsible for, environmental degradation.

The role of the public powers in a context of globalisation and fortification of the private sector is increasingly complex. It is a difficult exercise to maintain the balance between the interests of a population and the logic of market liberalisation. Civil society (such as NGOs, community-based organisations, and political parties) should consolidate its positions and be vigilant in order to prevent excessive or abusive actions.

In an international context punctuated with uncertainty, regional and international consultation is more than ever necessary and should be considered with a view to benevolent solidarity. After all, are we not all passengers in the same boat, which we must preserve for future generations?

Renewable energy in Morocco: limits and prospects

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1 Energy and sustainable development in Africa: the challenges

1.1 Sustainable energies

Energy is one of the structuring factors for the social and economic development and the integration of developing countries in the context of trade globalization. Energy and sustainable development are inseparable from one another for three principal reasons:

- Generalized access to energy is fundamental for improving people's quality of life, a key indicator of any society's level of development. The basic services such as health care, education, water, housing and transportation, cannot be effective without an appropriate, sustained energy service.
- The cost of energy and the security of supply, by their sizeable impact on the preservation and reinforcement of productive sectors' competitive edge (agriculture, industry and services), set the conditions for economic growth, the development of private investment or for expansion of the employment base.
- Our biggest challenge at the beginning of this millennium is to increase mobilization of self-energies, with a view to reducing gases that contribute to the greenhouse effect and the heavy pressure exerted on land cover, if we hope to preserve our environment and eliminate the threat of disastrous climatic changes.

Despite this heavy correlation to its contribution, energy alone cannot solve the overall problem of sustained development. But it is the energy theme that mobilises financial and human resources; as such, it could be used as a gateway for interested actors, facilitating the implementation of local dynamics but integrated with development.

1.2 The African context

The African continent, which boasts of a population of 803.7 million inhabitants or 13% of the world's population, contributes only 3% to commercial energy consumption worldwide. In order to meet their energy needs, African populations resort massively to biomass fuels, which represent 65% of overall energy consumption.

Primary energy is certainly available on the African continent, which contributes 7% to fossil fuel production globally, but most of the countries are not able to pay for this fuel and there is little trade across African countries. With a GDP of nearly 4%, the energy demand should grow, inducing more pressure on forest resources and deep environmental imbalances.

Decentralised, clean and often well-adapted renewable energies (solar, hydraulic, biomass, wind) – which are abundant in Africa – would contribute enormously to efforts to spark the dynamics of local development by mobilising investments, building capacities for basic service management and by promoting jobs and environmental conservation. Today, the privileged areas for renewable energies utilisation are:

- The production of electric power by hydro, biomass or wind energy. Hydro energy is at the root of 22% of electricity production in Africa, but its potential exploitation capacity is even higher. Wind and biomass energies, whose technologies have matured, are still underexploited. They could be further mobilised further in the scope of private investments, but this would call for reforms in the energy sector to allow independent producers to intervene.
- The production of hot water by thermal solar systems mobilises a local energy and can contribute to better management of energy demand in urban settings. Simple solar water heating technology could benefit from technological transfers and the rapid set-up of a new branch of local industry.
- Supplying isolated rural areas with fuels for electrification, cooking, heating, drinking wa-

ter, etc. Promising programmes are being implemented in, for example, South Africa, Morocco and Kenya. These programmes are highly innovative with respect to technical, institutional and financial arrangements, allowing the implementation of services within easy reach and whose "decentralised" aspect is the true guarantee for continuity and reproducibility. While pilot projects are becoming more and more successful, how do you define success, changes of scale in their implementation are still confronted with various problems hinging essentially upon financial and institutional matters and on human resources.

1.3 Energy demand in Morocco

National (commercial) energy consumption was set at 9 million TEO in 1998, including 67% in the form of oil products and 25% in the form of coal. 90% of the commercial energy is imported.

The consumption of non-commercial energy, firewood and wood charcoal is estimated at more than 3 million TEO, with 90% attributed to rural populations. There is heavy pressure on plant cover with a deficit equivalent to approximately 30 000 ha annually.

With the creation in 1982 of CDER (Center for the Development of Renewable Energies), a public agency, the Energy Department has incorporated renewable energies into the national energy policy.

Special attention is given to hydro energy in the framework of a mobilisation policy that has been applied for the past 4 decades. Nearly 100 dams have been constructed to date. Thanks to this effort, hydroelectric power stations generate 25% of national electricity capacity. Hydraulically produced electric power varies from about 7% to 17% of national production annually because of irregular rainfall levels.

Moreover, it is estimated that by the year 2010, commercial energy needs will exceed 13 MTEO, and net electric energy demand, which is approximately 12 000 GigaWatt hours today, is expected to double by that time. In addition to the low energy supply noted in the rural areas, it is worth adding that there is a 2/1 ratio between electric power demands during peak load periods and the demand during low load periods.

2 Energy and sustainable development in Morocco

This situation has changed radically over the past few years, thanks to major reforms in the sector which have made it possible to work towards:

- guaranteeing an adequate and regular energy supply
  compatible with mastering demands and ensuring environmental protection;
- providing energy at the lowest price;
- generalizing energy supply for the entire country in urban as well as in rural areas.

The promotion of renewable energies benefits greatly from these reforms. After completion of the phases involving prospecting, perfecting the technical supply and the development of important renewable energy pilot projects. Today, national infrastructure (electricity power plants implementation) and development (electrification and water supply in rural areas) programmes take into account renewable energy as an option during evaluation of energy options

2.1 Sector reforms

Morocco is undertaking various reforms in the energy sector. These include:

- privatisation of companies in the oil industry;
- concessions granted for electricity production;
- the development of national and regional energy networks through gas and electrical interconnections with other countries in the region, which will be reinforced;
- an acceleration in the implementation pace of the Global Rural Electrification Programme (*Programme d'Electrification Rurale Global* – PERG) with the objective of generalising electrification in the rural world by 2006;
- adjustment of tariff and fiscal structures for energy prices, designed as instruments that truly provide incentive for better management of energy demand – hence, the National Electricity Office has seen accumulative drop of 28% in its industrial energy rates since January 1996;
- reinforcement of oil research and prospecting.

2.2 Impact of sectoral reforms on renewable energy development

The new regulatory and institutional climate allows self-energy applications, particularly those drawing on renewable energies, to contribute significantly to the dynamics of developing the energy sector.

2.2.1 Electricity production

Wind energy has developed in Morocco because of three major opportunities in particular:

- Technological evolution and the cost of air-powered generators worldwide.

- Evaluations of wind energy resources and identification of sites on which wind-power parks can be constructed. Morocco's on-shore potential is estimated at 2000 MW.
- The introduction of a major reform in the Moroccan electricity sector permitting private electricity production projects to be implemented through BOT (build, operate and transfer) deals . A 50-MW wind-power park has been operational since August 2000. Three other parks that will have a total capacity of 200 to 400 MW are now under study by international consultants to determine who will obtain concession(s) for installation and operation. This programme will raise wind power's contribution to electrical energy production to 10%.

Other electricity production projects are also under study, such as the 30-MW Solar Power Station Project, which will be coupled to a 150-MW combined cycle gas power station or projects of electricity production from biomass (wood, urban trash)

2.2.2 Energy services in the rural environment

The government's gradual withdrawal from the productive sectors is being carried out to the benefit of an increased mobilisation of public financial means to better preserve economic, social and environmental balance. In the energy sector, this withdrawal benefits the rural world through the rural electrification programme mentioned above, the wood fuel programme and the "Energy House" programme encouraging young promoters to get involved in commercial energy services.

The global programme for rural electrification (PERG), launched five years, ago combines the grid extension with renewable energy. It involves 150 000 families per year, and costs $150 million US per year. The financial scheme shares the cost with all the partners – the electricity company, the urban population in a scheme of "National Solidarity", in which as all customers pay a 2% extra to support rural electrification. There is also contribution from local collectivities 20 %, and from users about 25%. To date, nearly 4 500 villages are connected to the grid thanks to PERG.

Decentralised rural electrification

For over a decade now, the government has developed large-scale pilot projects that have touched 10 000 households. The goal is to optimise services to be brought in, the institutional and financial operations set up and the operational mode to be applied for large-scale operations capable of providing 200000 PV systems ranging from 50-100Wc, over the next 6-8 years.

Projects	*International financing*	*Morocco financing*	*Application*
ERD-CE 2001-2004	US$10 m	US$3m	North
ERD-KFW 2001-2004	US$5 m	US$4.5 m	Tensift
PPER-France 1994-1998	FF30 m	US$7 m	Azilal Erracchidia Safi
Village Power 1996-1998	US$1 m		Chef-chaouen Taounate
PV Initiative of IFC (WB)	US$5 m		PV private sector support

The private sector has invested in marketing and distribution networks to meet the spontaneous private demand, which has attained 500 KWc annually.

It is expected that the 200 000 PV systems potentially demanded will be satisfied by mobilising private service operators who will operate on a 'fee for service' basis on behalf of the National Electricity Office (ONE). The service providers are required to provide maintenance for 10 years though the users will pay for it (US$5-10 per month and per family).

The potential market for the next five years is estimated at 10 MW PV for rural decentralised electrification. Cooperation between the private and public sectors enables the promotion of the technology, the development of standards and the costs reduction (PV SHS is around $500 per unit),

We note also the mobilisation of important investment, with the help of GEF-PVMTI and other international financing institutions,

Woodfuels

Current woodfuel programmes focus on fuel switching and energy efficiency. They include:

- Urban hammams (community bath houses): This involves promoting the massive dissemination of wood energy-saving technologies in Casablanca, through training, supervision, awareness-raising, informative and incentive-making measures (100 community bath houses are concerned in a first step of technology dissemination).
- *Integrated rural projects* comprising three components: Promotion of community hammams in the rural centres (50 units planned).

- Dissemination of fuelwood-saving stoves for cooking and heating in rural zones and encouragement of gas consumption.

"Energy houses" as rural ESCOs

The "Energy house" (EH) was designed to facilitate economic development in rural areas while addressing energy needs of populations. The EH is a microbusiness managed by a young entrepreneur who was selected after a rigorous selection process. The EH is in charge of the following:

Commercial services:

- marketing and sale of PV equipment and the accessories required for their operation (panel supports, lamps, gauges, batteries, regulators, etc.);
- marketing of solar water heaters;
- improving butane gas distribution and the sale of miscellaneous accessories (3-kg and 13-kg cylinders, lamp wicks, individual and semi-collective stoves, etc);
- marketing and sale of improved ovens and cookstoves;
- recharging batteries;
- installation, upkeep and maintenance services.

Promotional services:

The EH promoter acts as an interface between users, policy makers and energy entrepreneurs. The EH communicates the details of rural electrification programs and wood fuel programs to isolated communities and serves as a local information centre to sensitise populations about natural resource conservation.

Each EH requires an average capital investment of US$10000. A subsidy of US$5000 in the form of solar battery recharging equipment is provided by the government, US$2 000 of the capital investment accounts for the shop. The balance is equipment stocks, transport and some working capital.

Based on the experience developed through the decentralised electrification projects (PPER, PSE, Village Power, etc). each EH covers a rural commune (20 villages and nearly 1000 homes). The forecasted annual income for each house is US$10 000, guaranteeing a certain profitability and employment. More than 50 units have been launched in different regions of Morocco since 2000. Development potential nationally is estimated at more than 1 000 units.

In addition to the financial support mentioned, the young promoters are also invited to attend training sessions in technical fields, management and marketing offered by the government. Meetings between professionals and joint venture concerns are also organised to facilitate commercial cooperation between the EHs and professionals in the sector.

Renewable energy projects suffer during implementation from difficulties such as:

- timeframes given for raising funds unrelated to the dynamics of change in local approaches to implementation;
- inflexibility of available funding which adapts poorly to the type of development and action for some projects and hence to technological risks;
- inevitable commercial risks which professionals are unable to cover;
- the needs of solid technical and financial operators capable of meeting the demand generated by changes in the scale of projects, without hampering locally developed expertise;
- incompatibility between programs conducted in different parts of the world. The "PV roofs" programmes in Europe, for example, are not helpful to the decentralised electrification programme in Morocco due to the imbalance between subsidies that are still required for developing the market.

2.2.3 Solar water heating

Based on a market canvass study aiming at the development of the solar heater sector in Morocco, a potential market was identified for the installation of 400 000 m² of solar panels in the middle term. A national solar water heater (SWH) programme was launched in November 2000. This programme intervenes in four main areas:

A. Improvement in product quality

The quality of SWHs is guaranteed through the establishment of a Solar Performance Guarantee (GRS – *Garantie des Résultats Solaires*) chart, development of technical standards and specifications linked to solar heating equipment and setting-up of support procedures for CDER installations; training unit specialising in solar heating.

B. Incentives to facilitate access to SWHs

- Mobilisation and adaptation of existing finance tools at the level of consumer credit companies.
- Creation of a guarantee fund aimed to lower costs from the current US$500/m² to US$300/m² by means of incentive bonuses, reduction of the VAT from 20% to 7% and reduction in the sale price negotiated with the providers.

C. Policy

- Regulatory incentives: low building standards, encouraging the use of SWHs.

D. Awareness-raising and promotion

- Providing support (sensitizing, advertising) for the installation of 100 000m² of solar panels for individual and collective uses through the guarantee fund; the turnover for the commercial activities generated is an estimated US$43 million, with the market expanded to 40 000m²/yr instead of the current 5 000m²/yr.
- Installation of SWHs in government departments including education, health and housing departments;

The development of SWHs remains limited, due to:

- - low service reliability, which demands more serious efforts to improve the quality of equipment and related services;
- - high cost, which curbs its profitability; the potential for reducing costs (by 50%) is great;
- - non-availability of adequate industrial capacities and human skills,
- - insufficiency of messages that target potential users on this theme.

2.3 Hindrances and limits to renewable energy development

There are still many obstacles to the development of renewable energies. It depends on the extent of technological development for the subsector considered and the economic and social context in which it is exploited. The following can be noted:

i) The approach to renewable energies development in several projects depends solely on available technology rather than on the demand which, when taken into consideration, inspires the design and implementation of an appropriate, sustainable energy service.

ii) The quality of this energy service in terms of reliability of equipment, operation and maintenance still falls short of expectations, due to the inadequacy of standards pertinent to it.

iii) Local financial, industrial and human capacities are underused. Their reinforcement by ensuring their actual involvement constitutes an essential foundation for perpetuating the development process for renewable energies.

iv) Technological dependence is yet another hindrance to this development, especially when incentive measures are being set up in the Northern countries while other incentives in Southern countries are sometimes incompatible because of the way they are installed.

3 Prospects for integrated action

In light of the above, it is appropriate to stress the following:

- The necessity for greater development and application of these technologies on the African continent. Renewable energies should contribute as a complementary resource to meet needs on a cost-effective basis for electricity generation, and for rural uses (lighting, heating, education, health, agriculture).
- The importance of the private sector for the development of these technologies and the successful change of scale in their application.
- The importance of bilateral and multilateral cooperation in these endeavours;
- Further, to propose making special efforts to design an integrated plan of action for a large scale mobilisation of renewable energies.

3. 1 Plan of action

This plan focuses on three main areas:

Development of the market of well-tested technologies, by, for example: setting up innovative financial mechanisms that can cover the various types of risks related to investments and business development in renewable energy; a balanced subsidy on a sliding scale in order to bring technologies closer to the competitivity threshold; coverage of feasibility study and development charges for renewable energy projects; the development of local commercial distribution networks and after-sales service networks.

Technological transfers taking into consideration: the appropriateness of technology compared to part of local energy demands, how much the service brought in contributes to economic and social sustainable development; environmental conservation by reducing pressure on forest and gases aggravating greenhouse effects or the development of CO_2 sinks; the potential for developing a new local or regional industrial branch; and the existence of a favourable environment for investments.

Capacity-building by means of:

- Appropriate partnerships (joint ventures) permitting the strengthening of technological and industrial capacities in the region, in particular for wind energy, solar photovoltaic power and solar heat applications;

- Building up capacities at the human resources level in order to support auto-energy infrastructures and the promotion of renewable energies for sustainable development, by setting up training programs adapted to the needs of the African continent's various regions;
- The development of exchange and communication networks.

3.2 2001-2010: The decade for renewable energy

Finally, some of the concrete initiatives that the Commission on Sustainable Development could start to support such an action plan are to:

- incite people to plan precise quantitative objectives for 2010 with the assistance of developing countries;
- create a decentralised renewable energy fund devoted to expanding the market;
- identify a few leader countries that will receive special support for consolidating their experiences and be able to play the role of renewable energy promoters at the regional level;
- strive to achieve better communication by declaring the next ten years the Decade of Renewable Energy.

Barriers to the use of renewable energy technologies for sustainable development in Ghana

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1 Introduction

Sustainable development can be defined as "positive socio-economic change that does not undermine the ecological and social systems upon which communities and societies are dependent" (Rees, 1989). Any sustainable development agenda must be concerned with intergenerational equity – that is, with ensuring that future generations have the same capacity to develop as the present generation. A development path is sustainable only if it ensures that the stock of overall capital assets remains constant or increases over time. These assets include manufactured capital (such as machines and roads), human capital (knowledge and skills), social capital (relationships and institutions), and environmental capital (forests and coral reefs) (World Bank, 2000).

Sustainable development has many objectives. Its overarching aim is to lift the living standards of people, that is, raise per capita income. Embodied in this broad aim are specific goals of sustainable development, which include the following (World Bank, 2000):

- reducing poverty;
- expanding access to health services;
- increasing educational levels;
- helping to ensure a clean environment;
- giving everyone the opportunity to participate in public life; and,
- promoting intergenerational equity.

The role of energy in a nation's pursuit of its sustainable development agenda cannot be overemphasised, as energy facilitates all human endeavour. Energy is used for heating, cooking, illumination, health, storage of food, education, industrial production and transportation. These uses of energy are collectively called "energy services". A study of the goals or indicators of sustainable development enumerated above reveals that energy has a crucial role to play if any of the goals are to be achieved. For instance there is a link between the reduction of poverty and the availability of energy. While low energy consumption is not a cause of poverty, lack of available energy services correlates closely with many poverty indicators. Addressing the problem of poverty requires addressing its many dimensions – for example, inadequate or unavailable educational opportunities, health care, unavailability of potable water and accessible and functional sanitation facilities. Addressing these issues involves increasing the level of energy services (UNDP, 1997).

Meanwhile, the production, conversion and consumption of conventional energy entail adverse environmental impacts, many of which have contributed directly to recent global environmental concerns such as climate change, atmospheric pollution and acidification. As a matter of fact, "many of the human-based threats to the species and biosphere are energy-related" (UNDP, 1997). Since sustainable development has as part of its multi-faceted objectives the need to ensure a clean environment as well as promote intergenerational equity, increasing supply of and access to energy for socio-economic development should be pursued in an environment-friendly manner so that the world's ecological systems can be preserved for the generations yet unborn.

In spite of the fact that it has become widely recognised that sustainable development depends, to a large extent, on access to appropriate energy services, modern energy supplies and services are unevenly distributed in the world. According to 1997 estimates, over two billion people continue to cook using traditional fuels,[1]

[1] These traditional methods have their associated health hazards.

while 1.5-2 billion people lack electricity (UNDP, 1997; ESMAP, 2000). Majority of these people live in rural settlements in developing countries, especially in sub-Saharan Africa. A great challenge is therefore posed to governments in these countries to ensure that their people have access to clean, efficient, reliable, and affordable energy services.

Traditionally, rural energy needs the world over have been met mainly by extending electricity distribution network out of the cities and towns already electrified to rural settlements. As the years go by, however, the cost of bringing power to new consumers has increased because of lower consumer density in the new rural areas being served. In the light of increasing construction costs per consumer, low revenues (due to lower disposable incomes), and the logistical difficulties and associated costs encountered in managing rural systems, electric utilities around the world have found it increasingly difficult to meet demand for electricity in rural areas (ESMAP, 2000). As extension of the grid to rural areas became more and more expensive, the need arose for cheaper and decentralised options to be explored.

The use of renewable energy is one option that has become popular in recent times. The upsurge in the popularity of renewable energy can be attributed to three main reasons – declining costs, commercial maturation and environmental protection (limiting the environmental effects of energy use). Renewable energy is defined as an energy resource that replaces itself within a human lifetime. Examples include, sunlight, wind, running water, biomass and geothermal heat. Renewable energy technologies (RETs) are those technologies that convert renewable energy to electricity or any other form of modern energy. Examples of RETs include photovoltaics (PV), windmills, cogeneration, small hydro, etc. RETs offer a greater prospect of meeting the cardinal goals of sustainable development than conventional energy sources. This is because not only can RETs contribute to energy service needs, they also do so in an environment-friendly way. There are however some limitations and barriers to the adoption and utilisation of RETs.

Ghana, the study area, is a low-income developing country with a dominant unelectrified rural population. An estimated 60-65% of the population are without electricity or any other form of modern energy. In a bid to address this imbalance and its associated problems, the government of Ghana in 1989 launched the National Electrification Scheme (NES) with the aim of providing the whole country with reliable electricity for household energy needs, community services and productive uses by the 2020. The main strategy adopted in pursuit of this goal was the extension of electricity from the national grid to unserved areas. At the inception of the NES, no provision was made for the electrification of remote and/or isolated communities using renewable energy technologies, in spite of the fact that this in many instances offers cheaper options. Recently however, the government of Ghana through the Ministry of Mines and Energy (MME) is exploring the potential role of decentralised renewable energy-based electricity services as an alternative to grid extension and also as least cost options.

This paper examines the potential contribution that RETs can make to Ghana's sustainable development agenda. The paper analyses the barriers to the deployment of RETs in Ghana and recommends ways by which the barriers could be removed to facilitate the wide-scale adoption and utilisation of RETs in Ghana. The paper is divided into five main sections. Section two assesses the renewable energy potential of Ghana while Section three discusses and analyses barriers to three RETs – solar water pumps, biogas and small hydro power. Section four presents a range of policy options that could be adopted by the government to push forward the frontiers of renewables.

2 Renewable energy in Ghana

2.1 Resources and technologies

Ghana is endowed with a significant amount of renewable energy resources, which include biomass, solar radiation, hydro (both large and small) and wind. Biomass (an acronym for biological mass) is the dominant source of energy in Ghana accounting for 69% of the total energy consumed in Ghana (MME, 1998). Examples of biomass include woodfuel (made up firewood and charcoal), wood residues, crop residue and human/animal waste. Woodfuel is used significantly in the domestic sector for cooking and many other heat applications. At the beginning of the last century, Ghana had about 8.3 million hectares of tree cover. Currently however, the tree cover has dwindled to a little over 2.0 million hectares[2], due mainly to excessive logging activities. Until recently the timber industry was the country's second largest foreign exchange earner. The production of timber products (lumber, veneer, etc) generates a lot of waste/residues that can be used as biomass energy. Examples of logging waste include stumps,

[2] Out of this, about 1.63 million hectares are designated as forest reserves, whilst the remaining 0.4 million hectare is being exploited on a sustainable basis.

butt-end off-cuts, crown-end off-cuts and branch-wood. Sawdust, bark, slabs, edgings, off cuts, veneer waste, cores and shavings are examples of wood processing residues. In 1990 an estimated 688 262 tons of residue was generated from logging activities alone. In the case of processing residue, 517 845m^3 out of 805 665m^3 of log equivalent processed in 1993, went to waste (FPIB, 1993).

Agricultural residue is another important source of biomass energy in Ghana. Agriculture is the backbone of the Ghanaian economy with the sector contributing about 41% annually to GDP. Various kinds of tropical crops are cultivated in Ghana, which generate significant residues after harvesting. Examples of the residues include maize cobs, rice husks, palm branches, shells and nuts.

Ghana, located within the tropics (between latitude. 4° and 12°N and longitude 30°W and 1°E), is endowed with solar energy, particularly in its northern regions. The average annual solar radiation is 16-29 MJ/m^2 and the country receives daily solar irradiation of between 4 and 6 kWh/m^2 with a corresponding annual sunshine duration of 1800 – 3000 hours. The solar radiation is however very diffuse in the southern part of the country (around 45%) with northern Ghana having low diffuse radiation of around 32%.

Initial studies to assess the wind potential of the country concluded that Ghana did not have a favourable wind regime for the generation of wind power. Recent studies however have shown that the potential exists along the coastal regions. Preliminary estimates put the wind energy potential of Ghana around 2000 MW.

As stated earlier, Ghana is endowed with hydro resources. A total of about 70 small hydro power sites have been identified, 16 of which have been studied. It should, however, be pointed out that the small hydro power potential of Ghana, in comparison with the large hydro potential, is rather modest. This potential has been assessed under three different scenarios: minimal (cautious), maximal (optimistic), and medium (ACRES International, 1989). The estimated installed capacity under the optimistic scenario is assessed to be approximately 14 MW if the plants are connected to the grid and 4 MW if plants are to supply to isolated communities.[3]

Most of these types of renewable energy resources (except small hydro and wind) have been harnessed using various renewable energy technologies. Solar energy technologies used so far include solar water pumping (SWP), solar water heating (SWH), solar crop drying (SCD), solar refrigeration, solar home systems (SHS) and solar lighting while pyrolysis, improved cookstoves, biomass-fired drying, sawdust briquetting, biogas and cogeneration are the biomass technologies that have been experimented, demonstrated and disseminated to date. None of the small hydro sites mentioned above have been developed as yet. The only pilot project at a site called Likpe-Kukurantumi on the Dayi River in the Volta Region was abandoned in 1983 even though the project reached an advanced stage.[4] With regards to wind, as indicated earlier on in this paper, initial studies of the wind regime in Ghana had concluded that the wind regime was not favourable for wind power. This caused wind energy to be relegated to the background when Ghana was trying to develop its renewables. However recent studies have shown that the potential does exist in Ghana, especially along the coastal belt. This has rekindled interest in wind power and there are indications that within the next few years, the first wind park in Sub-Saharan African could be built in Ghana.

2.2 Policy

Exploitation of Ghana's renewable energy resources has been carried out under two main policy regimes – the National Energy Board Law, 1983 (PNDCL 62) and the Renewable Energy Development Programme (REDP), a component of the Energy Sector Development Programme (ESDP). The former established the National Energy Board (NEB) and among other things mandated it to direct the development and demonstration of renewable energy projects throughout Ghana. The latter is the policy framework that has been guiding the development of RETs from 1996 till the present. Several measures and instruments have been employed in the implementation of the above policies. The REDP had the following objectives:

i) to improve the efficiency of production, conversion and use of woodfuel;
ii) to demonstrate and evaluate renewable energy technologies with the potential to meet prioritised socio-economic needs of the people;
iii) to provide support for research, development and demonstration of RETs with the greatest potential to increase and diversify the country's future energy supply base;
iv) to promote the development of renewable energy industries that have strong indigenisation prospects over the short and medium term; and

[3] These estimate could be higher since it represents only an extrapolation.

[4] Almost all the civil works were completed and the generating plant brought in from India. The plant has since been lying idle at the Electricity Company of Ghana head office in Accra.

v) to develop the relevant information base on the stock and status of renewable energy resources, suitable technologies and end-use patterns for the purposes of establishing a planning framework for the rational use of the country's renewable energy resources.

The main strategies which have been used to achieve these objectives are research, development and demonstration, as well as education and information. Economic or market-based instruments have been used only to a limited extent. Some specific instruments used so far include subsidies, petroleum taxes and PV import duty waiver.

A careful evaluation of the REDP by the authors shows that the programme has not been effective enough to ensure commercialisation and widespread utilisation of the RETs they seek to promote. The REDP has neither an investment plan nor financing mechanisms and relies heavily on government budgetary allocation and donor funding which are not sustainable. The REDP is a document full of strategic objectives but devoid of an investment plan or set targets. What the REDP has succeeded in doing is to demonstrate the viability and feasibility of many of the technologies. What is needed is a policy framework that will ensure commercialisation and widespread utilisation of RETs in Ghana. Fortunately the REDP is coming to end and a new "National Renewable Energy Strategy" is being formulated under the Renewable Energy Component of the DANIDA Energy Sector Programme Support.[5] It is hoped that the Strategy will contain all the necessary measures and instruments required to push the application of the renewables forward.

Thus in spite of the efforts made by the government to promote RETs in Ghana, the contribution of renewable energy to the energy mix is still very small. Even in the case of solar PV where most recent efforts have been channelled, total installed capacity as at the end of 1999 was only 1 MW. Most of the technologies are now proven in Ghana, but they have not been able to move from the demonstration stage to the commercialisation stage. This suggests that there are barriers to effective development, implementation and widespread utilisation of RETs in Ghana.

[5] In 1996, the governments of Denmark and Ghana agreed that the energy sector would be one of the priority areas for future Danish-Ghana development cooperation assistance. Pursuant to this agreement, the Danish government is funding the ESPS. REC is a component under ESPS supporting the development and management of Ghana's renewable energy.

3 Barriers to RETs in Ghana

Barriers hampering the development and dissemination of RETs in Ghana have been studied and analysed in a report entitled "Renewable Energy Technologies in Ghana: Barriers and Opportunities". The study is a case study of Ghana commissioned by UNEP Collaborating Centre on Energy and Environment in Risoe, Denmark and undertaken by Kumasi Institute of Technology and Environment. The report looked at all the RETs implemented in Ghana so far but discussion and analysis of barriers was carried out on only eight of the technologies namely: solar water pumps, solar crop dryers, solar water heaters, small hydro power, sawdust briquettes, sawdust stoves, biomass fired dryers and biogas.[6] Out of the eight, detailed analysis of barriers was carried out on three, which were seen to have the greatest potential for successful implementation. These technologies are the solar water pump, biogas and small hydropower. In this section, we will limit our discussion of barriers to these three technologies because of the constraint imposed by the length of the paper and also because the three have been studied in more detail. However recommendations made in the last section as to how best identified barriers could be removed to facilitate the role of RETs will not only be restricted to the three but will be directed at RETs in general. Barriers are analysed under three broad categories – socio technical, economic and cross-cutting barriers.[7]

3.1 Barriers to solar water pumping

High costs and difficult to quantify benefits, lack of information, mismatch between resources availability and demand, and absence of government policy have been identified as the main barriers to SWP in Ghana.

3.1.1 Costs and benefits

The costs and benefits barrier has been found to be the most important barrier to the technology. SWP, like many of the other solar RETs, is characterised by high initial costs with benefits that are difficult to quantify. The costs and benefits barrier has several dimensions. First, there is the time lag between incurring the costs at the very beginning and reaping the benefits over time. Second, there is the issue of cheaper alternatives like hand pumps on the small-scale end and grid-connected pumping systems on the large-scale end of the domestic water supply

[6] Solar PV systems and biomass-fired cogeneration plants were excluded because they are already receiving much attention from various organisations in the country.

[7] See Appendix 1 for the framework used to analyse the barriers.

spectrum. Third, there is the well-known trend of PV costs coming down over time and the advantages of building the necessary infrastructure now in anticipation of reaping the benefits later in the future but there is also a question as to who should bear the higher costs at this point in time.

3.1.2 Lack of information

The second key barrier identified is the information barrier. The study revealed that information on the benefits associated with SWP was not widespread and that in general people are simply not aware of the costs and benefits of SWP. It was also revealed that information on the usefulness and reliability of the technology has not been adequately disseminated.

3.1.3 Mismatch between resource availability and demand

Another important barrier identified by stakeholders is the mismatch between resources availability (season/time of day) and demand. The demand for water peaks in the mornings and evenings when radiation from the sun is low. This characteristic often necessitates a storage tank to compensate for the demand and resource availability mismatch, which eventually goes to add to the cost of installation.

3.1.4 Absence of government policy

It was revealed in the study that there was no government policy to promote the use of SWP. This can however be attributed to the *information* barrier discussed above.

3.2 Barriers to small hydro power

Absence of policy on SHP, lack of financing mechanisms, a dearth of information, the low tariff level, and environmental concerns – all these have been identified as the key barriers to SHP in Ghana.

The RETs study (KITE, 2000) found the absence of policy for the development of the SHP resources in Ghana to be the most important barrier. Ghana's REDP has made no provision at all for the development of the SHP resources in the country. SHP schemes are not even classified under the renewables in the document let alone provision made for their development. Consequently SHP has not featured in the portfolio of RETs that the government is promoting in Ghana.

The policy barrier is the most important barrier because it has a bearing on the other key barriers identified. For instance if a policy had been in place, the requisite institutional arrangements and funding/financing mechanisms would possibly have been addressed. It is also significant to point out that there is an inter-relationship between the key barriers. For example, the absence of policy on SHP is due partly to unavailability of information to policy-makers on the usefulness of SHP. Again reliable information on costs and benefits of the technology has an influence on the availability of financing mechanisms.

3.3 Barriers to biogas

Lack of resource availability, unfavourable policies, appropriate financing mechanisms and lack of social acceptability have been identified as the key barriers impeding the implementation of biogas projects in Ghana.

3.3.1 Resource availability

Lack of adequate resources for biogas plants has been found to be the most important barrier to the dissemination of the technology. Cow dung and human excreta are the main biomass feedstock for biogas. Water will also have to be readily available to be used to mix the dung. However, the study revealed that the resources are not available at all times and in certain cases would have to be transported over long distances to be used.

3.3.2 Unfavourable policy

It was revealed through the study that the existing policy guiding the development of renewables is not very favourable for the wider dissemination of biogas. The strategy used so far is to demonstrate the technology through the establishment of pilot projects with the view of replicating the findings. This has however not been done.

3.3.3 Lack of appropriate financing mechanisms

There have been attempts by private entrepreneurs to set up biogas plants. However there are no soft financing mechanisms in place for private investors to acquire the needed capital. Entrepreneurs will have to borrow at high interest rates (45%-50%). Consequently many of their initiatives have been stifled.

3.3.4 Lack of social acceptance

It was again revealed that another main barrier to the biogas technology is lack of social acceptability, especially when biogas is to be used for cooking.

4 Strategies for improving the role of RETs

It is significant to point out at this juncture that, although the barriers identified in the previous section are technology-specific, many of them are generic to the RETs, using the same or similar renewable energy resources. For example, the "costs and benefits" barrier is typical of all the solar technologies, as most are characterised by high start-up costs with often difficult to quan-

tify benefits. In the same vein the "resource" barrier is also typical of most of the biomass technologies. Again, the lack of information barrier has tended to impede the development and commercialisation of almost all the RETs demonstrated and implemented so far in Ghana.

Having examined the barriers to RETs in Ghana, we are of the view that the following policy options could remove many of the barriers identified thereby paving the way for RETs to significantly contribute towards the achievement of Ghana's sustainable development goals. The options are discussed under solar, small hydro and biomass. Some general recommendations for all RETs are also presented.

4.1 Solar

With solar technologies, the key barrier has been identified to be the high start-up cost associated with the acquisition of the technology. To overcome this barrier, new and innovative financing mechanisms need to be devised. Consequently, the following measures are suggested:

- A fund should be set up in one or several financial institution(s) to administer soft loans, grants and flexible financing schemes to solar technology dealers and end-users. Such a fund could be fed by disbursements from the Energy Fund.[8] Money raised could be used to implement any of the World Bank's innovative financing mechanisms.[9] For instance, the dealer model can be experimented using money from the fund. However because the model thrives well in large and relatively high-income rural markets, areas that satisfy this criterion may have to be targeted for such an experiment. Alternatively the fund can be used to test the concession model as an appendage to the solar services centres already existing in certain districts. Options such as these help spread the start-up cost.
- Costs could be reduced further if the import duty reduction on PV panels is extended to a complete waiver.[10] Meanwhile, any such policy directive authorising a complete waiver should be formal (codified) and must not leave any room for ambiguity as is happening in the case of reduction in import duty.
- To help expand the market for solar PVs, rural electrification projects aimed at meeting the lighting need of the beneficiaries should consider the use of solar lighting as an alternative to the extension of grid electricity. In this regard, we recommend that a body, say Ghana Solar Energy Society (GHASES) or the Energy Research Group (ERG), liaise with MME to source funding to be used for conducting studies to determine situations in which between solar and grid extension, the former is a cheaper option for meeting the energy service needs of end-users. Once this is established, there should be a commitment on the part of the government under the Self-Help Electrification Programme (SHEP)[11] to go for solar electrification by paying for a greater proportion of the costs involved, as pertains under SHEP. Alternatively, a model akin to the concession model can be introduced under the SHEP whereby the government contracts and pays a local company to provide energy services to meet the rural electrification objective.
- In the same vein a market could be created for PV systems in the urban areas if PV systems are mandated to be integrated into urban housing and building designs, especially peri-urban areas yet to be serviced with grid electricity. However, because the use of the technology is uncommon in the building industry, some education and information programmes would have to be carried out. We therefore recommend that training programmes and seminars be organised by GHASES for private estate developers, the Ghana Institution of Surveyors, Architectural Engineering Services Limited, architects, building contractors, etc. on a periodic basis. The aim of these seminars/workshops would be to introduce participants to the methods by which PV applications can be integrated into buildings and their accompanying benefits. Funds for the organisation of such programmes could be sourced from the Energy Commission.
- The government could introduce a policy measure stipulating that all government-

[8] The Energy Fund was established under Section 41 of the Energy Commission Act, 1997. The fund is fed primarily by levy on petroleum products. Monies raised through the fund could be used inter alia for the promotion of RETs and rural electrification.

[9] These are the Dealer Model, Retailer Model and Concession Model.

[10] In May 1999, the government reduced import duties payable on PV panels from 27.5% to 5% in an attempt to reduce the cost of the PV systems.

[11] SHEP is a complementary activity to National Electrification Scheme, under which communities that are within 20 kilometres from the national grid could fast-tracked their electrification projects by procuring all the low voltage poles and ensuring that a minimum of 30% of houses within the community are wired.

funded building projects in district capitals and peri-urban areas such as the construction of new schools, district assemblies' offices, and health centres, must incorporate solar PV systems into such projects. In addition, a standard can be set for new peri-urban building schemes whereby private developers would be required to incorporate solar RETs into the design of the housing units. In view of the fact that compliance with such a measure would inevitably swell up the cost of the projects, some incentives like tax holidays would have to be provided for the private developers to ensure compliance.

- To help create a market for locally manufactured solar components such as ballasts, low voltage disconnect, and controllers, a policy directive should be instituted by the government which stipulates that all government funded and donor-funded solar PV projects should use local components where available. This will help reduce the costs of PV installations.
- Regarding SWP, we recommend that GHASES or ERG organise training workshops and awareness-raising seminars for all stakeholders in the water supply industry. Stakeholders to be invited should include staff of the Community Water and Sanitation Programme of the Ghana Water Company and World Vision International (an NGO constructing boreholes at various parts of the country) and district assemblies.
- For solar crop dryers we recommend that educational programmes be run for agricultural cooperatives and farmers' associations to inform farmers on the benefits of the technologies. COCOBOD (final buyer of all cocoa beans produced in Ghana) could also be lobbied to acquire solar crop dryers for major cocoa growing areas to be operated and managed by agricultural cooperatives and/or district assemblies. Meanwhile, for COCOBOD, farmers' cooperatives and/or individual farmers to have an economic incentives to adopt the technology, the educational programmes should be able to bring out the advantages and benefits that solar crop dryers have over the conventional mode of drying, which is virtually cost free.
- In the case of solar water heaters, similar training or awareness-raising workshops or seminars should be organised for the hospitality and manufacturing industries, also on periodic basis, to provide information on the technology. The government must then provide incentives to encourage operators to acquire the technology. For example, a tax rebate or holiday could be granted to hotels and manufacturing firms using SWH. Alternatively, firms not using SWH to meet their hot water needs could be made to pay a penalty. In addition, the Public Utilities Regulatory Commission could design special tariffs for households using SWH. All these measures will provide economic incentives for the acquisition of the technology.

4.2 Biomass

- Environmental standards governing urban waste disposal should be reviewed and made more stringent by the Environmental Protection Agency in collaboration with the Ministry of Environment, Science and Technology (MEST). This will provide an incentive for producers of urban waste to dispose of their waste in an environment-friendly manner. For instance a legislation, which outlaws the burning of wood residue as a means of disposal and imposes punitive fines on violators will help motivate timber firms to devise strategies for the environmentally safe disposal of their wood residues. This would likely create a conducive environment for modern biomass technologies such as briquetting and cogeneration.
- Metropolitan, municipal and district assemblies should also be statute bound to dispose of waste in an environmentally friendly manner. With this legislative backing, MEST, MME and Ministry of Food and Agriculture (MOFA) could then organise a series of workshops and seminars for district assemblies on ways of utilising waste for biomass energy and organic fertiliser. Private companies contracted by metropolitan authorities to dispose of waste should be invited to such workshops/seminars. Meanwhile education programmes should be run for the general public on the need for disaggregating solid waste into organic and inorganic waste. Separate containers should then be provided at waste disposal sites for the public. After these workshops, funds should be sourced by the three ministries (MME, MEST and MOFA) to implement demonstration projects at selected waste disposals sites. This requires closer collaboration between the three ministries and we propose the setting up of an inter-sectoral working committee to foster collaboration and linkages between them.
- As an incentive to investors to venture into residue-based power generation, the government should introduce some economic instruments. We propose that the five-year tax break currently being enjoyed by inves-

tors under Ghana's investment code should be extended for another five years for investments in residue-based power generation. Alternatively import duties on residue-based generating equipment could be waived or a premium tariff could be worked out by the Public Utilities Regulatory Commission for residue-based generation.

- We also propose that about 5% of the Reforestation Fund currently being administered by the Forestry Commission be earmarked for plantations that will grow short-rotation trees to be used as feedstock in biomass power plants.

4.3 Small hydro power

- For SHP we propose the formation of a Multi-Stakeholder Small Hydro Group (MSHG) by the Energy Commission. Stakeholders could be drawn from the MOME, EC, Hydrological Service Department, AESL, the universities and NGOs such as KITE and the Energy Foundation. The MSHG will among other things source finance from the Energy Fund and/or other governmental sources to:
  - i) Complete the Likpe-Kukurantumi pilot project;
  - ii) Develop local capacity to manage, operate and maintain the Likpe-Kukurantumi pilot project;
  - iii) Review, update and disseminate the assessment of the SHP potentials of Ghana; and,
  - iv) Organise workshops and seminars for districts having SHP resources with the aim of providing information on the benefits and opportunities associated with the development of SHP, particularly the revenue generation potential of SHP where excess power generated will be sold into the grid.
- In addition, the stakeholder group should work in collaboration with the PURC in fixing tariffs for electricity generated from SHP sources. To be able to do this effectively, the group will have to conduct comprehensive cost-benefit analyses on the sites.
- The stakeholder group when formed should also play an advocacy role by lobbying for the inclusion of SHP in national renewable energy programmes.

4.4 RETs in general

- The government must assign a clear role for renewables in its National Electrification Scheme. We recommend the introduction of a "Renewable Energy SHEP Programme" under which rural communities remote from the grid will be electrified through renewables. Before any community is connected to grid electricity, the MME should consider all supply options and choose that which is cheapest.
- To ensure private sector participation in the renewable energy industry, the government must provide a level playing field in energy services. In view of the fact that conventional energy is heavily subsidised, similar subsidies must be provided for the renewables while economic tariffs for all forms of energy are brought into force.
- Plans and programmes for the extension of grid electricity should be made available to the public to reduce uncertainty about when the grid will reach a particular location. This will enable private investors to identify potential markets for renewable energy service, that is, those that are unlikely to be connected to the grid in the near future.
- On the institutional front we recommend that the Renewable Energy Unit of the MME should be hived off into a full-fledged NGO using the "Energy Foundation"[12] model. This will guarantee autonomy for the unit in pursuit of its objectives.
- A Clean Development Mechanism (CDM) office should be set up by the government and the proposed renewable energy NGO should work with other interested parties to assess and package renewable energy projects that will pass for CDM projects as the CDM becomes operational.

4.5 Concluding remarks

We have already made a number of recommendations on ways to remove barriers and promote widespread utilisation of RETs in Ghana. Notwithstanding these recommendations, we are of the view that before the renewables can make any significant contribution to the energy balance in Ghana, the government must first set *targets* for the renewables and then devise strategies to achieve these targets.

We have therefore proposed a target of 20% Modern Renewable Energy (MORE) in Ghana's commercial energy sector by the year 2020. To demonstrate how this could be achieved, we have come up with what we termed "a wish list for

[12] The Energy Foundation is a NGO established in November 1997 to, among other things, take over the MOME's Energy Efficiency and conservation Programme.

20% MORE" [13], that is, how renewables can account for 20% of projected installed capacity for electricity in Ghana by 2020. We showed in the wish list that at a GDP growth rate of 10% (as envisioned in Ghana's Vision 2020[14] document) the installed capacity for electricity would have to increase from the current capacity of about 1500 MW to a little over 10 000 MW in 2020. Twenty per cent of the projected capacity of 10 000 MW will then translate into 2000 MW. The Wish List might appear ambitious but it has been shown that between modern biomass, solar energy (including wind) and small and medium hydropower the target is achievable. Both the resource potential and technical capabilities exist, what is needed now is the right policy framework with a range of instruments and measures designed to ensure that the 20% MORE target is met.

The biggest obstacle to achieving this target will be how to raise the large amount of investment capital required to generate 2000 MW of electricity from renewable sources. However, with the right mix of economic incentives, significant amounts of private capital could be mobilised. We see a window of opportunity in the CDM and other environment related financing mechanisms that are emerging.

Furthermore, power sector reforms could provide yet another avenue through which private investment could be channelled to renewables where found to be a cheaper alternative. Renewables can benefit tremendously from private investments with the rationalisation of tariffs – from current low levels to more economic levels – and the unbundling of what to a large extent, has been a vertically integrated electricity industry.

Finally, a target of 20% MORE will send clear signals to private investors that there is a long-term plan for renewables and hence renewables should be considered in their investment portfolios. This would also help to mobilise the investments required to generate 20% MORE by 2020.

References

ACRES International, 1989, Assessment of Mini Hydro Potential in Ghana.

ESMAP, 2000, "Reducing the Cost of Grid Extension for Rural Electrification", Report 227, Energy Sector Management Assistance Programme (ESMAP), The World Bank, Washington, DC.

FPIB, 1993, Log Production Statistics, Forest Products Inspection Bureau (FPIB).

ESMAP, 2000, Energy and Development Report, World Bank, Washington, DC.

KITE, 2000, "Renewable Energy Technologies in Ghana: Barriers and Opportunities", Report Submitted to UNEP Collaborating Centre for Energy and Environment (UCCEE), Risoe, Denmark, Kumasi Institute of Technology and Environment (KITE).

Ministry of Mines and Energy, 1998, National Energy Statistics.

Rees William, E, 1989, Defining Sustainable Development, Research Bulletin, Centre for Human Settlements, Vancouver, University of British Columbia.

UNDP, 1997, Energy After Rio: Prospects and Challenges, United Nations Development Programme (UNDP), New York.

World Bank, 2000, *World Development Report*, World Bank, Washington, DC

[13] See Appendix 2 for the "Wish List"

[14] It is a long-term programme launched by the GOG in 1995 to transform Ghana from a low- to middle-income status by the year 2020.

Appendix 1
Framework for barrier analysis

Socio-technical barriers

Resources

Resources too small
Time variations in resources do not fit demand
Shortage of dung (or input) in the case of biogas
Others (specify)

Technology/technical

Immature in some cases
Low R&D capabilities to develop and promote more affordable RETs
Capacity irreversibility
Lack of access to the technology and maintenance of the systems
No servicing of equipment
No operating manuals
Low durability
Others (specify)

Environmental

Energy prices do not include social and environmental costs
Lack of valuation of environmental externalities
Others (specify)

Social

No social acceptance
No local participation
No local ownership (the community do not cooperate without ownership/responsibility)
Neglect of socio-cultural aspects of technologies

Economic barriers

Market barriers

Energy Ministry cannot disseminate

Missing or segmented markets
Bad supply channels
No local access, only in major towns
Limited access to international markets of modern RETs
Others (specify)

Cost and benefits

Costs too high
Import duty and taxes on technologies
Energy prices do not include social and environmental costs
Subsidies on fossil fuels
Others subsidies
Others (specify)

Financing

Inadequate financing (local, national, international) arrangements
Missing consumer financing schemes
Others (specify)

Cross-cutting barriers

Information

Low consumer awareness
Lack of end-user acceptance
Lack of information to consumers about the usefulness, prices, reliability, etc
No mechanism for getting views from the communities
Others (specify)

Institutional

Institutional capacity limitations (R, D&D, implementation, etc)
Institutions do not collaborate
No detailed knowledge available at regional and district levels
Structural constraints and biases within the energy sector
Limited involvement of the private sector
Limited supply of skilled labour, professionals and training facilities
No payment rules for sales to the grid from independent power producers
Disparities between national, individual and community objectives
Others (specify)

Policy

Missing policy framework or energy strategy
Unfavourable energy policies and unwieldy regulatory mechanisms
Others (specify)

Appendix 2
20% MORE: A wish-list for RETs in Ghana[15]

	Solar	*Modern biomass*	*Wind*	*Small & medium hydro*	*Total*
Short term (2000-2005)	10	10	50	5	75
Medium term (2005-2010)	50	100	200	200	550
Long term (2010-2020)	200	500	500	300	1 500
Total	260	610	750	505	2 125

[15] Proposed targets (MW installed) for electricity from renewable energy in Ghana.

Renewable energy technologies in Egypt: Opportunities and barriers

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1 Introduction

As a result of the current concern with searching for new energy resources, supporting renewable energy technologies (RETs) already in use, increasing the efficiency of current systems and promoting RETs world wide, the UN and other international organisations are supporting many projects and programmes, especially in developing countries. This paper presents the results of the "Implementation of Renewable Energy Technologies Project – Opportunities and Barriers".[1] The project included case studies for three countries: Egypt, Ghana and Zimbabwe. In addition to the direct results of the national studies, the project aimed to provide input to the preparatory process of the Commission for Sustainable Development in its ninth session in 2001.

The project used case studies of renewable energy implementation projects to analyse the reasons for success or failure of specific projects or technologies. In particular the study aimed to identify possibilities for "removing" the main barriers and thus "promoting" increased implementation of RETs, and to "generalise" the experiences from the case studies and produce results that can be disseminated and utilised further in a planned second phase.

The specific objectives for the Egypt Country Study are:

- To determine, on the basis of analysis of the past experience, the barriers to implementation of RETs in Egypt, and to identify the favourable conditions and actions required for such implementation.
- To apply the knowledge gained and results of the analysis of past projects for a detailed analysis of barriers to a chosen set of potential RETs implementation projects with view to success.
- To identify specific RET projects for implementation, including necessary actions to overcome identified barriers.

This paper reviews the commercialised renewable energy (RE) technologies in Egypt, presents the current status of their applications, and identifies barriers, opportunities and key issues on which actions are needed to overcome these barriers. Section two presents the energy statistics and policy; section three presents the RE strategy in Egypt; section four summarises the current status of commercialised RET applications; section five presents the barriers hampering the dissemination and wide use of the three selected applications, and the actions required to overcome these barriers. Conclusions and recommendations are presented in section six.

2 Energy statistics and policy

Fossil fuels, in addition to hydropower and non-commercial fuels such as firewood, agricultural wastes and dried dung, are the main energy resources in Egypt; petroleum fuels are the most important energy sources at present and will be for many years to come. The total production of oil and natural gas has been increased about 60% over the last 18 years: in 1980/81 the total production was 33 MTOE (million tons oil equivalent), rising to 55.482 MTOE in 1998/99.

Hydropower resources supply a considerable amount of the current electric energy consumption in Egypt. The energy generated from the High dam, Aswan dams, Esna and Naga Hammady barrage power stations in 1998/99 was 15.3 TWh, representing 22.5% of the total electricity generated. This hydropower is not included in the renewable energy category.

Uranium and thorium have been discovered in Egypt. Special authority for nuclear materials was established under the Ministry of Electricity and Energy to accelerate its exploration and exploitation.

The total commercial energy demand of Egypt has increased from about 3 MTOE in

[1] This was initiated jointly by UNEP, UNDP and RISØ National Laboratory and sponsored by DANIDA. UNEP Collaborating Centre on Energy and Environment at RISØ (UCC/RISØ) was the co-ordinator for the project

1959 to 30 MTOE in 1998/1999 with an average annual growth rate of 4.57% [1].

The Supreme Council of Energy (SCE) is responsible for formulation of energy policy in Egypt. It consists of the ministers of electricity and petroleum, and works in consu1tations with the parliamentary committee for industry and energy. The energy policy in Egypt focuses on:

- enhancement of natural gas utilisation;
- adjustment of energy prices and removal of subsidies;
- energy conservation and efficient energy use;
- promotion of renewable energy utilisation.

3 Renewable energy strategies

In the early 1980s the government of Egypt recognised that traditional energy resources would be inadequate to meet future needs. Consequently a national strategy for the development of energy conservation measures and renewable energy applications was formulated in 1982 as an integral element of national energy planning. The New and Renewable Energy Authority (NREA) was established in 1986 to be a focal point for renewable energy activities in Egypt. The renewable energy strategy aims to supply 3% of electricity production from renewable resources by 2010. It is obvious that the implementation of such a strategy will be an essential element of the national plan for achieving sustainable development and protection of the environment via upgrading energy efficiency and replacing conventional polluting resources by renewable resources.

Apart from the recognised achievement in starting RET development, demonstration and commercialisation, the effective market penetration was below expectations. The total energy savings by RETs counts for almost 0.395 MTOE annually; over 39% of this is due to the commercialisation of some renewable energy applications, mainly domestic solar water heating (DSWH), industrial process heat, and electricity generation (solar and wind).

To achieve the government's goals, to satisfy the energy needs for the country's development plans, and to make sure that renewable energy takes its proper place in the sustainable supply and use of energy for greatest benefit of all, the following measures have been set for the development of renewable energy:

- assisting and promoting the real local, regional and global environmental benefits of renewable energy;
- research / transfer, development, demonstration and testing of the different technologies;
- establishing testing and certification facilities and development of local standards and codes;
- encouraging improved information and education on renewable energy;
- involving young people in information programmes and studying renewable energy, through a parallel closely integrated programme.

4 RETs applications in Egypt

Most of the solar, wind and biomass technologies and applications were demonstrated and field-tested. Other renewable energy resources and technologies are still in the research and development phase. The following section presents a brief review of the commercially exploited RETs applications in Egypt.

Solar thermal technologies

The first action enabling the achievement of the strategic objectives was the assessment of solar resources in Egypt. Several studies and research audits indicated that Egypt enjoys excellent solar availability, with an annual global solar radiation between 900-2600 kWh/m^2. The resource assessment led to the preparation of the Egyptian Solar Atlas, which includes data and maps for a typical meteorological year.

Solar thermal technologies were identified as among the main RET options that can make an impact in achieving the strategy targets. Intensive efforts were directed mainly at three options:

- solar thermal water heating (STWH) for domestic and commercial sectors.
- solar thermal systems for industrial process heat (IPH).
- solar thermal electricity generation (STEG).

STWH for the domestic and commercial sectors

In 1980, in order to introduce the technology to the Egyptian market, the Ministry of Electricity and Energy imported 1000 DSWH systems, using flat-plate collector technology. In the same year, the first private sector local manufacturing was started, since when DSWH systems are manufactured locally. Currently about 200 000 families are using DSWH systems in Egypt.

In 1992 NREA established the outdoor solar thermal laboratory which is currently the main research, testing and certification facility for solar thermal applications in Egypt. More than seven local manufacturers are now working in the field.

Over 65% of the total energy saving by renewable energies in the last decade was due to

the commercialisation of solar thermal technologies, mainly domestic solar water heaters.

Solar industrial process heat

The industrial sector consumes almost 50% of the total national primary energy. IPH accounts for more than 60% of the total industrial energy consumption, distributed among the different types of industry. Several studies have been undertaken to forecast future annual demand for IPH, with several scenarios proposed, relating to expectations of developments in the Egyptian economic structure and in industry. Two demonstration projects were implemented by NREA and another one is under implementation.

Solar thermal electricity generation

NREA has developed an ambitious programme for large-scale electricity generation using integrated solar combined cycle power plant to help meet local electricity needs and expected electricity exports to Europe. In 1995, NREA initiated a Bulk Renewable Energy Electricity Production Programme for large-scale power generation, which focused mainly on STEG, using mature and appropriate technologies. The first Egyptian integrated solar combined cycle system (ISCCS) power plant, with a capacity of 126 MW, is under implementation in Kuraymat. The GEF/World Bank funded the incremental cost with a target date of operation during 2004. Two other similar projects are anticipated to be implemented before 2010

Photovoltaic (PV) technology

Electricity demand is growing rapidly in Egypt, so efforts are directed at developing the use of renewable energy technologies in rural and remote areas. Photovoltaics for electricity production and pumping of groundwater seem to be the most cost-effective option for the current energy requirements of these areas.

The present use of PV in Egypt is characterised by a few traditional and/or professional applications financed on commercial terms and numerous donors. In 1995, total installed capacity of PV applications was estimated to be around 1MWp. Currently, however, several projects and plans totalling more than 10MWp are under preparation [2].

In general terms, PV applications in Egypt can be grouped into four categories:

- remote / professional services (telecommunication, railroad, navigation, and or AIDS);
- donor-assisted applications (mostly water pumping and treatment);
- private sector applications (billboards and small farms);
- NREA and other governmental body applications.

Wind energy applications

In the field of wind energy, the following preparatory activities were undertaken:

- assessment of wind resources;
- conducting financial and economic and environmental feasibility studies;
- establishment of training programmes; and
- establishment of demonstration projects.

These were followed by an active programme, started by NREA and supported by many international donors, for the implementation of large-scale grid-connected wind farms. The project aims at installing 600MW of wind turbines by 2010, with the first 300MW scheduled to be in operation by 2004; 63MW out of the 300MW have already been installed and connected to the grid.

For the purpose of training and capacity building, the Wind Energy Technology Centre at Hurghada was equipped with the necessary training facilities to serve as the first training centre in the Middle East and Africa in the field of wind energy technology. The centre is also used for monitoring and testing both large and small-scale wind turbines, and as a national and international training, research and certification centre.

Biomass energy

In Egypt the total biomass resources potential is 40 million ton / year (see Table 1) [3], and biomass resources contribute more than 3.6 MTOE / year of primary energy. With the expected applications of efficient new modern technologies to available biomass resources this contribution will grow.

Status of biomass projects

With few exceptions, biomass activities in Egypt have been focused mainly on small-scale biogas plants with a digester volume ranging between 5 and 50 cubic metres. Application of larger systems has been limited and unsuccessful. On the large-scale level, biogas activities have not moved away from the laboratory or pilot stage, so only a few larger plants have been constructed. One of them was a 170-m3 digester in EL-Giza Army Camp, constructed in the early 1980s by the Food and Agriculture Organisation (FAO). Presently a huge biogas plant is being constructed by General Organisation for Sewage Treatment (GOST), but it is not related to the biogas programmes.

Plant residues are the most important traditional fuel in Egyptian rural areas, so the biomass laboratories at NREA Testing and Certification Centre are equipped with an advanced briquet-

ting system to convert ligneous plant residues into an alternative solid fuel. These briquettes are uniformly shaped, easily transported and stored, and have better physical and combustion properties than do the residues in their unprocessed state. They are also free of insects and disease-carriers. Eventually this will produce an improved form of solid fuel that can be used efficiently to replace more petroleum and electricity.

5 Barriers and opportunities

Based on the following criteria three RETs applications were chosen for detailed barriers and opportunities analysis:

- adequate resource base for the RET (solar, wind, biomass, etc);
- available technologies and their costs;
- commercial viability and financing (public, private, international);
- environmental impacts and benefits;
- socio-economic impacts, including job creation;
- coverage of both centralised and decentralised options.

The selected RET applications are domestic solar water heating systems, electrification of remote areas using PV systems, and large-scale biogas systems.

Beside the previous review, questionnaires and interviews were conducted among manufacturers, organisations and agencies, users and owners, and targeted users. Responses were analysed, and the barriers were classified as being of the following types:

- economic and financial;
- awareness and information;
- technical;
- market;
- social;
- institutional and policy.

The following are the results of analysing the stakeholders' responses and comments for each of the three selected applications.

5.1 Domestic solar water heating systems

Although DSWH systems are generally straightforward, responses indicate that minor faults can lead to serious problems, especially when they are not detected early. It was also revealed that there is an urgent need to restore the confidence of both existing and potential users. Many installations have not performed as expected due to low level of awareness and some technical problems were aggravated by lack of maintenance.

The solar industry, until now, has not been able to prove DSWH systems as an environmentally attractive and potentially economical means of providing targeted users with hot water. The detailed barriers' analysis showed that self-sustaining DSWH market growth needs dedication and effort from industry and other interested parties.

A thorough understanding of the market situation is rather difficult, but the overall analysis shows many converging points:

- About 26.5% of the key players (users, manufacturers and experts) indicated that the economic barriers are the main barriers for DSWH industries.
- The awareness/information barriers were

Table 1: Biomass potential resources, available and used quantities.

Kind of wastes	*Total potential*		*Total available for energy*		*Total utilised as energy*	
	MT/y	*MTOE/y* [a]	*% To TP*	*MTOE/y*	*% To TP*	*MTOE/y*
Agr. residues: – Plant	18.7	7.48	46	3.50	41	3.06[b]
- Animal	7.6	2.66	36	0.95	15	0.40
Municipal	6.6	1.65	36	0.59	5	0.08
Sewage	4.3	0.86	56	0.48	10	0.09[c] 0.09
Industrial	–[d]					
Total	37.2	12.65	43.6	5.53	28.7	3.63

a. The average calorific value used in energy calculations for different kinds of wastes plants, animals, municipals and sewage are 4000 – 3500 – 2500 – 2000 kcal/ kg dry matter receptively.

b. 65 % is sugar cane bagasse used in the sugar factories as a fuel.

c. A huge biogas plant of 220 000 m^3 digester volume with a 18 MW electric power generation plant is being initiated in the El-Gabal El-Asfer sewage treatment plant for Cairo.

d. Data not available, but is a considerable amount.

ranked second with about 24% of stakeholder ranking it as such.

- Technical barriers were chosen as the third most important set of barriers by about 22% of the stakeholders – although some experts and users pointed out that it would be ranked first if the DSWH systems were more common. But manufacturers argued that the lack of knowledge about the system design and operation together with seldom maintenance are the cause of the problem.
- Other barriers given were: institutional – 14%' social – 6%; market – 6%; policy – 2%.

Recommended actions to remove DSWH barriers:

1. Development of effective public awareness and promotion programmes that depend mainly on market surveys and studies and concentrate on media, especially TV and newspapers. The concept, the benefits and the operating conditions required should be clear to end-users through these media strategies.
2. Allowing systems and spare parts to be available in shops and markets especially outside Cairo. This should be accompanied with availability of maintenance centres.
3. Dissemination and promotion of DSWH systems could be done through exhibitions held in syndicates, hotels, clubs, etc.
4. Demonstrating systems can be presented in "wide impact" places, like cities councils, clubs, big factories, conferences halls, stadiums, etc.
5. Some printed materials (leaflets, brochures, etc) should be made available to give the customers the necessary information needed for optimum choice of DSWH systems (technicalities, advice for operation and maintenance, entrusted companies, the phone numbers of the supervisory authorities especially in the case of complaints about quality and after sale services).
6. Organising courses, seminars, and workshops for targeted end-users in schools, universities and clubs to introduce DSWH technology in particular and renewable energy in general.
7. Establishing small-scale solar laboratories in schools and universities, similar to physics and chemistry laboratories.
8. Some form of federation, union or society which brings together representatives of users, companies, financial sources, policy makers and researches could be very useful to co-ordinate efforts.
9. Financial support from the government, private sector and donor agencies should be sought. Availability of credit facilities with low interests and reduction of prices for competing considerations must be the main concern.
10. Soft loans to young engineers and technicians should be provided through donor agencies or social development funds to establish new centres or retrofit existing centres to maintain and market DSWH systems.
11. Incentives corresponding to the subsidies given to electricity and natural gas consumers could be introduced, in the form of subsidising the initial cost or reducing users' taxes or electricity invoices.
12. Encouraging local manufacturing by reducing taxes and customs duties on DSWH components in addition to production requirements and necessities.
13. Providing financial and technical supports to the research and development activities in development and improvement of the products.
14. Company guarantees for systems performance and quality should be provided to cover the estimated lifetime of the systems.
15. Supervision of manufacturing companies (production lines, quality, and after sales service) should be ensured. The supervisory testing and certification authorities should be fully supported to prevent inferior products from entering the market.
16. Periodic checks on factories can take place, together with providing advice about improving quality. This should be for a small charge, and with full support from the government.
17. Rules and legal mechanisms that ensure the existence of sanctions and penalties and to enforce their importance should be firm enough regarding quality and after-sale service.
18. The current manufacturing standards and specifications should be revised carefully to include quality control and assurance components as well as proper installation requirements. New comprehensive standards are required urgently.
19. A programme or mechanism to solve the problem of the already installed systems in the new cities should be prepared and implemented. It should be the result of co-operation between all the responsible ministries and authorities as well as the manufacturing companies and dealers. The programme should include some mechanism for informing the inhabitants about the systems and their regular duties (cleaning and checks), and be given without charge.
20. Maintenance centres outside Cairo in other cities and villages should be set up; they could also serve as marketing outlets.

21. In the case of large tenders, the supervision of NREA or experts trained and approved by NREA on tender specification and systems acceptance should be considered of vital importance. Persons responsible for the preparation of tenders and specifications, as well as supervising installations and accepting the systems, should be properly trained and qualified – this is an important lesson learnt from the past.

5.2 PV rural electrification

The following are barriers to the dissemination of solar home systems (SHSs):

High dissemination costs

The target group for rural solar electrification is people living in dispersed rural dwellings, where there is low percentage of wealthy households. Dwellings are far apart, so that costs for commercial dissemination, installation and after-sales services are high – estimated to be about 30% of the total costs of PV systems [4].

Lack of information

In spite of efforts in recent years, there is still a dearth of information regarding the services that PV can provide. PV is still only an exceptional solution in rural programmes for potable water supply.

Tariffs system

The tariff system of utilities does not reflect the real cost of rural electrification. Tariffs for electricity consumption are identical in rural and urban areas, although the costs of supplying electric energy are much higher in the countryside. In Egypt there are even lower tariffs for small consumers and this has led to a situation where rural households in particular pay small amounts for their consumption of grid electricity. The SHS offers less comfort and fewer energy services than the grid, and is more expensive. For these reasons, it could be that rural population groups refuse PV and demand to be connected to be electrical grid.

Taxes and import duties

As in many other developing countries, SHS is considered a luxury product and is subject to high import duty in Egypt. Sometimes tax exemptions are limited to equipment, which is imported in the framework of co-operation projects, public projects, programmes, or the activities of NGOs. This is, of course, unfavourable for commercialisation. Imported equipment and materials have to be purchased in foreign currency, which may cause problems to businessmen in developing countries. If some components such as charge regulators and batteries are produced locally, importation of these components is often charged high duty, to protect the market for local manufacturers. Such a decision may cause severe problems, if the local technology proves unreliable.

High capital costs

This is a problem especially in the remote areas, where most people cannot afford these systems. At the same time there is no suitable financing mechanism to support them.

The opportunities and the potential contribution of PV systems in rural development programmes are:

- the high potential of small villages with no access to the grid;
- government policy to electrify all small villages and settlements;
- Egypt has very high solar radiation;
- the technical and technological experiences are available.

Means to overcome the PV rural electrification barriers

- High level, dedicated and continuous awareness campaigns should be launched to bring out the potential merits of PV systems and applications.
- Integrating PV rural electrification projects with other development programmes.
- Instituting a national programme that integrates all PV rural electrification projects.
- Manufacturers, suppliers, and agents should have their representatives and centres near the consumers.
- Creating new financial schemes.
- There should be more government-supported market incentives to encourage commercial development and deployment.

5.3 Large biogas plants

The following are the main barriers to disseminating large biogas plants (LBPs).

Information and awareness

- Lack of communication with the interest groups regarding environmental work.
- Lack of awareness about the economic and environmental impacts of LBPs.

Institutional

- Lack of cooperation between the involved institutions and organisations.
- Absence of NGOs playing a role.

Economic and financial

- Competing petroleum products and electricity are subsidised and availability in the countryside.

- The high capital costs of LBP in comparison to other organic waste treatment systems.
- There is no economic evaluation for the positive environmental impact of the LBP.
- Unavailability of land.

Technical

- Quality problems with raw material.
- Rapid change in animal-growing projects.
- The absence of a national developing, adapting and manufacturing programme for LBP to fit local conditions.
- Lack of local technical experts for design and construction.
- Lack of training facilities.
- Lack of maintenance facilities

Means to overcome these barriers

- Setting up a co-ordinating committee for planning and implementing the action plan for LBP. Instituting a national action programme for LBP implementation within a defined period to clarify whether technological development, agricultural, environmental, co-operatives and energy-related interests, could lead to the creation of financially competitive LBPs.
- Setting up a co-ordinating committee for planning and implementing the action plan.
- Strengthening the co-operation between the concerned ministries, authorities, institutions and organisations through involving them in the national action plan on logical basis with defined tasks.
- Awareness about the necessity of LBP as a source of clean energy, waste treatment, economic feedback and environmental and social benefits.

6 Conclusions

The case study revealed that for DSWH the main barriers are economic, followed by awareness / information , and technical and institutional barriers. For PV rural electrification, the most important barriers are economic and financial, awareness and information barriers, and then technical. For the large-scale biogas systems, the main barriers are institutional and capacity, economic, policy and awareness / information.

According to the project results the main actions that could be taken to overcome the barriers and make use of the available opportunities are:

1. Economic / financial

- Creation of new financial schemes for RETs applications, components and systems.
- Reducing the taxes and duties for the components and / or materials needed for RE systems.
- More government-supported market incentives to encourage further commercial development and deployment of RE technologies are needed to help overcome market reluctance to invest in RE systems.

2. Technical

- Setting rules and legislation for quality assurance, standardisation, and certification for all the RE components and systems.
- Manufacturers, suppliers, and agents should have their representatives and centres near the consumers and between them.

3. Information and awareness

- Development of effective public awareness and promotion programmes such as demonstrating systems, some printed materials, training courses, seminars, presentations and workshops for targeted users, small-scale laboratories in schools and universities.

4. Donor support

- The support of international organisations is urgently needed, especially for setting monetary values for emissions reduction to subsidise RETs.

References

[1] Organisation for Energy Conservation and Planning OECP, Egypt, “Energy in Egypt 1998-1999”, 1999.

[2] New and Renewable Energy Authority, Ministry of Electricity and Energy, Egypt, “Country Profile”, 1999.

[3] H. A. Gomma, ”National strategy for biomass energy in Egypt”, National forum on biomass energy, Cairo, Nov. 1999.

[4] UNEP Collaborating Centre on Energy and Environment, RISØ National laboratory, Denmark, “The indirect costs and benefits of greenhouse gas limitations: Mauritius Case Study”, 1999.

[5] Egyptian Electricity Authority, Ministry of Electricity and Energy, Egypt, “Annual Report of Electricity Statistics”, 1998.

[6] Mahmoud. M. K., “ Renewable Energy in Egypt, a Pathway to Sustainable Development” 17th World Energy Council Congress, Houston, 1998.

[7] Zanoon. M. And Hegazi. A., “New and Renewable Energy Strategy, Programs, Achievements”, 1994.

[8] Survey of Energy Resources, 18th Edition, 1998, World Energy Council.

[10] "Arab Republic of Egypt: Energy Sector Assessment. ESMAP Report No 189/96". ESMAP, The World Bank. 1996.

[11] "Feasibility Report. Wind Farms on the Gulf of Suez. Volume I and II", PA Consulting Group for DANIDA, October 1993.

[12] "Statistical Year book 1991-1996. Arab Republic of Egypt." Central Agency for Public Mobilisation and Statistics (CAPMAS). June 1997.

RURAL ENERGY

The role of woodfuels in Africa

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A recent Food and Agriculture Organisation (FAO) study on the use of energy from wood reported that, according to best current estimates, African woodfuel consumption reached 623 million m^3 in 1994. This consumption level means that Africa has the highest per capita woodfuel consumption (0.89 m^3 /caput/year) compared to other continents (Asia, for example, has 0.3 m^3/ caput/year). Except for the five North African countries and South Africa, all African countries still depend heavily on wood to meet basic energy needs. In the various African regions, woodfuel share ranges from 61% to 86% of primary energy consumption, with a major part (74% to 97%) consumed by households. It is therefore imperative that the management of woodfuel resources and demand is considered a major issue in energy planning processes in Africa.

Woodfuel consumption is a major contributor to total wood removal, accounting for around 92% of total African wood consumption. Woodfuel use is therefore a major local and global environmental issue in Africa, and should be fully integrated into forestry planning and environmental protection processes.

In addition, woodfuels play a major socio-economic role in almost all African countries. As is well documented, women are generally the most concerned with fuelwood issues since they devote a large part of their time to fuelwood gathering and cooking tasks; charcoal production and marketing, on the other hand, tend to be more formalised and male-specific, helping to provide jobs and substantial revenue for rural and urban people. These activities represent significant economic value in many countries, accounting for approximately US$6 billion for the whole of Africa. More than US$1 billion of this amount was due to charcoal. The social and economic changes associated with urbanisation will lead to a significant shift from fuelwood to charcoal, increasing its energy, environmental, economic, and social role in Africa in the future.

Despite these important interactions with development, environment, and social welfare, there have been only a few attempts in Africa to include woodfuels as a basic sector in planning

processes. The scarcity, limited scope, and poor quality of existing data, despite some efforts to improve woodfuel information systems have seriously hampered such attempts. Data shortcomings and the resultant little knowledge and understanding of the wood energy flows, balances and projections, make the design of relevant wood energy programmes difficult.

One of the results presented in the FAO study refers to the limitations of present woodfuel data sources for Africa. Some, such as FAO's own work, remain the sole source of data that includes almost all African countries and provide continuous time series for each country. However, our database presents estimates rather than actual figures, and provides no detailed sectoral figures. The assessment of databases on wood energy of IEA, ESMAP, ENDA and others, leads to the conclusion that there is an urgent need for better and more consistent data.

The following are some of the main findings and recommendations of the FAO study on wood energy:

- Woodfuels are likely to remain a major energy source and a determining environmental and development issue in Africa in the mid-term future and even in the longer term.
- Therefore, a special effort should be made aiming at improving knowledge on woodfuel demand and supply, as well as on its economic and social role.
- This should include a unified approach to a systematic data collection, compilation and analysis, with the involvement of major international organisations.
- The quality of woodfuel data in Africa should be improved considerably through a pilot programme targeting the major consuming countries or the countries where data quality is particularly poor.
- In the longer term FAO could act as a repository of the data collected at the country level. This would allow a continuous observation process for woodfuel data and a monitoring of the woodfuel situation.
- Regional collaboration and exchange of experiences could be developed among African countries.
- Some of the main findings of this study are:
- an upward trend in woodfuel use in Africa from 1980 to 1996, of the order of 30%;
- the wood energy use trend by subregion, with the West Moist Region being the highest, mainly due to the high consumption in Nigeria (which constitutes around 20% of total consumption);
- the relative contribution of various sectors to woodfuel consumption, with the household sector accounting for around 90%.
- the increasing importance of charcoal as an energy fuel; its consumption grew at the expense of fuelwood, indicating a fuel switch in both urban and rural areas;
- woodfuel consumption per capita in the different subregions – the drop in the West Moist Africa region reflects the decrease in wood energy in countries such as Nigeria, South Africa and Tanzania;
- the share of woodfuels in total primary energy consumption per subregion – these data reflect the availability of other fuels in North Africa, and the low energy use for productive activities in the East Sahelian, Central and Tropical Southern subregions of Africa.

The trends reveal that liquefied petroleum gas (LPG) use in Africa is unlikely to play a significant medium-term role in meeting energy demand. In the future, these trends are likely to be confirmed; in fact woodfuel use seems to be growing, owing to the following three parameters:

- Population growth is higher than the substitution process to LPG.
- An urbanisation process implying a shift to charcoal in most African countries. Low carbonisation efficiencies will mean greater wood demand.
- Concentration of consumption in urban areas leads to greater pressure on nearby forest resources.

These facts will lead to greater pressure on forest ecosystems.

National policies and an effective transfer of technologies to allow an upgrading of wood energy utilisation technologies are required.

FAO is presently revitalising its bioenergy activities. Woodfuels are only a part of the available and potential biomass which could be converted into useful energy for both urban and rural requirements. Agriculture has a dual role as an energy user and as an energy supplier in the form of bioenergy. This energy function of agriculture offers important rural development opportunities as well as a means of climate change mitigation by substituting bioenergy for fossil fuels. Any effort in the field of wood energy should also focus on the challenges and opportunities of advancing modern bioenergy technology, in general, and on the technical, environmental and economic benefits of the energy function of agriculture and forestry.

Production and use of biofuels as an energy source are linked to a host of issues, such as

agriculture and food security, land use and rural development, sustainable forest management and biodiversity conservation, and mitigation of climate change.

Bioenergy has to be seen in its relation to poverty, population development and health. The fact that women and children in many rural areas spend a good portion of their working day in search of fuelwood, reflects the need to look at bioenergy in the context of gender roles and survival strategies for the poorest of the poor.

Imbalances are to be resolved between household economy and environment, between conservation and consumption of biofuels and between present and future needs of societies.

Conclusions

- The potential of forest and agro-industrial by-products, as well as purposely grown energy crops as locally available, and renewable sources of energy in rural areas need to be stressed.
- Access to adequate and affordable energy is one of the prerequisites for equitable socio-economic development.
- The use of biofuels can contribute towards more gender-balanced rural employment and income, strengthen rural livelihood systems and attain better levels of food security.
- New and/or improved technologies for bioenergy utilisation as an industrial energy source at competitive market prices are required.
- Improved efficiency, effectiveness and safety of biofuel utilisation increases its contribution to rural livelihood systems.
- There is a real threat to forests and trees outside forests if fuelwood is used in an indiscriminate and unsustainable way. This threat can result in forest degradation or deforestation, deterioration of watersheds, loss of soil fertility as well as biodiversity;
- Substitution of fossil fuels through biofuels can contribute towards a cleaner environment, reduction of emissions and a mitigation of climate change.
- FAO is ready to assist governments in the development of policies and strategies that include the sustainable production and utilisation of biofuels.
- There is a need to improve the quality of country level data on biofuels, and to strengthen national and institutional capacities to collect, analyse and disseminate the information.
- Bioenergy activities need to be set in the context of a contribution to the implementation of the Rio Declaration and Agenda 21, as well as the Conventions on Climate Change, Biodiversity, Combating Desertification, and other energy-related international agreements.
- Bioenergy is a cross-sectoral concern and an essential element in the transition to sustainable development.

An overview of biomass energy issues in sub-Saharan Africa

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Note: The views expressed in this paper are those of the author and should not be attributed to the World Bank.

Introduction

Increasing awareness of the negative environmental impacts of fossil fuels energy systems offers a renewed opportunity for sub-Saharan African countries to rethink the pathways of their energy transition. These countries still have the possibility to adopt energy policies and technologies that could be socially equitable and environmentally sustainable.

To date, energy policies in the region have mainly focused on the conventional energy sector to the neglect of the renewable energy sources. With a new development paradigm that posits poverty reduction, equity, and environmental sustainability as key drivers, energy policies need to be inclusive of renewable energy, and particularly biomass energy, in order to stimulate social and economic changes to meet basic needs of populations in the region. This overview of biomass energy in sub-Saharan Africa focuses on: (i) the place of biomass energy in the energy balance; (ii) adverse effects of inefficient and unsustainable use of biomass energy; (iii) benefits associated with efficient and sustainable biomass energy use; (iv) barriers and constraints attached to the development of biomass energy schemes; (v) initiatives, new opportunities and challenge. Finally, some policy recommendations are provided.

1 Biomass energy in the energy balance

Per capita energy consumption of the region is amongst the lowest in the world. Access to conventional energy is low and the majority of Africans in both urban or rural areas rely on biomass energy. Traditional biomass energy in the form of fuelwood, charcoal, and dung represents about 70% of the final energy consumption in sub-Saharan Africa as a whole. When the Republic of South Africa is excluded, this share increases to about 84% of the final energy consumption (Bengaly et al. 1997).

There are striking differences in biomass use across regions of Africa. Based on 1995 figures, the share of biomass use is respectively 94% in sub-Saharan Africa, 5% in South Africa and 2% in North Africa (Lambert D'Apote, 1998). What these figures mean is that the majority of communities in sub-Saharan Africa have started the 21st century without the energy to sustain basic livelihoods, just the same way they started the 20th century.

Among factors that affect the demand for biomass energy, rapid urbanisation, household income levels, and poor access to alternative energy sources are important. Sub-Saharan Africa has experienced over recent decades high population growth rates that was not followed by good economic performance. As a result, living standards have remained low, especially in rural areas. Large numbers of the rural population are moving to urban areas to seek a better life.

In 1980, about 27% of the African population was living in urban areas. In 2000, this figure increased to 38% and it is expected that about half (49%) of Africans will be living in urban areas by 2020 (World Resource Institute, 1999). Provisions for social and infrastructure services, including energy services, are not following urbanisation. Most economies in the region have performed rather poorly. Consequently, the incidence of poverty in sub-Saharan Africa is high, with about 46% living below the international poverty line. Output per capita has decreased and is lower at the end of the 1990s than 30 years before. Similarly, investment and savings per capita have declined since 1970 (World Bank, 2000).

Theoretically, households are expected to switch to modern fuels with increasing income. Traditional biomass energy is expected to be used at low levels of income, charcoal, kerosene and bio-gas at intermediary income levels, and LPG and electricity at high income levels. This energy transition has started in many urban areas of sub-Saharan Africa. A growing preference for charcoal use in middle-income households instead of wood is generally the first observation.

LPG is also gradually being adopted in high-income groups in these settings. But, regardless of households' income level, woodfuels are still used. Instead of an orderly transition where households move to modern fuels, it is rather a transition with a multi-use of fuels that is so far experienced. Cultural preferences make households cook some meals using woodfuels even if they can afford electricity and LPG.

Biomass energy is expected to continue to play an important role in the energy balance in Africa for the next two to three decades. Projections prepared by the International Energy Agency with the assumptions of business as usual for population and GDP growth indicate that the share of biomass in the final energy consumption would be about the same (60%) for the continent in 2020 compared to 1995 figures. Between 1995 and 2020, consumption of biomass energy is expected to grow by about 2.4% per annum (Lambert D' Apote, 1998).

2 Adverse effects of inefficient and unsustainable use of biomass energy

Traditional biomass energy use is associated with health and environmental concerns. Inefficient burning of firewood and dung emits toxic substances like carbon monoxide, sulphur, and nitrogen oxides which cause bronchitis, emphysema and other respiratory diseases (UNDP, 1997; Sokona & Thomas, 1999; Listorti & Doumani, 2001). These health hazards affect mostly women and children and contribute to low birth weight and high mortality rates.

Increasing use of wood for energy is also a serious threat to the environment, especially in fragile ecosystems. Although land clearance, grazing and bush fires are more important contributors to deforestation, the mining of forest for energy also contributes when natural regeneration is low. The inefficient conversion of wood to charcoal to meet growing urban demand for energy is a particular serious threat for the environment. The efficiency of earthen kilns used in charcoal production is low – in the range of 40-60% – while in some areas about ten bags of wood is needed to produce one bag of charcoal (Hill et al., 1996).

Recorded rates of deforestation in sub-Saharan Africa are already among the highest in the world (Sharma et al., 1994) and continuing reliance on traditional biomass energy is likely to exacerbate negative pressure on forest resources. The evidence of this trend is observable around urban areas of major African cities where forest resources have been destroyed to provide households with wood energy. The main production zones of wood and charcoal are moving systematically further and further from urban centres. In some cases, urban traders of charcoal have cleared immediate forests of rural communities, pushing women and children to spent considerable amount of time and energy to collect wood further and further from their households.

Moreover, as a result of continuing civil disturbances, ethnic conflicts, and wars, there is a growing population of refugees in Africa that rely on the natural environment as a shield. Reports indicate pressure on biomass resources by refugees. Populations forced to seek refuge in neighbouring countries are exploiting in unsustainable ways forest resources to survive. Behaviours provoked by precarious life situations of refugees are factors accelerating the degradation of the resource base in asylum countries. Evidence of this tendency is found in countries such as Kenya, Tanzania, Sudan, Guinea, Burundi, and Malawi (UNHCR,1998).

In many countries, the state of biomass resources is unknown. Data collection efforts are rather weak or non-existent. International sources – mainly the FAO –allow some assessment of the resource. Modern methods such as remote sensing are needed to access the real situation and evolution of forest resources. Socio-economic and energy consumption surveys are also routinely needed to monitor wood flows.

3 Benefits associated with efficient and sustainable use of biomass energy

Sustainable exploitation of wood energy through planned forest management, efficient charcoal processing, and the use of biomass as a modern energy carrier, offer socio-economic, financial, and environmental and health benefits.

Socio-economic benefits: The trade of wood and charcoal in Africa is unofficially estimated about US$5 billion a year (Barnes & Floor, 1999). At the present, only strong urban-based commercial lobbies are mostly benefiting from this activity. These lobbies are well organised and often carry considerable political weight. Attempts to reverse their practice is often a concern of governments. In a situation where governments did not succeed in enforcing common property land management rules to replace traditional ones, the commercial lobbies operate in a legal vacuum, depriving rural communities of their natural resources. Community-based participatory forest management backed by reforms on the legal and regulatory framework sustaining the exploitation of forest resources has the potential to return earnings to rural communities, reducing income inequalities between rural and

urban areas and contributing to stop the tendency of rural areas subsidisation of urban residents. Rural areas could therefore become progressively attractive areas to other economic activities (for example the overdue development of agro-industries) and rural populations could have the necessary income to consume more goods and services.

Financial benefits: Technologies exist to convert biomass to gas, liquid fuels, and electricity. Some of these technologies have been used and are in use in sub-Saharan African settings (Karekezi & Ranja, 1997). Scenarios of future energy use indicate that biomass energy as a modern energy carrier has the potential to be a direct substitute for fossil fuels (UNDP, 1997). This is a particularly interesting option for non-oil producing sub-Saharan African countries, which currently spend a substantial amount of their foreign revenues to import oil to produce electricity for just a few. Balance of payments can be improved and freed resources can be allocated to poverty reduction programmes.

Environmental and health benefits: There are also environmental benefits associated with a better management and modernisation of the biomass energy sector. Sustainable and efficient use of biomass contributes to reducing emissions of carbon dioxide (CO_2). Healthy forests are good carbon sinks, and better management of forests contributes to mitigate soil erosion and acid rain. The efficient use of improved stoves contributes to reduced indoor pollution and health hazards associated with traditional use of biomass.

4 Barriers and constraints attached to the development of biomass energy schemes

Some key barriers and constraints associated with the development of biomass energy schemes in sub-Saharan African are: (i) the nature of energy systems and institutions; (ii) an unfavourable legal and regulatory framework; and, (iii) an overall weak political commitment to renewable energy.

The nature of energy systems and institutions: Energy systems and institutions in sub-Saharan Africa were constructed within an inadequate development paradigm. Unlike developed countries, where energy systems and institutions evolved with production and consumption patterns, in sub-Saharan Africa they were rather constructed in isolation with the intention to help countries make rapid progress and catch up with modernisation. Colonial administrations based on a mercantile rationale developed basic electricity infrastructure in targeted areas to support the exploitation of raw materials and to provide electricity services to populations in growing urban areas.

At independence, there was no fundamental change of policy sustaining the construction of energy systems and institutions. The focus was rather on the expansion of the colonial infrastructure, firstly to support the emerging "modern" productive economy mainly directed towards export activities, and, secondly, to facilitate access to electricity to populations living in urban areas. In some countries, efforts were made to connect main towns in rural areas to the grid. But, forty years after independence, in the majority of rural areas darkness prevails when the sun goes down.

Synergies between energy systems and the contextual requirements of agriculture, industry, transport, housing and other social services were weak right from the beginning. Rural electrification programmes, where they existed, were not fully integrated into rural development strategies. Social programmes, where they existed, were not designed to benefit from optimal choices of available energy resources. In short, energy systems and institutions did not evolve with the objectives of meeting and improving basic human needs such as food, housing, health and education services, running water, sewage management, and job creation. Sarr et al. (1998) have concluded that energy systems in the region are dysfunctional as they have developed separately to peoples needs and without a coherent strategy. Along the same lines, according to Best (1997), large-scale centralised energy systems dominated energy planning and the potential of readily available indigenous biomass sources favouring decentralised development were overlooked. Indeed, a supply-driven and capital-intensive approach was dominant and energy planning in the region neglected end-use considerations.

An unfavourable legal and regulatory framework: The legal and regulatory framework in the energy sector is not favourable to the development of biomass energy schemes. Wood energy prices are still too low and do not reflect the economic value of the resource. High start-up costs of biomass schemes discourage investment and competing fuel prices are an obstacle. Legal and regulatory frameworks are still based on a fossil fuel economy rationale, and social and environmental sustainability issues still have to be accounted for to allow the private sector and the civil society at large to participate in the operation of the sector.

A weak political commitment to renewable energy: Policies aimed at the promotion of fossil fuel-based energy have influenced the pri-

orities of policymakers. Policy discussions aiming at the development of renewable energies, including biomass energy, are often crisis-time rhetoric when urban areas experience severe power outages or when oil prices are high. When the situation becomes relatively normal these discussions are often not pursued. Short-term planning and crisis reactions to energy problems did not allow countries to elaborate strategies to develop the renewable energy sector. In some countries where strategies were elaborated, they were not implemented. In particular, governments find it difficult to take the necessary measures to regulate the biomass energy sector because it requires a systemic approach, as links with land tenure and agriculture policies are important ones.

5 Initiatives, new opportunities and challenges

A review of initiatives in the biomass energy sector are beyond the scope of this paper. They can be found in work done by World Energy Council and FAO, (1999). Only a brief discussion is attempted here. New opportunities susceptible to contribute to the development of biomass schemes and their associated challenge are also highlighted.

Initiatives: Many initiatives in the biomass energy sector stemmed from the increase in oil prices of 1973 and 1978 and also from experiences of repeated droughts in the region. Some of this first generation of programmes were demand management programmes, mostly focusing on the introduction of improved stoves and kilns to improve end-use efficiency of woodfuels. Programmes to accelerate interfuel substitution – from wood energy to LPG and/or kerosene – were also attempted. The idea was to accelerate the energy transition from traditional biomass energy to modern clean fuels and thereby reduce pressure on forest resources. There were also some large-scale forestry programmes as part of this first generation of initiatives. The woodfuel gap theory was the dominant theory sustaining both the improved stoves and forestry programmes. Deforestation was blamed on increasing demand for woodfuel.

In general, these programmes have had mixed results. Some succeeded for some time but faded later on as donor funding stopped. In some cases, interfuel substitution benefited from subsidies and when they were removed some households turned back to woodfuels. There were programmes that were also ill-adapted to the contexts and eventually performed poorly. Local communities in many places rejected large-scale public-oriented forestry programmes directed to solve the woodfuel crisis. Issues of community participation, local capacity development, adaptability of devices, and sustainability of initiatives were mostly overlooked at the design stage of these programmes. With the realisation over the years that the production and consumption of woodfuels is not the main force responsible for land degradation and droughts, coupled with a context of relatively low oil prices, donor interest faded.

A second generation of initiatives started mostly in the 1990s, with the growing understanding of human impacts on the environment. The Rio conventions sanctioned this momentum with a renewed interest in desertification, biodiversity and climate change issues. The second generation of initiatives is a combination of community and participatory forest management initiatives, demand-side interfuel substitution initiatives, and emphasis on local institutional strengthening. The approach and programmes initiated by the World Bank Regional Programme for the Traditional Energy Sector (RPTES) is an illustration of this generation of initiatives. Annex 1 provides a brief description of the programme and a summary of its main outputs as of December 2000.

New opportunities and challenges: Recently, there has been some renewed optimism about sub-Saharan Africa's energy future due to efforts promoting reforms, privatisation, regional cooperation, and energy and poverty reduction linkages. It cannot be assumed any more that the development of energy systems will stimulate macroeconomic growth which eventually will reduce social inequalities and poverty. It has to be demonstrated that energy services are benefiting the poor. Brook and Besant-Jones (2000) have raised some key questions based on this new expectation from the energy sector:

> (i) What role access to efficient and sustainable energy services can play in strategies for reducing poverty?…; (ii) How programs for liberalising energy markets can improve options for expanding access to energy services for the poor?…; and, (iii) What the key challenges – and key energy policy instruments – are in strengthening support to the poor?

Indeed, this is a new challenge for energy practice and a favourable one for the development of biomass energy schemes.

Socio-economic, financial and environmental benefits associated with the use of biomass energy as a modern energy carrier become an attractive option. What is not clear is how private companies running the energy sector based on market forces would adapt to local needs and conditions and eventually integrate biomass en-

ergy. Policymakers in charge of the energy sector are challenged to reconcile the commercial energy agenda with that of a broad social and economic transformation.

Another opportunity is provided by the growing interest in climate change and environmental issues urging for clean and efficient energy and a sustainable management of natural resources. Discussions generated by the Kyoto Protocol are windows of opportunities that sub-Saharan African countries should capitalise on. Financing mechanisms derived from the Kyoto Protocol, such as the joint implementation activities and the clean development mechanisms, should be explored. Biomass energy schemes as well as other renewable energy initiatives are eligible activities of these mechanisms. However, to mobilise meaningful resources, countries have to create the appropriate institutional environment and demonstrate that they are following a long-term vision of sustainable development.

Finally, at the level of some countries in the region, decentralisation reforms have made irreversible gains. Local communities are eager to exercise their authority to materialise their development aspirations. This is a ripe context to pursue community and participatory forest management programmes. A challenge here is for central administrations to delegate effective authority to local communities, to enhance capacity of local institutions and to clarify their roles within a negotiated legal and regulatory framework.

6 Some policy recommendations

Biomass energy will continue to play an important role in energy consumption is sub-Saharan Africa during the next decades. Trends of rapid urbanisation with those of a relatively slow economic performance indicate that, in many settings, the transition to modern fuels will be slow. The challenge is therefore to meet the growing demand of woodfuels in an environmentally sustainable way while interfuel substitution initiatives are pursued.

To this end, some policy recommendations are:

i) to elaborate energy policies within a long-term vision of sustainable development frameworks with the account of renewable energy resources;

ii) to recognise the important place of biomass energy in the energy balance of the region, and encourage energy institutions to account for this resource in sectoral strategic planning;

iii) to identify successful community and participatory forest management programmes and demand management initiatives and replicate them;

iv) to create an enabling legal and regulatory framework setting the rules and regulations for civil society, private sector, and public institutions in the operation and management of the household energy sector; and

v) to mobilise and develop capacity in the areas of natural resource management, renewable energy and climate change to improve the level of participation of national institutions in international negotiations.

References

Barnes, D. and W. Floor (1999). Biomass energy and the poor in the developing World. *Journal of International Affairs*. Fall 1999.

Bengaly et al. (1997). *Energy as a tool for sustainable development for Africa, Caribbean and Pacific Countries*. (Ed. Ugo Farinelli). A joint report published by the European Commission and UNDP.

Best Gustavo (1997). Maximising the benefits of bioenergy development Programmes. In *Biomass energy: Key issues and priority needs*. Conference Proceedings. IEA/OECD.3-5 February 1997.

Brook, P. and J. Besant-Jones (2000). Reaching the poor in the age of energy reform. In *Energy services for the world's poor*. ESMAP. World Bank. Washington D.C.

Ekouevi, K. (1999). Capacity development in the biomass energy sector in Sub-Saharan Africa: Strengthening local institutions by the mobilisation of existing expertise. Paper presented at the Symposium on biomass energy for sustainable development. Abidjan, November 29-December 2, 1999. World Bank/IEPF/African Development Bank/CIRAD.

Hill et al. (1996). *The future of energy use*. Earthscan Publications.

Karekezi, S. and T. Ranja (1997). *Renewable energy technologies in Africa*. Zed Books. London.

Lambert D'Apote, Sylvie (1998). IEA Biomass energy analysis and projections. In Biomass energy data, analysis and trends. Conference proceedings, IEA/OECD/UNEP.

Listorti, J. and F. Doumani (2001). Forthcoming. *Energy and environmental health: A literature review and recommendations*. ESMAP. The World Bank. Washington D.C.

Sarr, Secou et al. (1998). Report on the workshop on networks for promotion of renewable sources and environmentally sound eco-technologies in the context of the Regional Action Programme to Combat Desertification in Africa. UNCCD/RPTES/IEPF, Tunis 26-29 October 1998.

Sharma et al, (1994). A Strategy for the forest sector in sub-Saharan Africa. World Bank Technical Paper No. 251.

Sokona, Y. and Jean-Philippe Thomas (1999). Widening access to rural energy services in Africa: Looking to the future. Enda Tiers Monde.

United Nations (1997). *Energy after Rio*. New York.

United Nations High Commission for Refugees (1998). Environmental Guidelines: Domestic Energy in Refugee Situations. Geneva.

World Bank (2000). Can Africa claim the 21st century? Washington D.C.

World Energy Council and Food and Agriculture Organization of the United

Nations (1999). The challenge of rural energy poverty in developing countries.

World Resource Institute (1999). *World resources 1998-1999*. Washington D.C.

Annex: Regional Programme for the Traditional Energy Sector (RPTES)

Background

In many countries of sub-Saharan Africa energy sector planning has long been recognised as something of a paradox in view of the role of modern as opposed to traditional fuels in the economy. Although essential to the functioning of society, modern fuels generally account for only 15-40% of total energy consumption; however, since they are inseparable from modern methods of energy transformation and use, these modern fuels absorb virtually all investments in the energy sector. Traditional fuels, on the other hand, although they occupy a dominant place in the overall energy balance and in the consumption of households, have received little in the way of planning and policy-making attention and investments.

Because of this imbalance between levels of consumption and investment, development efforts have naturally favoured the modern sector, where the need for external financing has been more readily apparent. However, the idea that economic growth and development would produce a smooth transition from traditional to modern fuels is no longer part of conventional wisdom. The sluggishness of growth and the slump in revenues in both urban and rural areas have led to continued heavy resort to traditional fuels, which are still the most readily accessible source of energy (but not necessarily the most economical) for a rapidly growing population. The pressures being exerted on biomass resources and cultivable land in a deteriorating environment are jeopardising the long-term prospects of the economy as a whole with concrete desertification and climate change impacts, with most of the risk being borne by the poorest population groups (rural poor and women). In that context, the development of the traditional energy sector can lead to tangible improvements in terms of environmental sustainability (local and global), desertification mitigation, rural poverty alleviation, energy and economic efficiency and gender equity.

Objectives and scope

It is against this backdrop that in 1993 the World Bank's Africa Region decided, with the help of a trust fund provided by the Directorate General for International Cooperation (DGIS/NEDA) of the Netherlands Government, to undertake the "Review of Policies, Strategies and Programmes of the Traditional Energy Sector – (RPTES)" to assist the governments of sub-Saharan Africa in the planning and development of the traditional energy sector. A group of five Sahelian countries, comprising Burkina Faso, Gambia, Mali, Niger, and Senegal were selected to participate in the first phase of the Program. Following the work undertaken in that first group of countries RPTES was expanded in late 1996 to provide a mix of policy and operational support to an additional five countries, namely, Ethiopia, Guinea, Guinea-Bissau, Mauritania and Mozambique. Benin and Togo joined RPTES in mid-1997, followed by South Africa and Zimbabwe in mid-1998. Namibia and Zambia joined on August 1999.

Based on support from DGIS/NEDA a new five-year programme cycle started on December 1997. Because of the geographical expansion of the programme, the new five-year phase was been re-named as "Regional Programme for the Traditional Energy Sector". During this new phase the Programme has continued to evolve, assimilating the methodological, policy and operational lessons learned and will continue to expand its coverage gradually to other sub-Saharan countries on a *demand-driven* basis. While the Programme provides support tailored to the specific needs of each case, it generally assists countries to:

i) undertake a retrospective evaluation of the objectives, scope and approach of the work carried out to date in the traditional energy sector, as well as of the resulting policies, strategies and programs, on the basis of the official policies, their implementation by agents in the public and private sectors, and the activities of the external aid agencies;

ii) identify the main intersectoral linkages that affect the functioning of the traditional energy sector in each participating country and, while assisting in the creation of intersectoral consensus and policy convergence,

define an operational strategic framework for the sector in that broader context;

iii) draft a set of recommendations on the new approaches to be followed to develop the traditional energy sector and to define focused implementation priorities to be observed by national institutions and economic agents, together with appropriate external aid instruments; and

iv) identify and prepare investment projects and/or programmes capable of achieving concrete results as quickly as possible.

In addition to providing tailored assistance to each participating country, the RPTES also has a regional mandate which includes, among others: (i) conducting sector work on traditional energy issues/topics of regional interest (e.g. the Africa Traditional Energy Policy Initiative – ATEPI, traditional energy and decentralisation policy, and traditional energy and gender); (ii) supporting regional integration and connectivity among government officials/experts from the participating countries; (iii) promoting direct horizontal cooperation and activities leading to the exchange of information and experiences between participating countries; (iv) supporting the development of a regional-level traditional energy sectarian support mechanisms and working groups; (v) disseminating experiences and lessons learned to other African countries and the donor, technical assistance and NGO communities; and (vi) supporting and/or undertaking high impact R&D activities on traditional/biomass energy issues such as the "Millennium Gelfuel: A Renewable and Low-Cost Cooking Fuel for Africa Initiative", which was selected as a winner at the Innovation Competition of the World Bank's "Development Marketplace 2000.

Summary of RPTES outputs

By December 2000 the RPTES Program has resulted in:

- completion of traditional energy sector assessments and formulation of policy and strategy frameworks for seven RPTES countries;
- institutional development and substantive training (capacity building) of more than 90 African professionals;
- establishment of an innovative approach to development cooperation and regional integration for the traditional energy sector;
- contributing to the implementation and/or expansion of previously prepared projects totalling some US $15 million (Mali and Niger, June 1996);
- US $50 million in new investments in participatory projects in the traditional energy sector (Senegal, June 1997; Burkina Faso, September 1997 and January 2000) with full national ownership and implementation commitment;
- Prepared and/or assisted in the preparation of investment components for the traditional energy sector totalling US$20 million within energy sector or natural resource management projects in Ethiopia, Mauritania and Mozambique (June 1997) and Guinea Bissau (June 1998);
- Initiating the preparation of traditional energy sector investment components within World Bank projects and/or GEF or bi-lateral donor stand-alone projects totalling US$70 million: Ethiopia (Power Distribution Project, June 2001); Mozambique (Traditional Energy and Rural Development Investment Project, June 2001); Benin Natural Resource Management Project, June 2001); and, Zimbabwe, Mozambique and Senegal, (GEF Medium Size Project: "Renewable Household Energy Interfuel Substitution Project", June 2001);
- Launching the high impact "Millennium Gelfuel: A Renewable and Low-Cost Cooking Fuel for Africa Initiative" in partnership with the private sector, GEF and IFC (January 2000);
- Extension of the Programme to Eastern and Southern African countries.

Challenges in meeting biomass energy needs in West Africa

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Introduction

In terms of planning and promoting investments in the process of improving energy systems in African countries, one can say that the traditional energy sources (mainly biomass energy sources) have often been relegated to the background, to the benefit of the so-called modern sectors. And yet currently, traditional energy sources represent about 70% of the elements constituting global energy balance, and have a triple dimension in the African energy system:

Social: The majority of the population, urban as well as rural, uses woodfuels in their cooking practices.

Economic: The activities related to wood energy generate jobs and substantial income at the national level. According to the Food and Agriculture Organisation (FAO),[1] these activities generate a global turnover of US$6 billion, with $1 billion coming essentially from the charcoal industry.

Environmental: With a consumption level of more than 600 million m^3 in 1994, equivalent to the highest wood energy consumption per capita (0.89 m^3/yr), forest degradation is increasing, thereby contributing to environmental degradation. The deforestation rate for 1990–1995 was estimated at 0.7% for 520 million hectares of forest cover in Africa, or 3.6 million hectares.

This triple dimension is generally applicable throughout Africa. In light of this problem, actions favouring the sustainable management of traditional energy sources have not yet become widespread enough to engender a positive aspect for African populations and their environment. The various UN conventions and protocols (desertification, climate change, etc) adopted during the 1990s undoubtedly helped raise awareness in building North–South partnerships, but raising funds to ensure sustainable development remains a handicap. However, it is worth noting several initiatives that have emerged, including that of the Commission for Sustainable Development (CSD) in the United Nations System. Another laudatory initiative is RISO/UNEP's approach to induce concerned development actors to get involved in the dynamics of preparing the CSD.9, given such an important theme.

With an eye to enriching thought on the theme addressed at this high-level seminar, we propose to develop the following key points on the problematic of biomass energy in West Africa.

1 The macroeconomic context

West Africa has a population of nearly 225 million inhabitants, half of whom live in Nigeria, and a GNP estimated at US$80 billion in 1997. This is very low, considering that South Africa alone generated a GNP of $129.1 billion, while France's GNP was $1 392.5 billion for that same period. In West Africa, the GDP per capita is between $710 (for Côte d'Ivoire) and $160 (for Sierra Leone). The economies of the fifteen countries comprising this geographic space are highly dependent on agriculture, which contributes more than one-third of the region's GNP, and plays a dominant role in the process of economic change. The overwhelming majority of the population works in the primary sector, despite an urbanisation of about 32%, while the so-called informal sector represents more than 60% of the economy.

A high demographic growth rate (approx. 3%), combined with long years of drought which have destabilised the region for a quarter century (even if a slight improvement has been observed in the past two years) have largely contributed to weakening heavily subsidised economies. As a result they have generally failed to alleviate poverty, despite promising economic growth forecasts in some regions.

According to several development specialists, particularly those at the World Bank, not only must the development of agriculture and the primary sector in general be assigned the highest priority, but it is also imperative to achieve that

[1] The Role of Wood Energy in Africa – FAO Regional Studies, July 1999.

development without compromising the environment, most notably forest ecosystems.

The energy system remains a paradox, for the region has appreciable energy resources, but the potentials identified have hardly been exploited. In most countries in the region, the energy supply channels are disorganised and archaic, and it is difficult to gain access to modern energy sources. Generally speaking, the traditional energy sources – wood and charcoal in particular – constitute the major share of household energy consumption, representing more than 80% of total energy stock for some countries such as Burkina Faso, Benin, Mali and Niger.

Still classified in the informal sector, it must be said that biomass energy plays a major part in the lives of African populations. In Senegal, for example, the RPTES study shows that the fuelwood industry employs more than 4000 people and in 1995 apparently generated incomes upwards of $US 300 million

2 Constraints on development of the traditional energy sector

Examination of the traditional energy sector begun in West Africa in 1993, when the World Bank's RPTES Programme revealed the major constraints and paradoxes hindering the rational development of this sector in sub-Saharan Africa. At the institutional level, the sector remains characterised by the weak intervention of government services at several levels of the industry and inefficient institutional organisation dispersed among several ministerial departments. The lack of coordination among the different services and agencies intervening in this sector is another obvious and serious obstacle to the development of the sector.

At the legislative and regulatory levels, the energy sector in West Africa, as is the case elsewhere in Africa, is characterised by poorly adapted legislation and regulations, from the development perspective, with regulatory devices that no longer account for the needs expressed by households, except, perhaps, with respect to the true availability of wood resources. Likewise, the application of highly ineffective laws and regulations, despite the apparent influence of forestry divisions, is another serious obstacle to the energy sector in Africa.

As regards the fiscal system and tariff setting, the efforts undertaken still fall short of the mark in this sector. The constraints that continue to prevail are still linked to a fiscal system that is not very effective in dissuading exploitative forest cutting and does not favour village production, and to a price structure for traditional energy sources that takes little account of the economic value of wood and its environmental cost.

At the political and economic levels, often inadequate policies and strategies with objectives that are sometimes difficult to quantify contribute to poor performance. Moreover, the exceedingly low investment level, with modern energy sources absorbing nearly all funding earmarked for the energy sector, partly explains the overall low productivity in the energy sector in West Africa. Among the major economic constraints, one can also cite the overwhelming contribution of woodfuels to national energy consumption while their economic weight is relatively limited, and the existence of a severely segmented market, with intermediaries at several levels in the chain.

At the environmental level, irrational methods persist in the commercial utilisation of forests, which aggravate deforestation and cause imbalances in the forest ecosystems, despite efforts in this area to combat such practices. This phenomenon can be explained by, amongst other reasons:

- Rural populations being poorly informed about the importance of their forest heritage, which is manifested by the regular practice of extensive grazing and crop rotation using slash-and-burn methods that spark bushfires. These are currently considered to be primary factors in environmental deterioration (translating into the destruction of thousands and thousands of hectares of forests every year, a hard blow to biodiversity);
- Environmental education not taken seriously into account in the formal and informal school systems;

Added to this are a nearly non-existent information and evaluation system and a lack of reliable data on the sector, which impedes any credible action planning for energy supply and demand.

3 Issues related to biomass energy demand

Generally, in most West African countries, supply management in the woodfuel sector is conducted in a haphazard fashion without full consideration being shown for the available resources. When energy policies are formulated, often, little attention has been paid to household fuel supply, which should be used as a tool for analysing and forecasting consumer demand. Hence, the definition of targeted objectives has generally remained vague, which immediately jeopardises the successful implementation of political strategies chosen in the past.

Nearly all the countries in sub-Saharan Africa suffer from the lack of a permanent information system on the sector. And when structures do exist in a given country, the information is managed in a fragmented fashion, which reduces the relevance of the available data for projection purposes.

While governmental management and operational structures intervene upstream in the industry through the intermediary of forestry commissions, in contrast, their absence downstream sometimes leaves the field wide open for price speculation, much to the irritation of urban consumers. Even when the state intervenes and sets prices for fuelwood as an essential product, as is the case in a few countries in the subregion, the real prices in the markets vary considerably from the official ones.

For several years now, however, there has been a growing interest in this energy subsector, particularly in those countries hardest struck by desertification. In several Sahelian countries, governmental structures have emerged, supported by bilateral or multilateral co-operation projects. One of their greatest challenges is to rationalise biomass industries from production to marketing. The final objective is environment, notably forest ecosystems.

A major planning effort must be made, based on a permanent information management system, and this must be done on a continental scale if we hope to find a sustainable solution for the domestic energy issue in sub-Saharan Africa. It would also be advisable to re-establish the interest in using prices as instruments of sustainable energy policy, by justifiably internalising environmental costs into the economic value of wood resources in light of their opportunity costs, with a view to substituting them with liquefied petroleum gas, kerosene or other alternative fuels.

4 Issues linked to biomass energy supply

As we enter the third millennium, most African countries are confronted with the alarming and steady deterioration of their environment and more particularly their forest resources. However, the issue of forestry management in sub-Saharan Africa reveals a few nuances depending on whether one is located in an arid or a wet zone. In countries in the arid zone, the gravity of the degradation process, and indeed of the desertification process, is explained by the nexus of several complex factors which specialists tell us are known for the most part, but are still poorly understood. Among the most important are:

- harmful climatic factors marked by successive droughts and diminishing and irregular rainfall levels, with the disappearance of many forest and fauna zones and the degradation of the natural environment as a corollary; and
- factors linked to heavy population growth and the existence of farming and grazing systems that are most often extensive and poorly adapted to surrounding conditions, with the systematic plundering of forest resources as a consequence.

In countries in the wet zone, the forestry potential is obviously greater. Generating considerable income, particularly for the timber industry, this potential is overexploited, with no respect for regulations advocating rational utilisation or for the forests' regenerative capacities. One of the serious consequences of this overexploitation is the long-term deterioration of biological diversity.

During the FAO Regional Workshop on the Decentralisation of Forestry Programmes held in Harare in November 1995, participants agreed unanimously on certain constraints faced by their countries: a lack of information and knowledge about real forestry potential; the near-total absence of development and planning policies for forest resource management; and a lack of co-ordination between national programmes affecting forestry matters.

Moreover, those structures in charge of supply management (forestry departments), are most often characterised by old centralist traditions or by the inability to reinforce respect for laws which are in fact ill-adapted and ill-prepared by governments to regulate wood production for domestic use or the timber industry.

5 Challenges facing sustainable biomass energy management

The United Nations Conference on New and Renewable Energy Sources held in August 1981 in Nairobi was a new start in terms of sensitising development actors to their potential. Unfortunately, the hopes placed in this conference, based on its recommendations, failed to yield the expected results. In fact, new and renewable energy sources have not contributed significantly to reducing the oil bill in African countries, for example; it is still difficult for African populations to gain access to energy, with woodfuels being the only readily available resource; and the desertification process has advanced (loss of 3.5 million ha of plant cover) despite drought control and reforestation programmes, etc. Twenty years after the Nairobi conference, West and sub-Saharan Africa in general are entering the era of globalisation still faced with challenges in the

areas of health, education, human settlements, infrastructure and poverty.

Other challenges directly influencing sustainable natural resource management have been added to those noted above. According to the statistics provided by the United Nations Population Division, they involve the following:

Population explosion: Unlike other parts of the world, the sub-Saharan Africa region is expected to surpass a demographic growth rate of 3% per year. According to population forecasts by the UN Population Division, the West African population should increase from 209 498 000 in 1995 to about 241 000 000 in 2000, to more than 400 000 000 in 2020.

Urban expansion: It would appear that the trend of urban population expansion will continue, with the growth rate shooting up (4.9% on average). In 2020, it is estimated that Lagos will be the third largest city in the world with nearly 25 million dwellers. Urban agglomerations will be obliged to apply new methods of management and other types of behaviour to properly meet essential needs: water, housing, transport, energy, etc, and the financial charges related to urban facilities.

Demographic pressure in rural zones: Given a growth rate of about 1% for the rural world, farmers in Africa will have more labour and less land. The application of property rights required to secure land ownership will lead to the exclusion of migrants and possibly ignite border disputes. According to Philippe Hugon, in *Prospective de l'Afrique subsaharienne*, demographic pressure will foster emigrations from highly populated areas (for example the coastal forest belts of West Africa) to spaces with high absorption capacity). These migrations will be confronted with national policies and land control methods. Large towns will act as receiving zones for refugees. Arable land per capita will vary widely, with a tendency towards a marked drop in the number of hectares of arable land per capita.

The evolution of renewable resources and ecosystems: Over-utilisation of renewable resources in West Africa, combined with the degradation of the natural heritage, is a reality today. The crisis linked to the exhaustion of wooded spaces, the degradation of natural resources and to desertification concerns the Sahelian countries and Northern Nigeria in particular. Woodfuels, which on average represents more than 70% of the fuels consumed, is beginning to reach more than 80% for the arid and semi-arid zones while the demand will grow at the same rate as demographic growth (more than 3% a year).

6 Actions and vision for the sustainable management of biomass energy

Low-income rural populations consume very little of the so-called modern or commercial energy sources, preferring woodfuels for cooking and lighting needs, as a rule. If there is one fundamental imperative to ensure a country's development, it is obviously its ability to provide a reliable energy supply, since the perspectives for economic growth are intimately related to supplying reliable energy at affordable prices. Consequently, given their contribution to national energy balances, biomass energy issues should be given top priority and greater attention whenever energy policies and strategies are being defined for African countries, for it has been established that in most African countries these energy carriers account for more than 70% of total energy consumption.

The idea long upheld by African political leaders and by many development assistance organisations, by which growth and economic development would foster a harmonious transition from traditional wood energy use to modern fuels, has been a major factor in relegating the traditional energies sector to the back burner. Although biomass energy is not necessarily the most favourable source from an economic viewpoint, it still remains the most accessible, and for that reason, because of their low incomes, people will continue to use woodfuels extensively; this means that one cannot expect a full transition, at least not immediately nor in the medium term in most countries.

While it is still true that many African countries are in danger of suffering an acute fuelwood shortage in the long term, it is generally accepted that for countries located in the arid zones and in the Sudano-Sahelian zone, this risk is much higher. Given that Africa's average population growth rate is 3%, that it suffers from rampant urbanisation and its economies are still weak, one can imagine the context in which biomass energy issues are to be found the beginning of the third millennium.

The complexity of the biomass energy industry, from wood production to marketing with intermediaries at several levels, is also a major hindrance for planning or managing the sector.

As essential resources of a continent faced by the other major challenges in the world (education, poverty reduction and social well being, among others), the issues related to traditional energy sources should be addressed in the scope

of a new vision that has been forged by the African Support Group (ASG) in the RTPES Programme. That vision, which aligns with the concept of the sustainable management of natural resources, was defined with the hope that the various actors involved (politicians, decision makers, private and professional actors, etc) would be able to make the best of forest utilisation.

This vision is even more imperative now, considering that today it is well understood that development must be sustainable. Through energy projects in certain countries, and following the RPTES concept, energy derived from biomass could be used to implement this new sustainable development approach, based on essential factors of equal importance: economic growth, social advancement and environment conservation. Considering the changes occurring in most countries' energy policies and considering the complexity of the biomass energy business in Africa, it is advisable within the global context of poverty reduction to define a new vision of the sustainable management of biomass energy.

Since the early 1990s, poverty reduction in sub-Saharan Africa has been a creed for governments and certain development partners such as the World Bank and UNDP. It must be recalled that some of the principal causes of poverty in Africa are :

- the destruction of natural resources, leading to environmental degradation and a drop in productivity;
- poor access to job opportunities; and
- the absence of participation, for the masses are not associated with the elaboration of development programmes.

Given the place biomass energy occupies in the sub-Saharan African countries' energy balance, the predominance of rural populations and the rising rate of rural exodus (more than 3%), one has food for thought. It would appear that appropriate measures need to be taken as quickly as possible to ensure the sustainable management of natural resources for the benefit of rural populations.

With respect to the West Africa region, RPTES's African Support Group believes that the vision that must be created to solve the biomass energy problem has to be based on the guidelines defined below:

At the national level

- Create a global development policy framework which integrates all issues: forestry, agriculture, livestock breeding, natural resource management, population, urbanisation, decentralisation, poverty reduction, industrialisation of the rural zones, etc.
- Treat natural forests as an important resource for renewable energy production, and take this into account in the definition and implementation of national energy policies.
- Promote more rational forest utilisation by implementing a regulatory and fiscal structure better adapted to the realities of a resource that is becoming increasingly scarce.
- Grant rural populations in villages bordering forest zones the power to manage resources on their lands – in other words, guarantee that there is a real transfer of forest management to local groups.
- Make available a wide range of fuels to consumers: butane gas, kerosene, briquettes made from peat, farm residue or agro-industrial waste.
- Promote a policy for the reduction of wood energy consumption at every level of the industry, from production to consumption: improved logging and utilisation techniques.
- Promote a coherent, transparent information and planning policy involving all the actors by building capacities at every level.
- Create a favourable legal and financial structure which promotes the involvement of the private sector and decentralised community-based groups in order to promote income-generating activities in the context of sustainable biomass resource management (upstream and downstream) and the promotion of alternative and substitute fuels.
- Take advantage of the new financing mechanisms offered under the KYOTO Protocol Agreement on Climate Changes: (joint activities, countries' own development mechanisms) for the emergence of sustainable biomass energy management programmes;

At the regional and international levels

- In pursuance of the Abuja Treaty, create regional poles of excellence to act as councils or brainstorming units to achieve coherence in national policies and better planning for the biomass energy subsector.
- Develop the African specialists' designing, analytical and managerial capacities in line with the plan to appropriate the different concepts of biomass energy management and related technologies. Actions connected with IEC (Information – Education – Communication) based on modern communication technologies (Internet), should be promoted within the scope of subregional exchanges and consulting sessions. With that in mind, lists of specialists should be made available.

- Address traditional energy issues in the framework of international meetings related to energy and the environment: World Energy Council, African Energy Commission African (OAU Project) and other subregional structures involved such as CILSS, IGADD, Kengo, etc.
- The initiative taken by the African Support Group's Technical Secretariat to form a partnership with the ENDA-Tiers Monde Energy Programme in order to create a regional Resource and Study Centre for Strategies in the Traditional Energies Sector (CRETAS – Centre de Resources et d'Études des Stratégies du Sector des Energies Traditionnelles) certainly deserves encouragement.
- Drafting of the Action Plan for Biomass Energy in Africa, which was proposed as a result of the Abidjan symposium held in December 1999.

6 Conclusion

Biomass energy represents considerable potential for West Africa. However, the traditional methods of tapping into this biomass have not only had grave consequences for the environment, but have only been able to partially resolve the crucial issue of how to sustainably supply households with domestic fuels. Nevertheless, recent progress made in the improvement of technologies enhancing biomass energy provides a glimpse at interesting perspectives fostering the modernisation and better assessment of the biocombustible and biofuel industries.

Reflection conducted over these past years by a group of African experts, brought together around the ASG at the instigation of the RPTES Programme and founded on a new approach to forest resource management, illustrates the attention public powers are granting increasingly to biomass energy, which had been relegated to the back burner for so long, to the benefit of more "conventional" energy sources.

Considering the complexity of biomass energy issues, and their direct links to poverty, it is evident that isolated actions will never succeed in solving the problems currently faced. Thus it is essential to promote regional collaboration and partnerships for more effective actions and to capitalise on experiences, with the aim of ensuring sustainable development for the continent of Africa. Today, given the economic potential of more than US$6 billion generated by African forests, this implies the introduction of sustainable strategies which will result in increasing incomes and improving welfare in general. West Africa, masthead of the continent, will certainly not be an isolated case. Consequently, vigorous action supporting the sustainable management of natural resources as part of poverty alleviation programmes should be undertaken post-haste, in compliance with the Abuja Treaty establishing the African Economic Community.

Bibliography

RPTES Regional Report, Maastricht – 1995

World Bank Yearly Report – 1998

Treaty Instituting the African Economic Community, OAU, ABUJA – 1991

OAU/ECA Document on the Conference of African Mines and Energy Ministers, Accra – 1995

Taking Action to Reduce Poverty in Sub-Saharan Africa, World Bank – 1996

Mamadou Dianka, "La problématique des Energies domestiques en zone sahélienne et les différentes stratégies" – World Energy Council, Tokyo, – 1995

Annual Energy Review, European Commission – 1997

UNDP Annual Report on Human Development – 1999

Economic Report on Africa 1999 – The Poverty Reduction Challenge, UN/Economic Commission for Africa

Déclaration de Libreville sur la Croissance et la Lutte contre la pauvreté, January 18-19, 2000.

The Role of Wood Energy in Africa

United Nations Framework Convention on Climate Changes

United Nations Framework Convention on Desertification

Decisions of the International Symposium on Biomass – Abidjan, Dec. 1999.

Prospective de l'Afrique Subsaharienne – Philippe Hugon.

Botswana biomass energy projects: The challenge of mainstreaming biomass energy plans to facilitate sustainable development

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1 Overview of Botswana's energy sector

1.1 Introduction

The favourable pace and extent of economic growth realised in Botswana over the years has been accompanied by sharp increases in the demand and supply of energy. GDP growth has averaged around 6% per annum between 1981 and 1997. During the same period the primary energy supply has also increased from 33,025 terajoules to 75,021 terajoules, an increase of more than 200% (projected population in 1997 was 1,533,000). It is anticipated that this trend of increasing energy consumption will continue in response to the rapidly growing economy, which is diversifying and expanding its industrial base, and also due to a growing population, which is becoming increasingly urban.

1.2 Trend by primary energy source and consumption sector

Botswana's energy sector is characterised by both traditional and commercial energy sources, with fuelwood, being the principal energy source in spite of the associated pressures being placed on woodlands, especially in highly populated regions, where it is becoming scarce. During the period 1997/1998, fuelwood accounted for 57% of the total primary energy supplied. It is followed by coal at 23%, petroleum products (which are imported from the Republic of South Africa) at 18%, and imported electricity at 2%. The use of solar energy for electricity generation and water heating, even though currently making an insignificant contribution to the total energy supply, is on the increase and occupies an important niche in satisfying needs in remote areas.

Of the energy sources supplied, namely coal, fuelwood, petroleum products, electricity and solar, only fuelwood and solar energy are exclusively locally produced. Botswana has abundant coal resources, but small quantities of higher grades are imported for certain applications in industry. Botswana relies heavily on coal for its power generation: 96% of the electricity is coal-based and 4% based on diesel plants. Of the net electricity supply, 42% is imported from the SAPP (namely RSA, Zambia, Zimbabwe and Namibia) to meet the domestic demand. Imports of coal and electricity increased from 6204 terajoules (19% of local production) in 1981 to 65% in 1998. Total expenditure by fuel type (1994) shows that more was spent on petroleum products (namely petrol and diesel) and electricity.

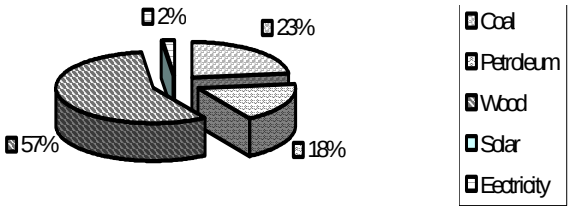

Fig. 1: Total primary energy supply 1997/98

On the demand side, the main consuming sectors for the same period were residential 50% (being mainly fuelwood, especially in rural areas where incomes are low and it is readily available and in some cases 'free'); transport 27% (mainly petrol and diesel); industry 16% (mainly electricity and coal); and commercial 6% (a combination of electricity, fuelwood, coal and LPG). Energy demand is projected to increase at an annual rate of 5.6% and 4.1% for the commercial and transport sectors respectively, but less than 2% for the other sectors.

1.3 Energy policy

To meet increasing energy demand, the Botswana National Development Plan 8 (NDP8)

energy policy aims at providing a least cost mix of energy supply which reflects total life cycle costs and externalities, such as environmental and social costs to the end-users. The objectives of the policy as reflected in the plan are: economic efficiency in the provision of services; increased access by households and communities to adequate and affordable energy services; and ensuring energy conservation, quality, reliability and security of supplies.

In pursuance of the policy objectives, the EAD, which is divided into six sections of Coal, New and Renewable Sources of Energy, Electricity, Energy Efficiency and Conservation, Planning and Documentation and Administration, implements a number of projects and programmes such the Rural Electrification Programme to extend grid electrification to rural communities, the Rural Collection Scheme, to assist in the uptake of electricity; and the National Rural Photovoltaic Programme to promote increased use of photovoltaic electrification are being pursued.

2 Biomass development in Botswana

2.1 Background

Botswana covers an area of 581 730 km^2 and has an estimated population of 1.572 million of which about 60% lives in the rural areas. In these rural areas fuelwood constitute approximately 80% of the energy consumption. Other biomass fuels (charcoal, dung, and crop wastes) form a negligible part of the national energy use picture, and therefore are not further discussed in this paper. Though fuelwood is essential for upholding people's lives, its scarcity is increasingly visible in both the urban and rural areas, especially around towns and large villages.

The total projected demand for fuelwood in 1995 was estimated at approximately 1.5 million tons per year. However, one has to consider that:

- current harvesting practices do not take into consideration the tree re-growth and sustainable harvesting practices;
- only a smaller share of the area, which is covered by woody biomass, is accessible for fuelwood extraction;
- agricultural land-clearing constantly reduces the area covered with natural woodlands; and
- woody biomass is also used for non-energetic purposes such as bush fencing and construction timber.

In the past, woody biomass resource assessments have rarely been undertaken on a national scale for the purpose of energy planning. Botswana biomass resources strongly reflect the two main constraints on vegetation growth in the country: the sparseness and seasonality of rainfall, and the low moisture-holding capacities of sandy soils. The vegetation types in the country range from restricted occurrences of highly productive riparian woodlands to bare saltpans. The greatest proportion of biomass resources lie in the woodlands, bushlands and shrublands. Dense closed-canopy woodlands, which take on a more open nature as water resources become scarcer, are found in the north. As water becomes scarcer still, there is an increase in the proportion of shrubs, and woodlands degrade into bush land and shrub land.

The country is semi-arid, hence covered with fragile shrub and tree savannah types of vegetation, with limited dense indigenous forest in the Chobe District (north-west), where rainfall rises to an average of 800mm per annum. The mean annual rainfall for the country ranges from 650mm in the extreme north-east to less than 250 mm in the extreme south–west. Though the ecosystems of arid areas are said to be more resilient over a long period, the tree spectrum of vegetation proves itself fragile in that, once depleted, it takes quite some time to recover. In fact, due to the ever-increasing pressure exerted on these fragile woodlands, it never recovers to its original biomass production capability.

It is against this background, and also in recognition of the need for energy planning to be embedded in a suitable institutional framework and to be seen in an integrated and dynamic context, that Botswana formulated its national policy through the process of integrated energy planning, documented in the Botswana Energy Master Plan. This process does not only take into consideration the needs of the energy supply industry, but puts the users at the forefront and builds on an understanding of their energy needs.

2.2 Policy issues

Biomass

One government policy objective is to improve the general living conditions of communities in rural areas, under the general policy objectives of economic growth, social justice, sustainable development, and economic dependence. Botswana recognises that the majority of its people still live in rural areas and their consumption of energy is significant in terms of the primary energy supply and the net energy supply. It is not the intention of government to encourage rural-urban migration, so initiatives are being taken to invest in rural areas. This might

not be considered economic under normal circumstances, but given the fact that the majority of the population lives in these areas, there is reason to do so in order to achieve social justice objectives. But it is realised that, since the energy policy objectives cannot always be met simultaneously due to conflicting aspects, the adopted policy will be a compromise which maximises the long term benefits to Botswana and the nation at large. The general objectives of the energy policy are to ensure that supply meets demand, socio-economic costs of energy operations are minimised, and that energy is delivered at least cost to the economy and the consumer.

In Botswana fuelwood constitutes about 80% of energy consumption. Although it is essential for the majority of people in Africa, and in particular for Botswana, for survival, its scarcity is increasingly visible in both the urban and rural areas, especially around towns and major villages. While other energy sub-sectors are comparatively well documented as regards their resource potential and supply figures, information on fuelwood is fragmentary and insufficient for proper sub-sector planning. No formal market for this resource exists, hence demand data is limited.

Data on the supply side is also limited due to a number of climate and biological factors which are vary across the country and will be difficult to establish precisely until thorough investigations are conducted. Although a slow transition process from fuelwood to modern fuels has begun in Botswana, fuelwood extraction will exert significant pressure on those areas where comparatively high population densities occur – especially in areas of fragile geology (deserts). It is therefore pertinent to gather data on biomass consumption by end-use in order to formulate policy. The NDP8 policy objectives for the biomass sub-sector are to ensure a sustainable supply of fuelwood and to establish an effective institutional framework. Consistent with this policy, the Biomass Unit was established in 1998 to implement projects aimed at achieving these objectives. To date, a number of studies have either been completed or are in the process of gathering the relevant data which will assist in formulating specific and appropriate policy interventions for this sub-sector (see Table 1).

Gender enrolment

Women play a central role in the provision of energy, especially in rural areas. They head more than 47% of the households in Botswana – predominantly in the rural areas. This means that the energy needs of the women are complex and their needs must be taken into account in the process leading to formulation of policy. As is well known, the main source of energy for rural women is fuelwood, the process starting with the collection of the resource, whereafter it is used for multiple purposes in food production and processing, including income-generating activities such as brewing beer.

The process of energy planning has always been centralised around urban needs with little, if any, input from rural communities. It is only recently that NGOs have demanded that the energy planning process broaden their boundaries to capture the voice of the female majority. Botswana has not been a saint in enrolling gen-

Table 1: Comparison of different studies on fuelwood standing stock and mean annual increment

Author and title of	*Standing stock (million tonnes)*	*Average standing stock per hectare (tonnes)*	*Mean annual increment (million tonnes)*	*MAI per hectare (tonnes/annum)*
UNDP (1984): Botswana: Issues and options in the energy sector		20-60		
NIR/ Tietema (1984): Firewood for Botswana		20-60	58.2	1
Wisner (1984): SADCC country studies: Botswana	1534	26		1.3
ERL/ODA (1985): A study of energy utilisation and requirements in the rural sector of Botswana (RES)	236	17	14.3	0.3 – 2.1
SADCC/ETC Millington & Townsend (1989): Biomass Assessment: Woody Biomass in the SADCC Region	1311	22.5	45.6	0.78

der in energy policy planning. A few years back the Women's Affairs Department was formed to try and bring to the forefront women's agendas in the development of the economy. But women remain largely absent at a higher level of decision-making and policy-formulation, especially at the planning stages to meet energy requirements. There is an urgent need, therefore, to establish sound energy management that has a holistic, multidisciplinary and intersectoral approach, to ensure that women and men benefit equally in the provision of energy resources. Government intends to play a meaningful role in realising these initiatives. Steps are already being taken to encourage rural women to make input in policy formulation, through the Extension Unit of the Energy Affairs, a government division of the ministry.

Current status

With the growing industrialisation of the Botswana economy, energy intensity, per capita energy consumption, and the efforts of a sound energy sector management also increased. However, as regard human resources, there is considerable shortage of skilled manpower in most institutions concerned with management of the energy sector. At present, the Biomass Unit of the Energy Affairs Division, the focal point of energy matters in Botswana under the Ministry of Minerals, Energy and Water Affairs, is critically understaffed – with three people to cope with the various problems associated with the resource. The private sector and parastatals compete with government institutions for qualified personnel. Although this may not be considered a drawback from a micro-economic point of view, it nevertheless affects the development of strong energy sector management and planning capacities. Although energy sector management need not imply a rigid framework along the lines of centralised fully planned economies, a certain degree of centralisation becomes necessary when energy intensities increase and the industrialisation of an economy progresses rapidly, as in Botswana.

In 1995, the government engaged the Energy and Development Group from the RSA, with assistance from Gesellschaft fur Technische Zusammenarbeit (GTZ), to finalise the Botswana Energy Master Plan (BEMP) and produce an energy policy document. The BEMP process started in 1985 and has gone through three phases. The first sought to collect and collate data on energy resources, energy technologies and energy supply and demand, and to set-up a database for energy planning. The second phase sought to develop and refine the database from Phase 1, to appraise energy projects and make recommendations on energy policy. The first two phases were a success in terms of developing good information on Botswana's energy sector, although the official appraisal of the first two phases identified a shortcoming in the process in that adequate local institutional structures had not been developed, including the development of personnel.

The final phase of the project was planned to build on the first two, and to conclude the BEMP process with processes and outputs that would consolidate Botswana energy policy with the institutional realities of Botswana energy governance. It started in August 1995 and was concluded in April 1996. The aim of the project was to make a substantive input into NDP8, to produce a policy document using updated information and to provide implementation details for the policies.

On biomass, the document emphasised the need to explore a number of different routes which can facilitate a rapid and multi-pronged implementation programme rather than focus purely on research and analysis, and also to come up with a policy goal of ensuring a sustainable supply of fuelwood. To arrive at this policy goal, the following were taken into consideration:

- unsustainable harvesting of woodland is taking place in some areas;
- data on the extent and seriousness of the problem is not adequately synthesised;
- fuelwood is not the only cause of woodland denudation, and may not even be a significant cause.

In order to guide fuelwood policies several policy measures had to be undertaken, some of which are to:

- establish and maintain information systems regarding fuelwood resources, demand and prices which provide concrete information to underpin policy;
- evaluate models of afforestation practice to identify those appropriate for Botswana;
- encourage and support community management of natural woodlands in communal areas;
- monitor and control the use of fuelwood by government institutions and support the introduction and use of other fuels; and to
- establish an effective institutional framework for managing fuelwood harvesting.

Description of current projects

In Botswana 90% of rural households use fuelwood for cooking and 85% consider it their main cooking fuel (followed by LPG). Of rural households, 8% have access to electricity, but it is used for cooking in less than 1% of cases, reflecting a dependency on fuelwood which will

long remain a reality. The high increase in population in Botswana puts the natural woodland at high risk as the consumer base increases in comparison to the resource base. There are disturbing facts attached to this issue:

- There are increasing reports about increasing degradation and deforestation in Botswana; in the past, intervention strategies have failed to address the problem adequately.
- The increasing urban population and poverty in the rural areas will result in the continued over-exploitation of woodlands and dependence on fuelwood for energy.
- Open-fired stoves are still common, despite the fact that they are not energy efficient.

Energy Affairs Division and its stakeholders have embarked on several projects to establish ways of solving the prevailing problem of inefficient use of fuelwood. It is envisaged that in concluding these projects, a national policy on biomass will be formulated together with the stakeholders and strategies developed for implementation. Listed below are projects which are on-going or have recently been completed.

Fuelwood flow paths in Francistown

The study was executed between February and April 1999 as a result of numerous concerns over the extent of the fuelwood trade in and around Francistown. Its purpose was to collect information on the fuelwood situation in and around Francistown: how it is harvested, transported and used, as well as the pricing structure at various stages of the flow path. The study was also to highlight current problems that relate to the harvesting and use of fuelwood in the area, as well as expected future problems, and to work out recommendations to guarantee a sustainable use of fuelwood. To obtain the necessary information parallel surveys were undertaken. The main part was a survey of 241 households in Francistown. Additionally 38 fuelwood traders and 18 public institutions were interviewed. It is envisaged that the information obtained will be used to develop strategies and programmes for conserving fuelwood resources and introducing alternative energy sources.

The main findings of this sturdy are that:

- fuelwood is still used by most of the households in Francistown (about 80%) and is the main source of energy for most low-income households (about 30%);
- low-income households have no realistic alternative and are not likely switch to alternative fuels until their economic situation improves;
- the public institutions still using substantial quantities of fuelwood in Francistown are the primary schools and community junior secondary schools;
- the current fuelwood demand of Francistown can be sustainably met within a 19 km radius;

The study recommended government to take precipitate action in relation to the use, harvesting, trading or selling of fuelwood, and that a policy review taking account of social, economic and environmental costs and benefits and involving all stakeholders should be undertaken. The government should also initiate a programme to re-equip the kitchens of urban primary and community junior secondary schools to enable them to switch to an alternative fuel such as coal or LPG.

Fuelwood/woody biomass study around Bobonong and Mochudi

The main objective of the study was to develop appropriate means for documenting historical trends in woody biomass/fuelwood resources in Botswana – a fuelwood inventory and monitoring programme. The main findings and recommendations of this of study are as follows:

- Both communities are managing and utilising the woody biomass resources in a sustainable manner. Low economic value of the fuelwood resources and the low priority given by the communities to the fuelwood problem makes the implementation of any community-based monitoring programme not justifiable. The most effective way of managing fuelwood resources is probably through socio-economic surveys as it has been done by EAD (two surveys ongoing, one in a rural area and one in an urban area); these studies determine also the impact of fuelwood shortage – distances travelled to collect fuelwood depending on meals cooked per day.
- Ikonos images with a special resolution of image are suited to monitor changes in the woody biomass resource, but high cost limit the application to only a few identified problem areas. Findings indicate that Landsat 7 can provide a useful overall woody biomass inventory but spatial resolution is too coarse for monitoring.
- The study recommends establishing a baseline inventory of woody biomass against which changes in the future may be monitored.

Fuelwood Inventory and monitoring Programme

The EAD commissioned NRP (Pty) Ltd to carry out a study on fuelwood / woody biomass assessment around Mochudi and Bobonong. The

main aim of the study was to design and test woody biomass inventory techniques in the two pilot areas and develop a prototype fuelwood inventory and monitoring programme.

The environmental impact of fuelwood cutting and the sustainability of energy supplies have been viewed with anxiety in Botswana since the early 1980s. The most comprehensive study was carried out by ERL in 1985 and concluded that while fuelwood shortages were not yet acute, they were being felt around the major urban areas, with the supply situation to some degree temporarily alleviated by the 1982-86 droughts, which had generated a lot of fuelwood.

Inventory of the woody biomass resource via land sat 7, and monitoring through the use of higher spatial resolution Ikonos imagery, is believed to hold considerable promise for such assessments, particularly through the field methodology developed via Tietema's (1993) parameter 'diameter at ankle height' and detailed in this report. The value of establishing baseline and monitoring data for the woody biomass resource is likely to be only fully realised in 5-10 years time, after which trends in the resource base may well be discernible, and management options clearer. In this respect there is enormous potential to link the proposed Fuelwood Inventory and Monitoring Programme (FIMP) to the ongoing Botswana Range Inventory and Monitoring Project (BRIMP), within the Ministry of Agriculture. Strong linkages exist between the objectives of the two programmes and should be pursued further via a working group made up of key representatives from both Ministries.

Rural energy needs and requirements study in Botswana

The objectives of the study are as follows;

a) Rural energy consumption assessment

- To determine present energy sources/fuels in use, consumption levels and patterns for each source/fuel at household, institutional, commercial and agricultural sectors for each region or District in rural Botswana.
- To investigate socio-economic, sociological, cultural and other factors influencing rural energy consumption patterns.
- To forecast rural energy demand on a similar basis in the next 10 years.
- To consider the potential for substitution of traditional fuels with other environmental sound energy sources.
- To determine energy expenditures and energy prices.

b) New and renewable energy resource assessment

- To assess the potential contribution which renewable energy sources could make towards meeting rural energy needs and requirements.

c) Analysis of options for development

- To identify and analyse energy measures/options to meet future rural energy needs and requirements.
- To evaluate these measures/options in relation to their potential contribution to meeting energy needs and related economic, social and institutional implementation aspects.
- To recommend an action plan to implement such energy measures/options indicating the necessary institutional arrangements, and supporting research to implement the action plan.

Fuelwood use patterns and future strategies in urban Botswana

The objective of the study is to update the existing energy database, to investigate how the socio-economic development over the last 10 years influenced fuelwood consumption patterns, to make projections and to come up with long-term strategies to reduce the fuelwood consumption in urban and peri-urban areas. This study is ongoing.

3 Commercialisation of fuelwood

The fact that the commercialisation of fuelwood reflects the development of Botswana from a mainly agriculture society to a developed industrialised country is often ignored. The commercialisation of fuelwood started with urbanisation and the increased creation of formal employment in government institutions and industry. There was suddenly a demand for fuelwood by people who either had no time to collect fuelwood, or no longer had direct access to fuelwood resources. Fuelwood traders took on the role of satisfy the basic energy needs for them and for those who could not afford, or did not have access to, other energy sources. Some established themselves in areas where the distance to collect fuelwood became too large – urban areas and major villages.

There is increasing concern about the cutting of live trees, mostly for construction and fencing – it is currently difficult to determine the extent to which live trees are cut down for fuelwood. The Biomass Section within EAD plans to monitor an area where a lot of fuelwood traders reside to determine the extent of the practice.

The commercialisation of fuelwood should be perceived as a normal energy service to satisfy a certain market demand. The need might arise in future to regulate this kind of energy service if:

- further economic development fails to reduce fuelwood consumption;
- programmes to increase access to other energy sources – like rural electrification and photovoltaics – fail to reduce fuelwood consumption;
- current harvesting methods by fuelwood traders prove to have a great negative impact on the environment through deforestation and land degradation;
- there is a further increases in land degradation caused by fuelwood harvesting.

Conclusion

The overall biomass regeneration rate in Botswana is still greater than the current demand, with 1.8 million tons being harvested. However, biomass over-harvesting occurs in some localities, and is often serious around larger villages (4,000 households or more) in all parts of the country. Fuelwood is still an important fuel to the majority of the country's people.

Stakeholders in the Botswana biomass sector have recognised that unsustainable use patterns exist which will lead to serious shortages of fuelwood and degradation of the environment. This has been reflected in the involvement of the higher echelons of government, which have issued directives curtailing the use of fuelwood in government institutions and encouraging a switch to other fuels. Energy, especially biomass, will remain central in efforts to alleviate poverty and improve economic and sustainable development. The resource is unevenly distributed, so there is a need for initiatives to make it available in areas of shortage. For decades to come, most people in Botswana will continue to rely on fuelwood for their daily energy consumption; it is therefore imperative that measures and programmes be put in place for its sustainability and also for the protection of our environment.

Last but not least: in the past it was taken for granted that what is good for urban areas is good for the rural areas. This is a misconception, and it is necessary to distinguish between rural and urban energy needs. In that context, it is necessary to investigate what is needed to influence the rural energy initiatives for proper management and utilisation. Botswana seems to be heading in the right direction, provided formulated policy proceeds as planned and recommended strategies are implemented with the involvement of all stakeholders.

ACCESS TO ENERGY: POWER SECTOR REFORM

Overview of the power reform programmes in sub-Saharan Africa

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1 The rationale for reform in the power industries

1.1 Globalisation, liberalisation and deregulation

The power industries reforms occurring in most parts of the African continent – and in SSA specifically – are part of the wave of liberalisation which has been taking place around the globe since the late 1970s and the early 1980s. These changes follow from the restructuring of the so-called network industries (telecommunications, transport, electricity, water and sanitation) on the basis of a greater importance of market solutions in the allocation of resources, as well as incentive-based regulatory mechanisms.

Considering this "global approach", one may say that the worldwide justification for restructuring the power industry relies on two major lines. The first relates to the role and the functioning of either the wholesale power markets (bulk transactions, spot market, etc), or the stock market as well as the futures market. The second refers to the incorporation of the developing countries' power systems into the world economy, and thus the sale of the state-owned power utilities' capital stock to foreign investors in order to include the developing countries' power systems in the global market .

It is possible to state that this approach may be associated with the actual globalisation process understood as "the strategy required to lengthen the life cycle of an industrial product beyond the domestic market, which is the firm's relocation key characteristic" (Eboué, 2000). The rationale of the reforms thus fails to take full account of both the domestic industrialisation

policies and the expansion of the countries' natural resources. These changes rely basically on a shift of paradigm, in that the power sector, which had been up to now solely managed by the state-owned monopolies, needs from now on to vote for a different process of accumulation.

This neo-liberal thought outcome casts light on the power sector command and organisation which depend on the structure of the industry as well as the arrangements of both the companies and the market. The network industries' restructuring leading issue – and basically the power industry's too – refers to the performance of the industry which depends on the command of the firms which itself is specified by the structure of the market. The designated process of accumulation is brought about by this economic formal perspective, which does not address positively the requirement of SSA energy development.

As a consequence of this paradigm, the reforms comply with a threefold scope :

- The *structure of the market* governs and supports the debate on structural reform – that is, the reforming of the industry structure framework understood as the vertical de-integration and unbundling of the three segments (generation, transport and distribution) which were traditionally dominated by a single monopolistic operator and the incorporation of a fourth segment: supply. The dynamics of this change aim at the specific specialisation of every segment, the segments with natural monopoly characteristics (transport and distribution) remaining regulated, and competition being introduced within the two others (generation and supply). There is a particular emphasis on competition in the generation segment, with the shift from public funds to private, in authorising private investors to construct power plants – independent power producers (IPPs).
- The *management of the firms* governs and supports the debate on ownership reform. It addresses ownership and management of the state-owned power utilities. This privatisation and/or divestiture of capital to foreign investors is a contentious issue in the developing countries. In fact, the dynamics of the process assumes that the private investors' style of management must be preferred to the public style in order to remove the inefficiencies which primarily originate from both the management and the excessive interference by the political establishment. The private sector has business management competency
- The *performance of the industry* governs and supports the debate on regulatory reform. This issue refers to the legal environment (laws, decrees, etc) and the institutional framework, including the launching of such organisations as regulatory agencies and rural electrification agencies. This debate refers to investor confidence by specifying the remuneration of their equity in clarifying the prerequisites for, and mode of, regulatory interventions.

1.2 Drivers for reform in industrialised and developing countries

Table 1 shows that, even though the rationale for reforming the industries relies upon the same theoretical background, it is obvious that the objectives are different, for they depend on the issues to be addressed by the concerned region. Up to now, the lessons learned from the SSA countries – as discussed below – do not seem to provide low-cost electricity to all customers, but rather to the urban ones only, whenever the case. This is evidenced by the expansion of the access provided by the private operators, which is mainly in urban areas. Since the low-income rural population is unable to fund the high costs of connecting to the networks, private investors do not have incentives to extend their network-only access to the rural and isolated areas.

Power sector reform has been driven from quite different perspectives, depending on the domestic environment and, as such, the outcomes of these changes have to be analysed depending on which region is concerned.

Table 1: Reform in industrialised and developing countries

Industrialised countries	*Developing countries (SSA)*
1. Mature power systems with 100% average access and thus a demand stagnation.	1. Power systems with very high potentialities of growth, especially for rural areas
2. Relocation of the power companies as a consequence of the excess of cashflow.	2. Major shortage of capital for infrastructure development.
3. Reforming the industry for competition to be introduced within the market.	3. Reforming the industry for competition to be introduced for the market.

2 Review of the reform process in SSA countries

2.1 The scope of the study

The opinions that follow reflect the reforms of power industries that are currently taking place in the African French-speaking countries. Although some of the conclusions might apply to other countries, it has to be noted that the political and, above all, the legal circumstances differ (Kouo, 1998).

2.2 The implementation of reforms

The pattern of power industry restructuring being applied in SSA countries derived from the experience of the industrialised countries with large and mature power systems. The model advises separation of generation from transmission, which in turn may be separated from distribution. The generation sector is then opened for competition between several players – but planning for a small system must take into account that it may be harder to achieve real competition in the generation sector. This model is based on capturing the benefits of competition in the generation segment and regulating those parts of the system that cannot be competitive and may therefore exploit their monopoly position (Bacon, 1994).

Since the SSA power systems refers to small systems – examples are indicated in Table 2 – it might be of relevance to take this into account when drawing lessons from these reforms: SSA countries may experience a very different balance of advantages and disadvantages compared with those related to large or mature systems.

Table 2

	Installed capacity 1996 (MW)	*Installed capacity 2005 (MW)*
Cameroon	841	1 046
Côte d'Ivoire	918	1 200
D R Congo	1 480	2 808
Gabon	301	370
Guinea	176	196
Madagascar	225	435
Mauritius	396	591
Mali	85	102

Source: Energy biennial publication for the French-speaking countries (IEPF, 1996)

The changes under way in SSA power industries reveal that most of the countries have adopted the model highlighted above, as indicated in the data provided in Table 3. As indicated in Table 3, the pattern adopted by the SSA countries for reforming their power industries can be summarised as follows:

Table 3: Power reform in some SSA countries

	Structural axis	*Ownership axis*	*Regulatory axis*
Benin*	Generation and transmission separated from distribution. Authorisation of IPPs.	Privatisation of the state-owned utility SEEE: concession arrangement	Regulation operated by the Ministry.
Cameroon*	Vertical integration of generation, transmission and distribution. Authorisation of IPPs.	Privatisation of the state-owned utility SONEL: concession arrangement	Regulation operated by a specific organ: ARSEL
Central African Republic*	Vertical integration of generation, transmission and distribution.	Privatisation of the state-owned utility ENERCA: affermage arrangement	Regulation operated by the Ministry
Côte d'Ivoire	Vertical integration of generation, transmission and distribution. Authorisation of IPPs.	Privatisation of the state-owned utility ENERCA: affermage arrangement	Regulation operated by a specific organ: ANARE
Gabon	Vertical integration of generation, transmission and distribution. Authorisation of IPPs.	Privatisation of the state-owned utility SEEG: concession arrangement	Regulation operated by the Ministry
Guinea	Vertical integration of generation, transmission and distribution. Authorisation of IPPs.	Privatisation of the state-owned utility ENELGUI: affermage arrangement	Regulation operated by the Ministry
Mali	Vertical integration of generation, transmission and distribution. Authorisation of IPPs.	Privatisation of the state-owned utility ENELGUI: affermage arrangement	Regulation operated by the Ministry
Senegal	Vertical de-integration of generation, transmission, distribution and supply	Privatisation of the state-owned utility SENELEC	Regulation operated by a specific organ: ARSE
Togo	Generation and transmission separated from distribution. Authorisation of IPPs.	Privatisation of the state-owned utility CEET	Regulation operated by the Ministry

* Reform in progress

The *debate on structural reform* has been limited to the introduction of the single-buyer model in most of the countries. The governments in SSA have separated the transmission-distribution segments[1] from generation, and have given private investors the authorisation to construct power plants to generate electricity and sell it to the newly established national – private – power company. IPPs sold their output through long-term power purchase agreements (PPAs) that include take-or-pay quotas or fixed capacity charges to protect investors from market risks.

The *debate on ownership reform.* Since public ownership tends to result in productive inefficiency, and also because of the shortage in capital for infrastructure development, the privatisation axis is the main lesson to be drawn from this ownership issue. Almost all the countries in SSA have made the decision to divest the utilities' capital stock to private players through concession or *affermage* – lease contract – arrangements [Kouo, 1998]. This shift assumes that private industry can capture the potential gains in productive efficiency and passed these gains to the consumers. This might be the case, i.e. the move from public ownership to private ownership might produce large allocative net benefits for the economy, provided that the private company is skilfully regulated.

The *debate on regulatory reform.* Up to now, just a few countries (Cameroon, Côte d'Ivoire and Senegal.) have embarked on the incorporation of a regulatory agency; most of the other countries tend to chose to preserve – for the moment – the key role of the sector ministry. In that sense, this third axis seems to have been overlooked by the governments and, thus, the influential role of these agencies remains questionable.

Up to now, evidence from SSA countries does not suggest that these changes could significantly improve access, for they do not address the rural and remote areas. In the SSA region one can assert that these changes might have some positive impacts for the interconnected and urban – including peri-urban – areas (provided that the regulatory axis is endowed with the appropriate human resources and also that their influential role is not government-oriented). But what about the rural and remote areas where more than half of the population resides?

[1] Some governments went further and split the national utility into transmission and distribution companies, intending ultimately to turn each of the segments' facilities over to the private sector !

3 What impact for the development of access ?

To be successful in the objective of promoting access to energy for the majority (mostly rural) in SSA, the reform process needs to be streamlined and directed to address this issue. The development of energy sector policies to promote access should be based on interventions that improve both all its aspects and the general economic well-being. Meeting the needs of the majority and allowing this majority to gain access to energy requires:

- widening the scope of the reforms and incorporating in the analysis all aspects of the energy sector (traditional and renewable energy, oil & gas, electricity and energy efficiency). More thorough reforms are needed aiming at reaching also the rural population located beyond the existing networks and at the margins of the cash economy.
- a rectification of government interventions based on explicit hypotheses on how specific elements of energy policies – individually or together – are assembled, to formulate a real strategy which takes into account the economic and social development of the country; the master plan of electricity, oil and gas networks; and the legal and institutional environment to implement for the emergence of a balanced public-private partnership.

The actions to be taken have to be sustainable; in that sense the state has to play a positive role in close cooperation with the private investors.

References

BACON Robert, Restructuring the Power Sector: the Case of Small Systems. The World Bank, FPD Note N° 10, June 1994.

BRANCART René-Yvon, Les États d'ASS dans la dynamique des changements de paradigme et des mutations institutionnelles du secteur de l'énergie, Séminaire international IEPF de Cotonou, décembre 2000.

EBOUÉ Chicot, Les enjeux africains de la mondialisation, Texte non publié, Septembre 2000

GIROD Jacques, le développement énergétique en Afrique subsaharienne après l'ère des réformes, IEPE-CNRS, octobre 2000.

KOUO, Dibongué (Dir.) Investissements et nouveaux aspects contractuels dans les industries électriques africaines, Collections de l'IEPF, Avril 1998.

KOUO, Dibongué (Dir.) La restructuration des industries électriques africaines, Collections de l'IEPF, parution en mars 2001.

VILLAGRAN Eduardo, Key drivers of improved access— off-grid service The World Bank – ESMAP, Energy and Development Report 2000: Energy services for the World's Poor, April 2000

Implications of power sector reform in South Africa on poor people's access to energy: Lessons for Africa

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1 Introduction

A high-level regional meeting on Energy and Sustainable Development was held in Nairobi, Kenya in early January 2001. The purpose of this meeting was to bring together African key energy decision-makers and stakeholders to draft a statement on Africa's position with regard to energy and sustainable development. This statement is to be officially presented at the ninth session of the Commission for Sustainable Development to be held in New York in April 2001.

The Statement formulated by this meeting emphasises how important, and necessary, it is that poor people in Africa gain better access to affordable energy sources. Indeed, most delegates at the meeting supported the notion that improving energy access is Africa's key energy sector objective. Yet, each of the various case study presentations on the implications of power sector reform on poor people's access to energy indicated unambiguously that power sector reforms in Africa so far have not improved poor people's access to electricity, nor are they likely to do so in their current form. Furthermore, these presentations indicated that power sector reforms (again, in their current form) are even likely to have *negative* impact on access.

In response to these views, delegates of the meeting called for a re-think of current power sector reforms in Africa, and suggested that they be formulated to seek significant access improvements in addition to system and economic efficiency improvements.

This paper looks specifically at the case of the power sector restructuring in South Africa. It tries to understand the impact electricity industry reform is likely to have on poor people's access to energy. Thereafter, it presents broad reflections relating to how South Africa can best make use of the small window of opportunity that is presented to us by power sector reform to significantly advance programmes to improve poor people's access to energy. The paper also draws lessons from the South Africa experience for other African countries on the verge of designing and/or implementing power sector reforms.

2 Drivers for change

Electricity distribution industry reform

South Africa's electricity distribution industry (EDI) is now in urgent need of reform. Current problems in the sector are many and serious, and can be summarised as follows:

Financial viability: The EDI is currently in financial crisis. Many municipal distribution businesses in recent years have suffered financial collapse and many others are now close to bankruptcy – facing severe debt problems, including a backlog of non-payment for bulk supplies to Eskom. The financial crisis facing many distribution businesses has very real and severe consequences.

Inequitable treatment of consumers: The current arrangements in the EDI are the result of historical accident and form no coherent pattern. As a result, consumers face significantly different tariff levels, standards of supply reliability and service across the country. The result is widespread inequity among consumers. This is inconsistent with government objectives of promoting economic and social development throughout the country.

Inefficiencies: The EDI is currently highly fragmented, with some 400 distribution businesses, which by international standards are extremely small. As a result, many of the basic economies of scale in the sector are being lost. Administration and technical functions are duplicated across adjacent distributors in rural, urban and industrial areas. Costs and prices in the sector are, in consequence, unnecessarily high, and will remain so until the number of businesses is reduced radically, in line with earlier Cabinet resolutions. The highly fragmented nature of the sector also

means that the EDI is currently very difficult to regulate and monitor effectively.

The EDI is an important element of the South African economy, and has a key role to play in the government's economic and social development plans. The South African government believes that EDI reform should be undertaken in order to:

- provide low-cost electricity to all consumers, with equitable tariffs for each customer segment;
- provide a reliable and high quality supply and service to all customers, in support of the government's economic and social development plans;
- meet the country's electrification targets in the most cost-effective manner, and so ensure that electrification is contributing to social and economic development;
- meet the legitimate employment, economic and social interests of all employees in the sector, and ensure their safety; and
- operate in a financially sound and efficient manner, in order to provide a reliable and sustainable future for both consumers and employees.

*E**lectricity supply industry** inefficiencies*

In many respects, the electricity supply industry (ESI) has served South Africa well. Importantly, Eskom has provided a good quality of supply, in recent years it has lowered its prices, and it has implemented a large electrification programme. Various factors behind Eskom's ability to maintain low prices as well as fund the electrification programme have been identified. These are that Eskom (i) has benefited greatly from the low purchase price of coal; (ii) has done well to utilise power station technologies that maximise economies of scale and exploit the lowest value (and cost) coal; (iii) continues to receive substantial assistance in the form of subsidised export credit financing from foreign governments and subsidised South Africa Reserve Bank forward cover; (iv) has already amortised the loans required to fund the generation capacity that now feeds South Africa's power requirements; and (v) receives a large subsidy from the state in that it has been exempt from taxation and dividend payments.

If Eskom's operations in various areas are in fact inefficient, and *if* these inefficiencies result in a cost burden on the South African economy, it does not necessarily follow that the entire electricity industry should be restructured, or that a change in industry ownership should be forced. Such, perhaps, radical changes are currently being suggested because of various other driving factors.

Firstly, South Africa is a global player and must always be looking for opportunities to improve the performance of its key economic sectors. Manifest in growing international experiences, there is a realisation of the following:

- Outstanding technological improvements indicate that all components of the electricity industry are no longer necessarily vertically integrated monopolies deriving significant social and environmental benefits through economies of scale.
- Energy security can be achieved through greater diversification and flexibility of supply, including increased cross-border energy trade, and uneconomic energy industries need no longer be protected.
- Government need not necessarily be the provider of public services in order for delivery of these services to be ensured.

Indeed, as the White Paper on Energy Policy for South Africa notes, "[t]he rapid changes in the political and economic context of the electricity supply industry world-wide in recent years raise questions about the continued ability of South Africa's monopolistic electricity industry to meet customers' electricity services needs in future."

Power sector reform has been driven not only by these international developments, but also, by imperative emanating from within South Africa. On a broad level, power sector reform initiatives coincide with government's decision to restructure its largest state-owned enterprises. The Minister of Public Enterprises and the Deputy Minister of Minerals and Energy recently noted that from a government perspective, the primary objectives for restructuring Eskom are to:

- maximise financial and economic returns to the state both from the point of view increased opportunities for debt reduction and increased fiscal revenue;
- increase economic efficiency in terms primarily of achieving allocative efficiency with regard the next investment in generation capacity, in driving operational costs down;
- widen resource availability and opportunities for technological change by considering competitive imports from southern Africa, in particular natural gas from Namibia and Mozambique, as well information and computer technologies;
- Promote opportunities for black economic empowerment;

- improve customer service and introducing choice of supply (Radebe 2000; Shabangu 2000).

At the time, the Minister of Minerals and Energy (Mlambo-Ncguka 2000) accepted these main objectives and added another:

- to protect public benefits such as widened access to the poor, energy efficiency, ongoing research and development and environmental sustainability.

3 Plans for change

Rationalisation of the EDI

To address concerns in the EDI, government now plans to consolidate it into a maximum number of financially viable independent regional electricity distributors (REDs). This process will amalgamate Eskom's distribution division with the local authority distributors into a number of REDs. As an interim step, Eskom Distribution is likely to be transferred into a transitional EDI Holdings Company for the entire distribution industry. Eventually REDs are likely to become independent of the EDI Holdings Company.

Government's appointed technical advisors of this particular initiative recently released working papers (PriceWaterhouseCoopers 2000) detailing views that have emerged following extensive (yet ongoing) analysis and various stakeholder meetings. A selection of these views is given below.

RED definition: It is suggested that six REDs should be established. Each RED will contain a major economic centre.

Ownership: It has been suggested that shares should be used to compensate existing distribution undertakings for the value they contribute to the REDs, and that Eskom has been restructured, shares in respect of Eskom distribution should be held by national government.

Governance and legal status: It is recommended that each RED be controlled by its own professional Board of Directors, elected by its shareholders. Furthermore, the REDs should be established as companies incorporated in terms of the Companies Act.

Commercial arrangements: REDs should purchase generation and transmission services by means of a regulated Wholesale Pricing System (WEPS). The WEPS would contain separate generation and transmission components, both of which would be regulated. Once the wholesale energy market is established (see below), REDs would be allowed to purchase from this market. The regulatory regime would provide REDs with an incentive to minimise the cost of energy purchased on behalf of their customers, and would limit cross ownership between REDs and generation companies so as to encourage energy purchase to be made on a fully commercial basis.

Regulatory arrangements: The new regulatory regime for the EDI should provide a role for local government to complement the role of the National Electricity Regulator (NER). Local government would be involved in micro regulation of the RED in its area to meet its legal and constitutional obligations, and the NER would be concerned with macro regulation of the whole EDI with a view to meeting national objectives for the industry. The "end-state" regulatory regime for REDs would include (i) separate regulation of (and licences for) distribution activities, captive market retail activities and contestable market retail activities; (ii) efficiency incentives for the distribution business and the captive market retail business of REDs through regulation of the allowed revenue for each RED; (iii) tight monitoring and performance against quality of supply and quality of service standards.

Without substantial increases in tariffs, major reductions in distribution costs, or the curtailing of the electrification programme, it is furthermore recognised that this rationalisation and restructuring process alone will have limited impact on improving the overall financial health of the industry. It is for this reason that the White Paper on Energy Policy states that "the entire industry (generation, transmission and distribution) must move to *cost-reflective* tariffs with separate, transparent funding for electrification and other municipal services."

Competition in the wholesale market

While it must be emphasised that very few decisions have been made on the appropriate model for ESI reform, and indeed that the way forward for ESI reform remains open-ended, it seems presently likely that ESI reform will follow the logical steps as illustrated in the generic models illustrated by Figures 1, 2 and 3.[1] Figure 1 illustrates the Purchasing Agency model whereby Eskom continues to dominate the electricity industry, controlling Generation, Transmission and the unregulated Eskom Enterprises. Essentially, this model is representative of a near-term situation since (i) Eskom is currently being corporatised in preparation for the introduction of competition in the wholesale electricity market, (ii) Eskom has already been split into a regulated

[1] This likely reform path is directly related to electricity sector policy statements as outlined in the *White Paper on Energy Policy for the Republic of South Africa* (1998), as well as policy statements appearing in the Ministry of Public Enterprises Accelerated.

(core) business subsidiary (generation, transmission and distribution) and a non-regulated (non-core) subsidiary being Eskom Enterprises; and (iii) the distribution industry is soon to be rationalised into a small number of financially viable REDs.

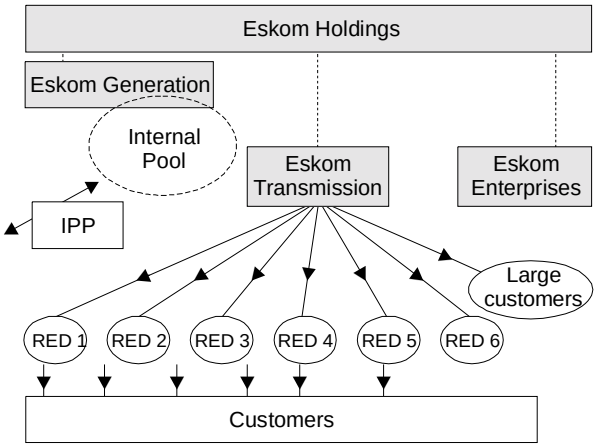

Figure 1: Purchasing Agency Model
Source: Adapted from Mkhwanazi (2000), Hunt & Shuttleworth (1996)

It is broadly accepted that Purchasing Agency Model cannot last indefinitely. Under this model, any new generator entering the market would sell power to Eskom. Government would find it difficult to attract new investments into the industry, as investors would be concerned about the inherent conflict of interest in Eskom, as the owner of Transmission and owner of various generation plants. Open, non-discriminatory access to the system would not be guaranteed. At a minimum, new independent power producers (IPPs) would demand long-term power purchase agreements (PPAs) which could result in consumers being tied to non-competitive prices for years to come.

Transmission in the Generation Oligopoly model (Figure 2) is established as a separate state-owned company. It seems likely that this will occur in the near future. An external, transparent power exchange is also established. Eskom will continue to control Generation and Eskom Enterprises. Eskom Generation units are grouped into different clusters, or operating divisions, under the control of Eskom Holdings. These different operating divisions would however, bid separately to sell power into the pool. Government is likely to adopt this model since it has expressed a concern about the undesirability of introduce private participation into the wholesale electricity industry while it is still organised in a single holding structure. This model is not likely to prejudice the existing strengths of the electricity supply industry. As the system evolves into the next model (see Figure 3), companies in these clusters should not be allowed to allowed to gain control of the transmission and distribution part of the industry as this could lead to abuse of market power. The central challenge facing the government at this time relates to the timing and phasing in, of a competitive market structure in generation.

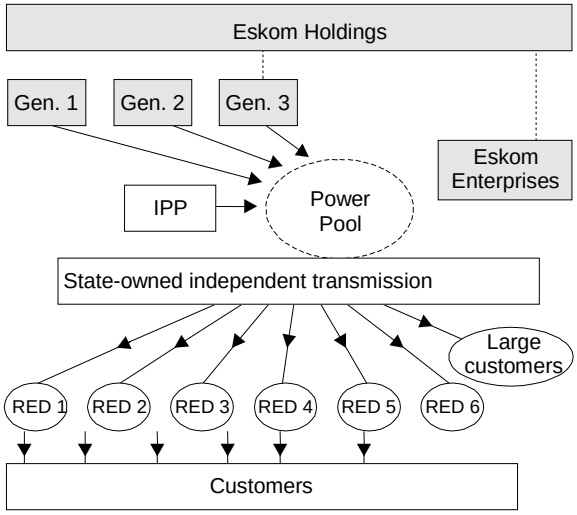

Figure 2: Generation Oligopoly Model
Source: Adapted from Mkhwanazi (2000), Hunt & Shuttleworth (1996)

In the Generation Oligopoly Model, there is general concern that Eskom Holdings would be able to exert excessive market power through its subsidiaries. Without regulatory support, investments in large independent generation plants would therefore still be unlikely.

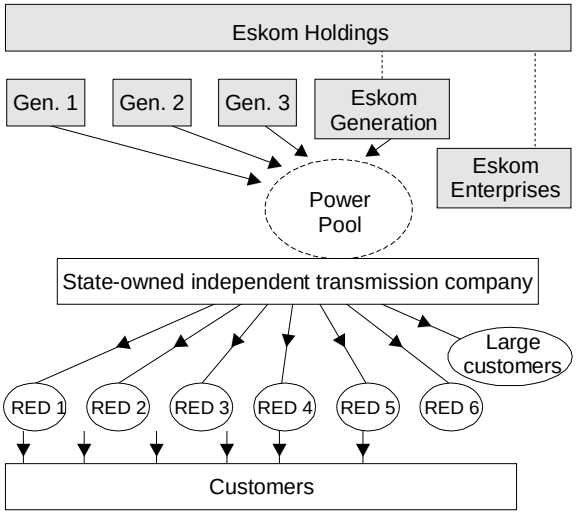

Figure 3: Wholesale Competition Model
Source: Adapted from Mkhwanazi (2000), Hunt & Shuttleworth (1996)

According to the Wholesale Competition Model illustrated in Figure 3, Eskom would be left with a highly diluted portfolio of generation assets (in addition to Eskom Enterprises). The re-

mainder of generation would be separated into competitive independent companies. These could be privatised through, for example, black economic empowerment provisions, or an initial public offering.

Transmission in the Wholesale Competition Model is likely to remain, at least partially, in the hands of the state. The introduction of a strategic equity partner into this independent transmission company might be considered. It is probable that generating companies will be precluded from owning the transmission network, and vice versa.

Retail competition could be introduced at this stage (or perhaps even earlier). This process would entail separating out the natural monopoly 'wires' business from retail services at distribution level. It is unlikely that full retail competition will be introduced in the next decade.

4 Impact on poor people's access to energy

In this section, a discussion on the potential impacts of power sector reform on access programmes is presented. Until now, the reform of the EDI has been seen by government as a separate process to that of the reform of the ESI. In line with this, the discussion is broken down into impacts associated with the reform of the EDI, and impacts associated with the reform of the ESI. It should be noted, however, that this (divided approach) is not necessarily the most appropriate, since the benefits associated with distribution industry restructuring are only fully unlocked when competition is introduced into the wholesale electricity industry. Likewise, the benefits of wholesale competition will only fully be realised when the distribution industry is operating well.

EDI reforms to increase access

It is our contention that the reform of the electricity distribution industry could have significant positive impact on poor people's energy access. This is for the following reasons:

- It will be a licensing responsibility for each RED to provide services in its licensed supply area.
- The boundaries of REDs have been defined so as to balance out customers of varying means. In this way, the electrification obligations of REDs will be spread out more equitably.
- The EDI Holdings Company is mooted to become the new "home" of the national integrated electrification programme.[2] An Electrification Division is likely to be established, and capacitated with experienced staff, who will also be responsible for ensuring that the new REDs build capacity in this area. National electrification planning will be undertaken by this division, which will report through the EDI Holdings Company to the Department of Minerals and Energy, and to the Minister.
- Capital expenses related to increased electricity connections to poor people are set to be covered by the fiscus, and associated ongoing operational losses will be covered by all other electricity customers.
- A social support task team is also likely to be established within the EDI Holdings Company. This task team will make recommendations on how poor peoples' needs can be addressed by the REDs, and will review the progress of the REDs in this regard.
- The establishment of REDs could also contribute towards the consolidation of the off-grid concessions programme. One of the key reasons why the programme has got off to such a slow start has been because municipal electricity distributors (as service authorities) in their current organisational and financial state have not been in a position to administer the off-grid programme, or enter into contracts with the concessionaires.
- Lastly, a poverty tariff is likely to be introduced to ensure affordable electricity prices to poor customers.[3] This proposed poverty tariff is very important from the point of view that domestic customers are currently underpaying for electricity consumption by up to 50 per cent. Without the availability of this poverty tariff, and with a move towards cost-reflective tariffs, poor people could be heavily effected.

The extent to which the above initiatives are successful will ultimately depend on the financially viability of the REDs. This may take some time, for some of the REDs. Until then, these

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[2] The national integrated electrification programme comprises both grid and off-grid electrification. As noted, grid electrification will become the responsibilities of the REDs, and off grid-electrification will be undertaken by private sector concession companies, subsidised to do so.

[3] The Ministry of Minerals and Energy recently commissioned a national study to investigate minimum access to basic services by poor households. "What underpins this study", she explains, "is the establishment and quantification of the amount of relief that the economy can support on an equitable basis in respect to energy sources to poor households". The scope of the study covers electricity, renewables, illumination paraffin, LPG and low smoke fuels (NER, 2000). Following the submission of recommendations emanating from this study, a decision will be made by Government on whether to implement the tariff or not.

social responsibility programmes are likely to be kept to a minimum, and just within licensing obligations. One could argue, however, that given the current state of the electricity distribution industry, 'things can only get better'.

ESI reform's mixed impact on access

Earlier, it was noted that government plans not only to reform the EDI, but also, at some stage, to introduce competition into the wholesale electricity industry, as well as potentially privatise the industry. Implementation of these plans is likely to be some way off. Implications of these initiatives on the people's access to energy are less direct but are equally important, and relevant to this discussion. These are as follows:

- The price for which customers pay electricity is likely to change as wholesale competition is phased in. In many countries that have already undergone this process, the wholesale price of electricity has dropped, shareholders returns have increased, but the price customers have had to pay for electricity access has increased (Albouy & Nadifi 1999). It is highly likely that this will occur in South Africa where the tariff structure is not currently based on the true cost of supply. But, as indicated earlier, it should be remembered that this analysis must be seen in the light of price impacts of distribution industry restructuring, as well as the proposed introduction of the poverty tariff.
- Privatisation programmes may free up precious government funds to be used on other human development programmes (for example, education, housing and health services). Indirectly, this may result in positive impact for poor households. However, without adequate regulation and purchase compacts there is no guarantee that the private sector will continue to invest in energy infrastructure, especially in deep rural areas, where it is expensive to do so.

As debates on the reform of the electricity distribution and supply industries have taken place, and as plans are being formulated, the Minister of Minerals and Energy (and various others) have remained adamant that the electrification programme should in no way be hindered by these reforms. Indeed, the Minister has, on occasions halted discussions and final closure on issues, to ask that more time is spent on understanding the implications of reform plans on electrification and access to energy, particularly by the rural poor. The Minister and others continue to call for the electrification programme to be seen as an element of an integrated and wider programme to substantially improve livelihoods of rural dwellers. Interestingly, the Minister recently noted that the Department of Energy might be in a position to play a role in co-ordinating the infrastructure cluster of an initiative seeking in turn to co-ordinate governmental rural development related programmes.

5 Reflections on South Africa's situation

Poor households and communities typically rely on diverse sources of energy, using one fuel for heating, another for cooking or lighting, another for agricultural or other productive activities. This has substantial implications for the way in which policy- and decision-makers seek to meet the needs of the poor for sustainable energy. Firstly, if they are to achieve any success in meeting the needs of the poor, then they must seek to gather accurate information on how poor people currently obtain and utilise fuels services – and of the nature of their demand for improved services. Policy- and decision-makers in South Africa must continue to gather information and insight into the demand and supply patterns to ensure successful and effective interventions.

That households use various fuels to satisfy household energy requirements has implications, secondly, for whether power sector reforms alone can have real positive impact on poor people's access to energy. Surely, if the objective is to make a contribution towards the improvement of the livelihoods of poor people, then policy- and decision-makers emphasis should be on 'energy sector' reforms, instead of the narrow focus denoted by 'power sector' reform. South Africa should be designing thorough reforms that better develop markets in a variety of energy services for households and communities. In South Africa, the notion that an "integrated" approach to energy provision and to poverty alleviation is well supported on an intellectual level. However, in practical terms, we do not fully understand how to do this.

The South African case study begs a discussion on whether policy- and decision-makers should be emphasising their attentions on power sector reform as a means towards improving poor people's circumstances, or whether direct interventions through infrastructure services and community interventions better achieve these developmental objectives. In our view, the jury on this one is still out. For now, South African policy- and decision-makers are seeking to adopt a balanced approach. Power sector reforms are being considered (and as noted are likely to be implemented in one way or another). The state goals of these reforms are to bring about substantial economic and efficiency improvements to the electric system, as well as improvements related to poor people's energy access. At the same

time, the South African government appears not to be relying merely on these reforms as a way of improving poor people's livelihoods. Rather (as illustrated in the section above), it is in the process of establishing a series of other parallel programmes (electrification subsidies, poverty tariff etc.) that in most cases are more directly linked to the local level and to poor people. It will be interesting to note, in the future, whether power sector reforms have impact on the success or failure of these parallel programmes.

Finally, if the primary objective of Africa (and South Africa?) is to improve poor people's access to energy services, should we in fact be seeking to understand what the impact power sector reforms are having on poor people's access to energy? Or should we rather be seeking to design power sector reforms that radically improve access while also improving the efficiency and economics of the electricity system? Or, is our new challenge in designing more thorough reforms that better address South Africa's needs?

6 Initial recommendations for Africa

South Africa's electricity industry, and its national utility portray many dissimilar characteristics from those of other African countries. Therefore, African energy decision-makers should remain cautious about soliciting guidance from South Africa. Additionally, South Africa is yet to implement its plans for reform in the electricity distribution and supply industries, and therefore few lessons can be drawn from actual experience. In designing its power sector reforms, however, South Africa has looked closely at emerging experience from both developed and industrialised countries, and has also looked carefully at its own situation. Accordingly, it may be possible to draw together the following broad recommendations that African countries could take account of when considering whether, or how, to improve access to energy, as well as introduce reforms into electricity industries:

Getting the model right for Africa

Many countries around the world have sought to reform their electricity industries. Many, though certainly not all, have not had to plan for pressing human development challenges; neither have they had to concern themselves with improving their citizens access to electricity, or to energy in general. African countries should look carefully at whether it is relevant to implement power sector reforms given these additional challenges. Electricity sector reform plans in Africa should take heed of important national developmental objectives. If reforms do not seek to address these national developmental objectives, then the reform plans should be carefully scrutinised. If reform is deemed to be the most optimal way to go, African decision-makers should not cease to remember that power sector reform can have both positive and negative impact on public benefits programmes. Additionally, African decision-makers should keep in mind that if mechanisms to provide these public benefits programmes (such as rural electrification) are not put in place, it is highly unlikely that they will be invested in.

Getting the distribution business right

Grid and off-grid electrification programmes, as well as other initiatives that seek to improve poor people's livelihoods through increased access to electricity (and energy), are best designed and implemented on a local level. If the distribution industry (public or privately-owned) is not in a fit state to roll these programmes out, then such programmes are likely to be non-starters, or at the least, very expensive.

Adopting an integrated approach

Grid-based electricity supplied by publicly owned enterprises many not necessarily be the way forward for African countries seeking to improve citizen's access to energy. Improved energy access may be far better achieved utilising off-grid electrification options such as solar power, fuel cells, etc, or else alternative sources of energy such as LPG.[4] If this approach is accepted, then it follows that power sector reform should not necessarily have as significant an impact on people's access to energy as might have originally been envisaged. African decision-makers should look carefully into the nature of distribution and supply chains of available and cost-effective energy source options, in addition to learning how and why energy end-users currently utilise energy in the way that they do.

Designing a relevant, robust and independent regulatory framework

In order to ensure that the benefits of reform in the electricity distribution and supply industries trickle down to end-users, it is advisable that African energy decision-makers look carefully into setting up appropriate regulatory frameworks. Reform measures (including introducing competition and privatisation initiatives) do not necessarily mean that the need for regulation falls away. In fact international experience indicates that this is the time when regulation becomes all the more important. Many of the new barriers that public benefit programmes face when reforms are implemented can be done away with if

[4] Ideally, this integrated approach should be extended to all services – including water provision, education, housing, health etc.

appropriate regulations are put in place. Specifically regarding access to electricity, appropriate regulations can ensure prices are kept low, that distribution utilities are obliged, as part of licence agreements, to increase customer base though installing new connections etc. It should be noted, however, that regulations are not necessarily the panacea to improving energy access – energy sector roleplayers are notoriously good at finding ways around regulations!

Separating out public service obligations from mainstream obligations

If privatisation is on the agenda of African countries, then attention should be paid towards separating out government's public service obligations (like improving access, ensuring a reliable and quality power supply, and undertaking research and development activities) from business-related initiatives (such as selling more kWhs). Unless regulations are clear and enforceable, private utilities may have little incentive to invest in the former type of programme – that is if doing so has a negative impact on the utility's bottom line. If African governments regard these public-benefit type programmes as important, they should make specific provision for them. In order to improve access to off-grid based electricity, for example, the South African government has invited private sector concessionaires to implement off-grid programmes in various parts of the country. These concessionaires will be able to apply for a subsidy to do so. Without this subsidy, it is unlikely that the private sector would see this programme as a viable investment option.

Getting the structure right before privatising

An important lesson learnt around the world – and in Africa – is that it is vital that desired structure of the electricity industry is achieved before its ownership is changed. If there is competition in the industry, and if regulations are right, then private sector participants will not easily be able to establish monopolies that abuse market powers, and therefore customers. If the 'right' structure is achieved, then it is more likely that programmes that support increase access to electricity or energy can be advanced.

Promoting regional integration

African countries should work together in identifying ways of improving their people's access to energy sources. Numerous important experiences can be drawn together to contribute towards more appropriate policymaking and implementation mechanisms. African countries should also assist each other in identifying appropriate reform models for the continent.

African countries should also work together for trade purposes. If it is unambiguously found that regional integration – particularly with regard the buying and selling of electricity – yields quantifiable economic benefits to participating partners, then collaboration should be encouraged. For example, if the Southern African Power Pool results in a reduction in the wholesale price of electricity, thus creating new opportunities for more people to gain access to electricity, southern African countries should focus their attention on enhancing these systems. Appropriate, and consistent regulatory approaches would clearly need to be adopted to ensure the most optimal outcome for all countries.[5]

References

Albouy, Y & Nadifi, N 1999. Impact of power sector reform on the poor: A review of issues and the literature. World Bank report. Washington.

Brook, P & Besant-Jones, J 2000. Reaching the poor in the age of energy reform. ESMAP Energy and Development Report: Energy Service's for the World's Poor. World Bank, Washington D.C.

Department of Minerals and Energy 1998. White paper on energy policy for the Republic of South Africa. Pretoria.

Department of Minerals and Energy 2000a. The National Electrification Programme: Policy framework and strategic direction. Presented to the NECC meeting on 18 August 2000. Pretoria.

Eberhard, A 1999. Moving the debate on a competitive electricity market forward. Electricity Regulatory Journal. November/December, 12-13.

Eskom 1999. Annual report. Sandton

Hunt, S & Shuttleworth, G 1996. *Competition and choice in electricity*. Wiley & Sons: England

Mkhwanazi, X 2000. Vision for ESI in the new millenium. Presentation to Britain/South Africa Partnership Week. Michelangelo Hotel, Sandton, 22 November.

Ministry of Public Enterprises 2000. Accelerated agenda towards the restructuring of state-owned Enterprises. Hatfield, South Africa.

Mlambo-Ngcuka, P 2000. Opening address, People's power Workshop. 26 – 28 September, Eskom Conference Centre, Midrand.

National Electricity Regulator, 1999. Electricity supply statistics for South Africa for 1998. National Electricity Regulator. Sandton, South Africa.

National Electricity Regulator, 2000. EDI Restructuring Roadshows. *Electricity Regulatory Journal*. December: 4-6

[5] Interestingly this is the approach that SADC Energy Ministers are adopting. In May 2000, they gave approval for the establishment of a Regional Electricity Regulatory Association. A constitution is currently being reviewed.

PriceWaterhouseCoopers 2000. Working Paper 7. Consolidated emerging views. Electricity Distribution Restructuring Project. www.dme.pwv.gov.za.

Radebe, J 2000. Restructuring of state-owned assets. Address presented to the DME/DPE/WB power sector reform workshop. April.

Shabangu, S 2000. ESI change drivers, policy directions and challenges. Address at the DME/DPE/WB power sector reform workshop. April.

Versagie, C 1999. Residential market management: Striking a balance. Paper presented at DUE conference, March 30.

UNEP/UNDESA 2001. Statement: African Regional Perspective on Energy and Sustainable Development for the nineth session of the Commission of Sustainable Development. Nairobi, 10-13 January 2001.

The structure of the power sector, power sector reforms and implications for expanded access to electricity in Southern Africa

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Background

Access to electricity, and the implications of electricity reforms for increased access must be seen in terms of the extent of electricity service to the population and economic activity. Access in this paper is defined in terms of population served (measured in terms of households connected) and the availability and reliability of supply for economic activities. Access can be defined even more critically in terms of affordability by households and, in the SADC region, by small-scale industries, which have been just as poorly served with electricity as households.

The route of electricity sector reforms in SADC has been the "spiritual transition", moving from autarkic approaches to electricity sector development guided by a strong desire to maintain high security of supply through indigenous control of investment and distribution and the reasonable need to exploit local resources to support electricity sector development. This reform has led to three main structural changes in the electricity sectors of SADC member states: the acknowledgement of the externalisation of sources of electricity by utilising the regional power pool; the acknowledgement of independent power producers as main actors in the supply of electricity; and the unbundling of public sector electricity conglomerates, accompanied by official divestiture in the sector. Accompanying these three main structural changes is pressure for market-based electricity pricing structures and the abandoning of official price determination.

This is a massive transition in the power sector, which cannot be fully appreciated unless the background to the old regimes is clearly specified. In this paper, we can only give a brief background to the rationale for the old system and dwell at some length on the structure of the old/present system, including the Southern African Power Pool (SAPP).

More briefly, we critique the implications of SAPP and other reforms on access.

Rationale for state controlled electricity conglomerates

Electricity generation and distribution was generally regarded as infrastructure development by many governments and was considered a vital sector where social responsibility was to be exercised in order to keep control from falling into a single set of private hands. The risk of failure or other forms of disruption was considered too high. Such sectors as railway transportation and telecommunications were in the same category. This rationale, ironically, was not the brainchild of any of the present governments in Southern Africa but of colonial authorities. Ironically again, it is these same colonial authorities who now criticise state-run utilities, and seek passage of control to private capital. This line of thought seems to bear out those who treat the pressure for electricity sector reforms as a ploy through which colonial powers who controlled this sector through the state want to maintain control through private capital in which their nationals have a hand. This argument is seen as not altogether unfounded if one reviews the levels of concern raised by western capitals when reforms seek to give preference to local capital or to capital from regions other than those with traditional economic interest in the region.

In any case, it is also true that state-run utilities have become hubs of corruption and inefficiency, which has seen a complete rundown of utilities in most countries of the region. Far from being concerned with greater access, present-day electricity sector reforms are geared to unbundle capital and allow a more liberal and perhaps more efficient supply regime in the sector.

Overview of SADC economies

The regional population in 1994 in the SADC region was around 174.71 million (up from 145 million in 1990) which represents a high growth rate and a large potential market for

inter-trade among countries for various commodities. At the average population growth rates (SADC 1992 estimates) of 2.87% between 1990 and 2010 and 2.37% between 2010 and 2030, the population of the SADC region will grow to about 275 million by the year 2010, and to 440 million by 2030. Assuming similar proportions of demand, the electricity demand will grow to about 1.5 times in 2010 and about 2.5 times in 2030 that of 1994 which was 67TWh.

Electricity connections in the region are generally still below 20% (see Table 1), indicating very low access rates and a large potential market for future regional electricity trade.

The current population growth rate outstrips electrification. Out of the regional population of about 175 million, only 36 million (20.5%) have access to electricity and there are huge national differences from 2% to 50% (Sadelec1996). The emphasis for electrification has been on urban areas. Rural electrification is much more expensive per unit of electricity delivered to the household, and rural communities have low demand loads, making it uneconomic to supply electricity. These factors have been largely responsible for the little progress in rural electrification.

There is already a significant effort being made in the region to connect more households, including those in the rural areas. Eskom set a target in 1994 of electrifying over 1.75 million households in South Africa by 2000, a target which has been surpassed. Other regional countries are also involved in active rural electrification programmes. Zimbabwe has just completed a rural electrification master plan which would be implemented after approval by parliament. This is in addition to current efforts which includes a universal rural electrification levy to raise funds for increasing rural access to electricity. Rural electrification will be even more critical in those countries, like Mozambique and Angola, emerging out of a war situation . Although electrification targets have so far not been met, in most SADC countries the household electricity share is poised to increase.

The SADC region has two countries on the mainland classified as in Upper Middle Income category by the World Bank, namely South Africa and Botswana, with annual per capita income above US$2700 in 1994 (Table 2). Angola, Namibia and Swaziland are Low Middle Income (per capita income above US$1000 except Angola, * which is rich in oil and minerals), but the rest are in the low-income group with per capita below US$500. The economic status of countries will determine future borrowings for sector expansions and ability to service the loans. On the demand side, economic status will determine affordability of power and hence the market for traded electricity.

The economic outlook, according to the *Standard Chartered Bank Africa Quarterly Review* (Feb 1997) shows a generally depressed economy in the greater part of the decade to the year 2000. In 1994, the average GDP annual growth rate for the SADC region was low (1.7%)

Table 1: Regional population and electricity market (1994)
Average household size = 5 people

Country	*Population million 1994*	*Growth Rate %*		*No. of Households*	*% of Connected H/Hs*
		1990-2010	*2010-2030*		
Angola	11.4	2.7	2.0	2280000	NA
Botswana	1.42	2.2	1.5	284000	10 (26 +4)*
Lesotho	1.99	2.5	3.6	398000	3+
Malawi	9.60	2.1	3.1	1920000	4 (19 +1)
Mozambique	16.90	3.0	2.6	3 380000	5 (28 +<1)
Namibia	1.53	2.5	2.1	306000	NA
South Africa	40.40	3.0	3.7	8080000	10+
Swaziland	0.88	2.5	3.2	176000	11+
Tanzania	27.40	2.4	2.6	5480000	3 +
Zambia	9.25	1.9	2.1	1850000	18 (37 +2)
Zimbabwe	10.94	2.8	2.87	2188000	14 (55 +3-5)
DRC	43.00	2.3	2.37	8600000	
TOTAL	**174.71**			**34942000**	

Notes:

*( ) = (Urban % + rural % of H/Hs access)

Source: SADC, 1992 & UNEP/RISOE, 1995.

Table 2: Economic structure of SADC countries

Country	*GDP (US$m)*	*Growth rate*	*Per capita*	*Exchange rate (US$)*	*Consumer inflation rate (%)*	*Debt burden (debt/GDP) (US$ m)*
Angola	4445	8.6	397	6741.48[a]	972	11178 (2.5)
Botswana	3849	4.1	2711	2.59	10.6	695 (0.18)
Lesotho	803	6.0	404	3.40	8.3	550 (.68)
Malawi	1291	-12.0	135	4.46	34.7	1955 (1.5)
Mozambique	1431	5.0	85	5282.54	52.5	5421[b] (3.79)
Namibia	2885	5.4	1885	3.40	10.7	444 (0.15)
South Africa	121951	2.3	3019	7.50	9.0	27900 (0.23)
Swaziland	988	3.0	1122	3.40	14.3	198 (0.20)
Tanzania	2449	3.5	90	472.77	34.1	7748* (3.16)
Zambia	3463	-5.4	374	656.95	55	6890 (2.80)
Zimbabwe	4879	7.4	446	55.00	65%	4501 (.92)
DRC	14728 (1993)	-7.4	343	34.85	23770	11618* (.79)
Average		1.70				(Debt/GDP)

a) This is readjusted Angola Kwanza = 2195 new Kwanza

b) Estimated by Saddle

Source: Sadelec/*MEPC (1996)*

with a quarter of the countries having negative growth rates. Inflation rates and interest rates are increasing (already above two digits); exchange rates are deteriorating (particularly in the non-Southern African Customs Union countries) against the major foreign currencies; mineral and agricultural prices are depressed; aid flows are stagnating, and debts are more than 150% of national GDP in a third of the countries. The London-based Economic Intelligence Unit predicts falls of 6% in non-fuel commodity prices and 12% in metal prices in the short term for the region.

Economic growth in the region is also presently suppressed by high interest rates which are above 35% in most countries, and exceed 60% in Zimbabwe. The political instability in some of the SADC countries will further constrain the economic performance of the involved countries and discourage entry of external investments, particularly the foreign direct investments which may become the most important source of energy development financing in the future.

These factors are critical in influencing infrastructural development and programmes which enhance household ability to pay and increase load. To increase rural access, the concept of "load development" must be implemented. This concept seeks to support rural households' ability to pay and to increase the presence of small-scale and agro-processing industries to share the cost of supply and infrastructure development in rural electrification (RE). The income structure of rural households also has to be considered. Their cash flow is not spread throughout the year. Creative payment schemes such as prepayment meters could be used to enhance access. Most utilities in the region are familiar with this mechanism and have tried it to one extent or the other.

The region's economic outlook may change after 2000 as there is optimism and determination to develop the region, as demonstrated by the cooperative agreements signed by SADC countries to promote development – like the trade, energy, water and transport protocols.

In view of these developments, energy demand (mainly electricity) and the related development costs will grow to significant proportions in the future. It is estimated that the region will require US$ 15 billion to finance rehabilitation and new programmes to meet demand growth in the next 6-8 years (personal comm., 1996). The bulk of financing (59%) for energy development is often borrowed from multilateral lending institutions thereby worsening the region's debt burden. The World Bank finances 59% of power sector projects compared to 27% and 7% for self-financing and private financing respectively; the other 7% is secured financing (Sadelec/MEPC, 1996). This implies that most planned expansions are on the premise that the multilateral agencies will be able to finance.

Economic development and energy needs

Based on the 1990/91 data, the residential sector in the SADC region is the largest consumer (68%) of total energy but mainly in form of biomass fuels (Sadelec, 1996). Industry is second with 13%, followed by transport (7%), agriculture (5%), mining (3%), and others, including commerce, (4%). While empirical data is not available, it is thought that no major transitions in this fuel demand structure have occurred within the decade.

In terms of electricity demand, industry is already the largest consumer of the total electricity consumed in 1995 followed by mining and domestic as suggested by data for selected SADC countries shown in Table 3. In South Africa, most of the electricity is supplied to the 'Other' as bulk to municipalities (43%), agriculture (2%), traction (2%) and international (exports = 1%) although industry is still the largest single consuming sector in that country.

Table 3: Electricity consumption by sector (%)

Country/ sector	*Mining*	*Commerce*	*Domestic*	*Industry*	*Other*
Botswana	55	25	13		7
Malawi		16	22	62	
S Africa	21	1	2	27	48
Swaziland		9	22	51	18
Zambia	60	11	17		12
Zimbabwe	17	15	18	40	10

Source: Sadelec (1996)

Figure 1, which is a plot of GDP, net energy consumption and electricity consumption for South Africa between 1950 and 1993, shows the relationship between economic development and energy needs. Economic sectors depend more on electricity for development and hence also the similar relationship of GDP with electricity consumption for the same period. It stands to reason that future commercial energy, particularly electricity, will increase, depending on the economic performance of the region. The sectoral share of electricity as depicted above will also indicate in which sectors the demand is going to be largest. This information is critical in estimating electricity demand in the baseline to 2020.

The figure shows that energy consumption continues to grow with GDP growth, which is typical of developing countries. The energy intensity for the region is 15-50% higher than those of industrialised countries *(Energy In South Africa, Revision 1. Department of Minerals and Energy, 1996).* Although the data shown here is for South Africa, this pattern would be the same for other countries in the absence of serious political and economic turmoil. Such political factors are probably not considered in utility demand projections. In terms of magnitude, the South African data would to a large extent influence the pattern of the regional baseline as its energy demand is also the largest.

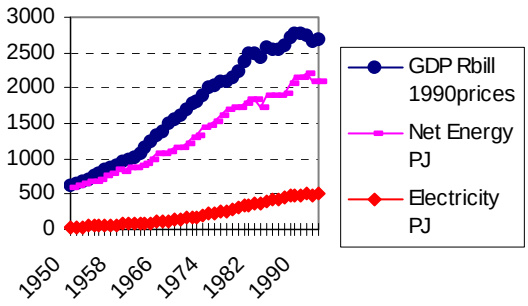

Figure 1: Economic development and energy needs in South Africa
Source: Eskom (1994) Statistical Yearbook. Johannesburg

Access for conventional industry has remained effective and stable, save for the common regional problem of poor grip with electricity pricing. This has been quite unpredictable and fluctuated between the two extremes of officially determined prices and semblances of long run marginal cost pricing.

Summary of regional energy use

The main energy resource of the region is woodfuel (63%) 86% of which is mainly used in the domestic sector for cooking. Electricity and LPG, which may be used for the same end-use and are cleaner substitutes, are considered too expensive for the majority of regional households who are of low income. Of woodfuel, 9% is used in industry – probably the informal sector. The only other users of woodfuel are agriculture (3%) and commerce (2%). Figure 2 summarises energy use by sector and fuel type.

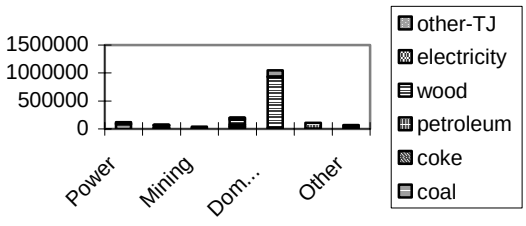

Figure 2: Energy use by fuel and activity sector for SADC Region (1990)
Source: 1990 Energy Statistics Yearbook- SADC TAU

Coal is in large supply, and the exploitable resources in all the coal-producing countries at the current mining rate would last for over 300 years. It is used for power generation mainly in the coal-producing countries of South Africa, Zimbabwe, Botswana and Namibia to the tune of 99%, 99.6%, 98% and 82% of the thermal capacities of those countries. The proportion of the coal used in power generation in South Africa alone, which mines 243 million tonnes annually, is 40%. The figure is even higher in Botswana (80%) and Zimbabwe (over 58%). At a regional level, power generation takes 53% of coal consumed. Namibia generates some of its electricity from coal imported from RSA. The second-largest consumer of coal is industry both as raw coal (23%) and as coke (98% of coke). Smaller quantities of coal are used in agriculture (8%), commerce (6%), mining (5%), transport (4%) and the household sectors (1%).

Oil is another important commercial fuel, but in power generation only diesel, jet fuel and fuel oil in decreasing proportions are used but to a smaller extent (10%) than coal. It is only Angola which has oil reserves, but its electricity source is mainly hydropower (79%). Only 4% of the oil products are consumed in the power sector in the region. The largest consumer of petroleum products is the transport sector, which takes about 49% of products consumed in the region. Smaller quantities are consumed in commerce (14%), industry (13%), domestic (9%), agriculture (6%) and mining (5%) sectors.

Considering 1993 electricity consumption data combined for South Africa, Zimbabwe and Botswana, Table 4 shows that electricity is mainly used in industry and commerce (52%) followed by mining (26%) and in the household sector (15%). Transport (4%) and agriculture (3%) are the lowest consumers of electricity.

Electricity consumption by industry and commerce is also highest in South Africa (52%) and Zimbabwe (53%), but in Botswana mining – the mainstay of the economy – is the largest consumer (55%). Botswana's industrial base is small, hence the smaller share of electricity consumption (33%); the domestic sector consumes 12% of electricity and a tiny proportion is used in agriculture for water pumping. Mining is the second largest electricity consumer in South Africa (26%) followed by the domestic/household sector (15%), transport (5%) and agriculture (2%). In Zimbabwe, the second largest electricity consumer is the household/domestic sector (22%), then mining (17%), agriculture (8%) and transport (below 1%).

About 1.1 trillion cubic metres of natural gas have now been identified as exploitable in a number of SADC countries, but its use in power generation is still to be tapped. This is a cleaner fuel for electricity generation which both utilities and independent power producers are likely to introduce into the electricity market. In consideration of the large reserves being discovered, costs of imported oil, environmental concerns (natural gas is a cleaner fuel than coal for power generation), natural gas is likely to be a popular fuel for power generation in the future of the SADC region. The rest of the natural gas has already found use in industry, and another use may be found in transport in the form of liquid natural gas and compressed natural gas.

South Africa and Namibia have uranium resources, but only RSA is using it for power generation for 6% of its electricity supply.

Although hydropower is the most significant resource for power generation, untapped potential is concentrated in the northern countries with the DRC, Mozambique, Angola and Zambia having over 80% of the region's resources.

The use of renewable energy technologies like solar, wind and biogas in the whole of SADC is small (well below 1% of national energy consumption) but shows signs of growing. The potential use in the power sector is as solar home systems, which would reduce demand for fossil-derived electricity in rural areas remote from the grid, and later as central PV and wind hybrid systems feeding into the regional grids. This technology should be considered quite important given the high cost associated with grid power and the poor loads exhibited by domestic end-use in rural areas.

Energy policies and access

The region has energy policies which have changed over the years but which tend to favour least-cost energy development options, use of internally derived fuels/sources to cut on import

Table 4: 1993 electricity consumption for selected countries (GWh)

Country	*Agriculture*	*Mining*	*Industry & commerce*	*Domestic*	*Transport*	*Total*
Zimbabwe	611.4	1306.4	4116.1	1717.6	36	7751.4
RSA	3507	37466	76011	21395	6545	144924
Botswana	2	576	343	122	0	1044
TOTAL	4120	39348	80470	23235	6581	153719.4
Combined share %	3	26	52	15	4	100

Source: SADC Energy Statistics, 1993

bills and ensure security of supply, improving on access and enabling economic development and employment creation. The more recent inclusions relate to improving efficiency of energy use and protecting the environment.

The need to increase access to energy for the rural people has seen a major drive for renewable energy technologies (RETs), particularly solar in the domestic/residential sector. RETs could be an answer to rural households where consumption for electricity is still too low to warrant extension of grids to supply electricity to remote areas – an infrastructural development which would be critical in utilising pool benefits for increasing access. RETS, however, would not be a substitute for fossil fuel-derived electricity in the near future.

Thus, natural gas and coal must be seen as important alternatives to electricity. SADC has conducted a major study on the use of natural gas and coal bed methane in its energy base. A number of countries, particularly Botswana, Zimbabwe and Tanzania, have conducted detailed assessments of expanded coal utilisation with a view to increasing rural access to conventional fuels through greater household use of coal. So, in the region's view, there are various other alternatives being considered to enhance rural access, and grid electricity, the mainstay for interconnected electricity flows, does not rank the highest.

Fuel pricing policies generally take into account some special socio-economic considerations and is in many cases tailored for certain consumer groups. Prices tend not to be cost-reflective because subsidies and cross-subsidisation have resulted in distorted prices. Apart from direct subsidisation of fuel prices, a number of indirect subsidies are in place in the region. Diesel is generally cross-subsidised by petrol. Kerosene is also subsidised in order to make it affordable to low-income households. This is despite the fact that there is a general trend toward the deregulation of petroleum fuel prices in many countries within SADC. Major consumers of electricity like the base metal mining industry have also negotiated lower tariffs in the past.

The impact of such approaches on access to electricity remain to be assessed.

SADC electricity subsector

Rationale for regional electricity cooperation

Regional cooperation in the electricity subsector is embodied in the agreements of the Southern African Power Pool (SAPP).

The compelling arguments for stronger regional cooperation in electricity supply are:

- Demand-supply imbalances. The uneven distribution of electricity resources in the region warrants cooperation among utilities in order to supply electricity from areas of surplus to those with deficit either as a result of unexpected climate variability or technical faults or surging peak demand.
- Regional electricity subsector cooperation can benefit from economies of scale through low prices from large suppliers and sharing of risks. The cooperation also offers opportunities for bundling projects to raise the scale.
- Security and quality of supply: The varied sources of electricity supply will ensure reliability as the grid is linked with more than one supplier. The availability of choice of supplier and type of electricity source will create competitiveness and hence quality of supply.
- The financial constraints of crippling investments required by both utilities and governments can be overcome if there is joint power project planning and investment. Since on the regional level, in the medium term, there is also surplus generation capacity (in Mozambique and Zambia for hydropower, for example, and in South Africa for coal-based thermal power), countries with deficiencies (like Botswana and Zimbabwe) can defer investments in additional generating and transmission capacity. Cooperation can thus also allow avoiding the problem of indivisible single investment projects.
- The region's combined electricity resources of both thermal and hydropower offers opportunities for countries to shift dependence according to the constraints of the time. In times of drought, countries have the option of shifting to thermal power. And hydropower is cheaper and cleaner and can be an alternative, when available, to limit costs of electricity imports and also meet greenhouse gas reduction requirements.
- Differences of time zones can result in complementary demand curves – when some countries are at low demand others will be at peak demand, thus shifting the resource where it is needed but without a need to increase the generation capacity.
- Regional cooperation will also allow better monitoring and control of environmental degradation and pollution which may be caused by one utility with consequences on the other countries. This calls for a code of practice for the utilities in the region.
- The imminent element of global emission reduction, which the multinational agencies

will require as conditionality for financing projects, will require cooperative efforts to achieve; jointly accessing global funding for such purposes could boost the region's economies.

The immediate advantage of the SAPP has been the enhancement of the exchange of power over regional interconnections and the facilitation of the further development of the regional grid.

Electricity trading had, however, started in the late 1950s, with the interconnector between Nseke in DRC and Kitwe in Zambia supplying power to the Zambian Copperbelt. The construction of the Kariba Dam and subsequent sharing of power from there between Zambia and Zimbabwe was another living example of such regional cooperation. Although this latter arrangement had some problems of asset-sharing at the dissolution of the Central African Power Corporation, it remains the backbone of the regional interconnections and power exchange. Recently, new transmission links between Botswana, South Africa, Zimbabwe and Mozambique constitute further strides towards better power exchange.

Regional distribution of resources for power generation

The distribution of resources across the various countries of the region is uneven in terms of the type of resources and extent, raising the need for both balancing off deficits through pooling power. In some countries the seasonality of supplies from hydro power (east Africa) and the deficits created by droughts (in all regions) creates the need for electricity flows from coal-based systems to the hydro-based systems. This section looks at distribution.

The major resources available in the SADC region for power generation are coal, hydro and, to a limited extent, oil (diesel). Natural gas and renewable energies (solar, wind and landfill gas) have potential for future increased use in electricity supply. Nuclear power is used in South Africa only, but problems of waste disposal limit its wider use. Coal-based power is produced in the southern countries: South Africa, Botswana, Zimbabwe, Mozambique and Swaziland, while hydropower potential is concentrated in the north, notably in the DRC and Zambia. Oil is produced in Angola only, but a number of countries have recently discovered natural gas depos-

Table 5: Energy resource base for power generation in the SADC region

Country	*Coal reserves (mn t)*	*Hydro potential (Mwe)*	*Oil (mn t)*	*Natural gas (million m^3)*	*Uranium (mn t)*
Angola	-	16 000	156	372000[a] 402000[b]	
Botswana	3300	0	0	0	
Lesotho	0	450	-	0	
Malawi	16	900	0	0	
Mozambique	240	12 500	0	41000	
Namibia	0	120	0	134000	101000
South Africa	55000	3 500	0	20 000 134000[c]	426000
Swaziland	208	600	0	0	
Tanzania	200	6 000	0	35000	
Zambia	70	21 400	0	0	
Zimbabwe	1700	13300	0	0	
DRC	54	100 000	0	1	
TOTAL	60 788	174770	156	1138001	527000

Source: GHG and Power Pool study

a) Associated

b) Non-asociated

c) Coal-bed methane.

its.

Coal

Coal is by far the largest resource used for electricity generation in the SADC region. Significant coal resources have been discovered in nearly three-quarters of the SADC countries, although quantities vary (see Table 5). The major coal reserves are in South Africa which has 55 gigatonnes (Gt) compared to Botswana (3.3 Gt), Zimbabwe (1.7 Gt), Mozambique (0.24 Gt), Swaziland (0.21 Gt), Tanzania (0.2 Gt) and Zambia (0.03 Gt). South Africa, Zimbabwe and Botswana are the only countries using their coal resources for power generation. Although Zambia has some coal reserves, the resource is not being used for electricity generation because of excess hydropower potential. Mozambique and Swaziland also use diesel and gas for their electricity generation. Namibia generates the greater part of its electricity from coal imported from South Africa. Malawi (0.016 Gt) and the DRC (0.054 Gt) have low coal reserves which are also not being used for power generation.

Coal production in the region is highest in South Africa, with annual production of about 183 million tonnes, of which 39.9% is used in electricity generation, 28% is exported and 22% is utilised by the Sasol Group for synfuel and chemical production (Department of Minerals and Energy Policy, RSA). Zimbabwe produces about six million tonnes/year and more than half goes into the electricity sector. Botswana produces about one million tonnes/year, about half of which went for power generation in 1994. South Africa, Zimbabwe, Botswana and Namibia are the countries with significant coal thermal generation capacity (>100 MW).

Comparing coal reserves (60 788 million tonnes) and the rate of annual coal production (185 million tonnes per year) shows that the region has a vast potential for meeting its future electricity demand from coal.

Hydropower

Hydropower is the next most significant resource for generating electricity in the region, with the DRC having about 57% of the resource (see Table 5), 40% of which is at the Inga dam site (40 000 MW). The next largest hydro potential is on the Zambezi River shared between Zimbabwe, Zambia and Mozambique. The generation of hydropower from shared river systems like the Zambezi and the Cunene (Namibia and Angola) calls for a regional rather that national approach (planning and investment) for easier implementation of hydropower projects.

Only about 5% of the regional hydro potential has already been exploited (ZESA) which leaves a large potential for reducing local pollution and CO_2 emissions. The full hydropower potential is about four times the current regional thermal power installed capacity and thus can offset significant new investment in power plants. The exploitation of the hydro resource requires enormous financial resources and this makes hydro an expensive option. Although hydro-dams are associated with CH4 emissions(which are not well studied), the level of GHG emissions is much higher in coal thermal power plants.

Table 6: Hydropower potential and exploitation in the SADC region (1994)

Country	*Hydro potential (MWe)*	*Nominal hydro capacity (MW)*	*Available capacity (MW)*
Angola	16 000	293	202
Botswana	0	-	-
Lesotho	450	3	3
Malawi	900	145	145
Mozambique	12 500	2182	510
Namibia	120	240	240
South Africa	3 500	540	540
Swaziland	600	41	41
Tanzania	6 000	382	379
Zambia	21 400	1632	1632
Zimbabwe	13 300	666	666
DRC	100 000	2458	2458
TOTAL	174 770	8580	6814

The setback with hydropower in the region is associated with the erratic rainfall patterns and frequent droughts, which have resulted in low generation capacity in most of the dams. The vulnerability of these dams was demonstrated by the 1991/92 drought which resulted in power shortages in Zimbabwe, where 34% of the generation capacity is hydro based at the Kariba South Plant. In that year, Zimbabwe had to augment its electricity supplies from hydropower imports from Zambia and the DRC. South Africa has a hydro potential of 3 500 MW but with a very low capacity factor (10%) and also highly unreliable. These conditions very much affect access defined in terms of reliability of supply.

Oil and natural gas

Only Angola has known oil reserves. Natural gas reserves are prevalent in the region but exploitation is still minimal. Natural gas has been recently discovered in South Africa, Namibia, Mozambique and Tanzania. Angola also has gas as a by-product of oil production and refining. The other source of gas in the region is coal bed methane (CBM), exploitable from coal fields also usable for power generation. All the countries producing coal have potential for CBM, but reserves have not been adequately assessed in all the countries concerned.

For those countries without oil reserves, diesel thermal power generation depends on imported fuel. The diesel thermal capacity in the region is in excess of 450 MW and that for gas turbines is about 300 MW. Gas turbines are currently being used in Angola, the DRC, South Africa, Mozambique and Tanzania.

Plans are underway in South Africa and Zimbabwe to explore the possibility of using CBM for power generation in addition to its other potential applications in industry. Landfill gas is another potential source of gas for power production. This is an attractive alternative as it can limit indiscriminate waste disposal as well as reduce greenhouse gas emissions when land-fill gas is substituted for coal and diesel. Landfill gas is also a renewable source of energy. Tanzania is also preparing to exploit landfill gas from municipal solid waste produced in Dar-es-Salaam under a GEF-funded project (Inforse, 1997).

Thus, depending on the costs of exploitation and utilisation, three gas source options exist (natural gas, CBM and landfill gas) for generating power from a less polluting fuel than coal and diesel.

Power demand and distribution in the SADC region

Electricity consumption in 1994 for the SADC region is presented in Table 1.3. This clearly shows that the largest share of the consumption was in South Africa followed by Zimbabwe, Zambia, Tanzania and Botswana, which all consumed in excess of 1 000 GWh in 1994. Only South Africa and Namibia have annual per capita electricity consumption above 1 000 kWh. The annual per capita electricity consumption for South Africa was five times the regional average of 800 kWh (the average for the OECD countries being 10 times this). Consumption is even lower in Angola, the DRC, Tanzania, Malawi and Lesotho, where annual per capita consumption is less than 200 kWh. The rest of the countries' per capita consumption is close to the average. The low per capita electricity consumption for the region presents a huge potential for further electricity consumption.

The main determining factor for electricity consumption in the SADC countries is undoubtedly the size of industry and commerce. The low access to electricity by the rest of the economy is another contributing factor. Commerce and industry consumed 72% of all the regional electricity sold in 1994, with national proportions higher in Zambia (82%), Botswana (80%), Zimbabwe (71%) and South Africa (73%). The rest of the countries had a modest share for this sector of 45-65%. Angola, which was still engaged in a civil war, consumed only 15% of its electricity in industry and commerce. The economy of Angola is, however, expected to grow fast, considering its abundant resources of oil, natural gas and minerals. The overall regional economy, which is emphasising expansion of the industrial base, is expected to grow in future, thereby increasing demand for electricity in that sector and associated upstream and downstream activities.

Electricity consumption in the domestic sector is also considerable; in 1994, it consumed 18% of all the electricity sold in the SADC re-

Table 7: Country and sectoral electricity consumption and distribution (1994)

Country	*Electricity sold/GWh*	*Commerce and industry (incl mining)*	*Domestic*	*Other*	*Per capita consumption/kWh*
Angola	811	125(15)	154 (19)	532	104
Botswana	1106[1]	882(80)	150 (14)	74	935
Lesotho	259	86(33)	53 (20)	327	156
Malawi	704	441(63)	144(21)	119	104
Mozambique	728	402(55)	318	8	58
Namibia	1562	614(39)	825(53)	123	1239
South Africa	141 481[85]	102 999(73)	23 834(17)	14 650	4199
Swaziland	546	326(60)	110(20)	109.2	821
Tanzania	1462[1]	696(48)	545(37)	221	77
Zambia	6477[4]	5 324(82)	802 (12)	351	927
Zimbabwe	8423[5]	5 936(71)	1672 (20)	815	844
DRC	3788	2 274(60)	1514 (40)[a]	-	144
TOTAL	167 346[100]	120 105[72]	30 121[18]	17 329[10]	ave 800

Notes:

[ ] % of total regional electricity sold; e.g. electricity sold in Zimbabwe was 5% of total electricity sold in region

( ) % of total electricity sold within a country e.g. 80% of electricity sold in Botswana was consumed by Commerce and Industry.

a) Includes domestic and other low voltage

gion. Notable electricity shares for the domestic sector were in Namibia (53%), Mozambique (44%) and Tanzania (37%). In the majority of countries, the domestic electricity share was between 10% and 20%. The urban subsector was the largest consumer of electricity in the domestic sector (18%) and had the largest number of customers in all the countries (70 to 80 %). In spite of this situation, in general, less than 10% of the households (urban and rural) in the region are connected to the grid (UNEP, 1995).

Access to electricity in rural areas is expected to trigger economic activities, thereby creating employment and boosting rural incomes. The current use of low-grade fuels like coal and woodfuel in households, with associated indoor air pollution resulting in ill-health, is also cause for concern to policy makers. Hence, most countries have embarked on rural electrification programmes. A combination of urban and rural electrification will result in increased electricity supply and hence GHG emissions and other pollution.

Other sectors, including agriculture, also consume significant amounts of electricity. In agriculture, electricity consumption is associated with water pumping for irrigation which is increasingly becoming important due to uncertainty in weather and climatic conditions. Irrigation will increase electricity demand in the southern countries which are already in arid to semi-arid conditions. The dependence of SADC economies on agriculture will also result in increased electricity demand.

Table 8: Electricity supply in the SADC Region – generation, imports and exports (1994)

Line/Link	*In-service Date*	*Voltage (kV)*	*Length (km)*	*Capacity (MW)*
DRC-Zambia	1955	1x220	435	300
Mozam.- Zim.	1992	1x132	85	40
Zambia-Zim.	1961	2x330	3	1200
SA-Swaziland	1970	3x132	75	150
SA- Mozam.	1975	1x275	100	120
SA- Namibia	1975	1x110 2x220	120 860	50 215
SA- Botswana	1994	1x132	145	200
Zim.-Botswana	1991	1x220	185	120
SA-Lesotho	1992	2x132	100	80
SA-Zimbabwe	1994	1x110	22	40
Mozam.-SA	1997	1x400	420	500
Mozam.-Zim.	1997	1x400	310	500
SA-Zimbabwe	1995	1x420	405	400
SA- Swaziland	1997	1x275	155	220

The largest coal-fired plant size in Zimbabwe is 920 MW. In Botswana and Namibia, all the power plants are below 150 MW. The size of the plant has a bearing on its efficiency. South Africa's plants have high output efficiencies averaging 34%, while the other similar plants in the region have an average efficiency of 30% and below, depending on the technology in use.

Diesel plants have even lower efficiencies of between 20% and 35%. All the diesel plants in the region are small (below 50 MW per plant), most with capacities ranging from 20 kW to 10 MW and generally supplying isolated demand centres remote from the national grid. Of the total available diesel powered capacity of over 225 MW, only six power stations have capacities in excess of 10 MW each. This represents about 40% of available capacity. Some of these diesel plants are standby generators supplying backup when there is an outage on the grid. Angola operates the largest diesel plant (32.6 MW) in the region.

Gas-turbines in operation in the region are slightly larger than diesel plants, with a range of 3-180 MW. South Africa (171 MW), Angola (93 MW), Mozambique (79 MW) and Tanzania (18.5 MW) operate sizable gas turbines. The efficiency of gas turbines is higher than that of coal power plants and ranges between (35% and 46%). Combined cycle gas turbines have high efficiencies of 44%, while simple gas turbines average 31%.

There are over 50 hydropower plants in the region but 36 of them have capacities below 100 MW. Only five havecapacities above 500 MW and only two above 1 000 MW. The hydropower plants in the region are substantially smaller than the coal power plants. Mozambique has the largest installed hydro-capacity (2 075 MW) although it is not fully exploited at the moment. The DRC has a 1424 MW plant at Inga II. Other plants are Kafue in Zambia (900 MW), Kariba South in Zimbabwe (666 MW) and Kariba North in Zambia (600 MW). The efficiency of hydropower plants is high (about 75%). Where water generation capacity is available, this is the most efficient plant type for power generation. The capital costs are higher, while operational costs are lower than for thermal generation.

South Africa operates one nuclear plant of 1 930 MW capacity. The efficiency of a nuclear plant is about 36.5% but the issue of nuclear waste disposal makes it an unpopular type of electricity generation, especially in the region where technologies for handling the nuclear waste are lacking.

Transmission network

The current transmission network in the region has varied capacity levels as indicated in

Table 9. It consists of three main corridors, the most developed being that linking the DRC, Zambia, Zimbabwe and South Africa. This corridor was developed during the days of the Federation of Rhodesia (Northern and Southern) and Nyasaland to ferry power from the Kariba Dam to the copperbelt of Zambia and the neighbouring mines in the DRC. The link with South Africa was developed with an immediate objective to supply Zimbabwe with electricity. The link is a 400 kV line with a transfer capability of 750 MVA. The line linking Matimba in South Africa with Insukamini in Zimbabwe tees off at Selibe Phikwe to supply the Botswana load. Another transmission line of 132 kV also links Gaborone in Botswana with South Africa.

The second corridor links Mozambique with South Africa and consists of a 500 kV DC line from Cahora Bassa to Appolo Substation in South Africa. This line was refurbished and has been operational since 1997. There is also a new corridor which links the Songo Substation in Mozambique and Bindura Substation in Zimbabwe. Construction work on this link is now complete and the line operational.

The third corridor will link Angola with South Africa through Namibia and Botswana. This is proposed to be a 330 kV line but this is not yet developed. Angola has split systems and has no major transmission lines internally.

The Democratic Republic of Congo (DRC) is considered a future strategic source of hydropower, considering the massive potential of 45 GW at Inga Falls. There is already a 500 kV DC line linking the Inga falls with Kolwezi inside the country but the portion linking Kolwezi with Zambia is a 220 kV line which offers a limited transfer of power. Both the terminal equipment at Kolwezi and the 220 kV line would need to be upgraded to realize adequate transfer of power even under current generation capacity in the DRC. The upgrading becomes even more imperative in the future if the Inga hydro potential is to be tapped by the whole region.

The development of the regional transmission network will have to target developing the link between the DRC and the load centres which are mainly concentrated in the southern countries of South Africa, Zimbabwe and Botswana. These are also the countries whose capacity is mainly thermal and may offset their future thermal electricity demand by importing the cleaner hydropower from the north, availing an opportunity to reduce local pollution and greenhouse gas emissions.

A well developed transmission network in the region is desired and will be necessary under the proposed greenhouse gas mitigation strategy under SAPP.

A significant effort is already under way to upgrade the network in the region. Between 1996 and 2005, the countries within the region are planning to upgrade both generation and transmission capacities. Although 88% of the funding is planned for the transmission network, the financial resources are not yet committed. The regional grid is being upgraded to adequately cater for regional electricity trade.

Table 9: Electricity transmission network in the SADC region

Line/Link	*In-service date*	*Voltage (kV)*	*Length (km)*	*Capacity (MW)*
DRC-Zambia	1955	1x220	435	300
Mozam.- Zim.	1992	1x132	85	40
Zambia-Zim.	1961	2x330	3	1 200
SA-Swaziland	1970	3x132	75	150
SA- Mozam.	1975	1x275	100	120
SA- Namibia	1975	1x110 2x220	120 860	50 215
SA- Botswana	1994	1x132	145	200
Zim.-Bots	1991	1x220	185	120
SA-Lesotho	1992	2x132	100	80
SA-Zim.	1994	1x110	22	40
Mozam.-SA	1997	1x400	420	500
Under construction				
Mozam.-Zim.	1997	1x400	310	500
SA-Zim.	1995	1x420	405	400
SA-Swazi	1997	1x275	155	220

Investment and ownership structure

Power utilities in the SADC region are all state-owned. Exceptions are the South African Eskom and Hidroelectrica de Cabora Bassa in Mozambique (which is run as a private utility, although the government of Mozambique has some shares in it). There are also a number of private generators in the region, such as Botswana Ash (20 MW), Luchiamo power station (9.6 MW) and Refinaria (10 MW) in Angola. In Swaziland private industries generate about 57 MW, consisting of 43 MW thermal (burning woodwaste and bagasse), 8 MW coal fired, 5 MW diesel and 1 MW hydro. Tanzania has Tanwat (Tanganyika Wattle Co), which operates a 2.5 MW wood-fired power station. In Zambia, Zambia Consolidated Copper Mines owns two small hydro plants (Mulungushi & Lunsemfwa, 38 MW) and four gas turbine plants(with a total capacity of 80 MW) and a 40 MW waste heat plant (Sadelec-MEPC, 1996).

Government institutions also run various small isolated diesel generation plants to provide electricity to the centres remote from the electric-

ity grid. The largest share of the regional capacity is, however, owned by the utilities themselves.

Some of the utilities receive government grants and their decisions are directly influenced by the governments. Typically, a government-appointed board of directors steers the policy and strategy of these utilities while the management teams are responsible for the day to day running of the utilities.

Power development strategy may also be influenced by the multilateral funding agencies like the World Bank, who are encouraging utility autonomy or privatisation of the utilities under economic structural adjustment programmes.

It would appear that the introduction of new strategies in utilities would ordinarily require the approval of both the utilities and governments. Multilateral funding organisations, such as the World Bank through the Global Environmental Facility (GEF), have also become involved in determining what projects could be funded depending on their environmental soundness.

There is now favourable political and economic climate for increased private sector participation in the region and further IPP investments are in the offing. The driver for IPP participation in the power sector will mainly be the return on investments (and hence pricing of electricity) which is expected to be above 15%. When that return is met, IPPs may exploit the gas resources (natural gas, coal bed methane, and landfill) for power generation. Hydropower plants tend to be capital-intensive and have a high business risk and would tend to be taken up by governments themselves, probably through a combination of own and multilateral funding. Future investments will also depend on the availability of capital to the region. Some of the governments in the region are no longer creditworthy due to high debts and may not qualify for multilateral funding to expand their own generation capacity.

The existence of SAPP, however, could reduce the risk of investment, as a ready market for the generated power would be available. This benefit would, however, be limited in an environment of IPP competition, but that also would encourage deployment of efficient power plants.

SAPP could also facilitate easier access of international financing to implement cleaner power generation. Any global funding to reduce greenhouse gas emissions could be channelled through SAPP. Operations of the IPPs would have to be monitored to include environmental benefits rather than being driven by financial returns alone.

Electricity trade agreements and planned SAPP projects

Existing electricity trade agreements

South Africa's Eskom was, in 1994, the largest exporter of electricity in the region, with 2628 GWh, followed by Zaire with 1278 GWh, Zambia 855 GWh and Namibia with 28 GWh. Mozambique became the second largest exporter after 1994 when its Cahora Bassa hydropower plant became fully operational.

Eskom trades its power with Botswana, Namibia, Lesotho, Swaziland and Zimbabwe. Lesotho has been completely dependent on Eskom for all its electricity supply but will soon draw hydropower from its own recently constructed Muela (72 MW Capacity). Botswana has negotiated for up to 512 MW from Eskom until 2003 when it hopes to have upgraded its in-country power station at Morupule by 240 MW. Zimbabwe is a beneficiary of Eskom power for peaking load. Namibia imports power from South Africa – and sometimes exports small amounts to South Africa Zimbabwe was the largest importer of power in 1994 with 1863 GWh, followed by Namibia (883 GWh), Mozambique (700 GWh), Swaziland (547 GWh), Lesotho (312 GWh) and Botswana (298 GWh). South Africa and the DRC, both of which were the largest exporters, only imported 58 GWh and 53 GWh respectively in 1994.

Zimbabwe gets its imports mainly from Zambia, the DRC, South Africa and from Cahora Bassa Hydropower Station through the 400 kV inter-connector linking that power plant with Bindura in Zimbabwe. The power imported from the DRC is wheeled through Zambia and Zimbabwe itself sometimes wheels power from Zambia to Botswana when the hydrological situation allows for excess power.

Implications of electricity reforms for expanded access

The region's experience with actual reforms is limited. Most of the countries are preparing to adopt, or have begun introducing, reforms – which mainly include unbundling the national utilities into generation, transmission and distribution entities. In a number of cases, there appears to be some preference for generation to remain in a state-controlled parastatal with transmission going to an independent grid operator. Distribution seems to go into several hands purchasing power from the independent grid operator. All the entities would be coordinated through various licensing and regulatory instruments administered by a regulator. Ordinarily the regulator seems to have close contact with the minister responsible

for energy and the regulator's office is established in law.

In addition to unbundling, there is open access to generation, transmission and distribution by private actors. The most conspicuous of these are the IPPs focusing mainly on generation. Their share or generation, however, remains small compared to state-supported generating units. In Kenya where reforms are quite advanced, KenGen, the generating company, is a state-owned private company and produces 90% of all electricity generated in Kenya. IPPs and imports are responsible for the remaining 10%. In the Kenyan case, transmission and distribution is fully controlled by Kenya Power and Light company which is the sole buyer of power from Ken Gen.

The regulatory frameworks and operational terms under the new reformed regime are quite complex and can have major implications for the consumer burden associated with reforms. This could be seen in Zimbabwe, when the national utility Zimbabwe Electricity Supply Authority (ZESA) sought to open up to the private sector, leading to major irregularities in the award of tenders for partnerships or for the disposal of existing power plant to IPPs. A major contention was the cost implications for the entry of the new actor who saw electricity prices to consumers close to doubling after the takeover by a private operator. A case in Tanzania involving a 100 MW private power station at Tageta led to a yet unresolved problem in which the private generator who has not yet produced any electricity (2000) is demanding compensation from government for losses associated with non-generation – the basic problem being that the IPP was allowed to begin investment in the absence of a regulatory framework and was left in a position where they could vary terms the permission to operate.

Such issues raise problems in the domain of electricity pricing usually embodied in a power purchase agreement, the pricing of electricity by IPPs in the absence of a PPA, and the burden to which society is exposed in terms of supporting the participation of IPPs in power supply. We discuss each of these briefly below.

Electricity pricing

Traditionally this was the role of the state, which stipulated prices to be charged by state electricity utilities, and of local boards where local authorities generated electricity. In self-generating and own-use utilities, prices were set for accounting purposes only and are rarely commensurate with cost of supply. State determination of prices usually led to subsidies or cross-subsidies intended to prop up critical sectors of the economy or social groups. These practices have been widely blamed for inefficiencies in the sector and lack of strategic development. This is why some utilities have attempted long run marginal cost pricing. The problem faced here is that LRMC could not be applied in a situation where pricing of key inputs such as coal is by contract and where the state has a major hand in deciding investment patterns for the utility.

The advent of IPPs has even worse problems, unfortunately. The IPP entering a market has to rely on existing transmission and distribution networks which are still owned by central utilities; they have to negotiate an agreement with the state utility for prices and volumes to be sold. By virtue of their scale, IPPs have higher operating costs and must put forward much more expensive investments per unit of installed capacity since these are new plant with no benefit from previous installed investment.

PPA as a social burden and passage of risk from investor to society

The PPA thus is a social guarantee for the IPP's business, which has the security of a guaranteed price and guaranteed purchase orders. The risk of the IPP, in this cases, passes on to the state. It may be argued that, to avoid this situation, the state should not be involved at all and leave the market to operate. As a replacement, a bidding system could be put in place, such as the one in Kenya where new entrants into the generation market should submit pricing bids for any emerging load slot. This could work well but there is the problem that a price thus accepted has a certain duration. During its life, it has to be respected, leading to a situation where society is not given the advantage of cheaper options which may become available immediately or later – perhaps through cheap imports or the emergence of more efficient option from management or technological advancement. The social cost of such guarantees is therefore, quite high. This makes it difficult to imagine how a higher cost supply option can extend access particularly to disadvantaged social groups, which must be the natural target for expanded access.

Pricing without PPA

This could be possible in the event of direct sales by IPPs to large single consumers or to a local area network operator. Such networks have existed before in the region and have supplied local communities selling excess to national grids where connectivity was available. These operated without any regulatory frameworks in countries such as Tanzania. The sugar industry throughout the region is an example of such unregulated IPPs. Botswana, a large country with a thin network density has had to rely significantly of diesel

operation/generation in the form of local area or in-house operations using diesel. These networks have obviously served an essential purpose but have not been targeting communities such as the urban poor and rural households. They served company compounds in remote settlements or individual households with enough resources to run independent units. IPPs, on the other hand, seek to supply the general public but at this early stage in the reform process, they have tended to want certain guarantees which make them a burden to society.

Conclusion

Current reforms in the electricity sector are detrimental to expanded access, particularly by the poor. They cannot add to a competitive environment at this early stage, as their own mode of operation is not open market competition due to their demands for guaranteed purchases and guaranteed prices. Power pooling faces a similar dilemma. It was not designed for expanded access and its presence has had no downward pressure on cost of supply – an essential aspect of power pooling. Stabilising reliability and security of supply has also not been a clear achievement of power pooling in SADC. Present reforms, therefore, have made little or no contribution to access, security of supply or reliability and much less affordability. The present regime of power sector reforms in Southern Africa cannot be counted upon as an effective mechanism for enhancing access to electricity by rural communities and by the urban poor.

References

ADB, ADF. Africa Energy Programme, 1996. The Electricity Sub-Sector in

Africa. Energy Sector Technical Paper Series, Abidjan.

AmbioVol.22 No. June 1993. Are hydroelectric reservoirs significant sources of

greenhouse gases

Dale, AP. The drought and its effect on the hydroelectric generation capacity of

Zambia and Zimbabwe

Eskom, 1994. Statistical Yearbook. Johannesburg

Maya, R. S. 1993. African Development Bank, Africa Energy Programme. Africa Energy Surveys. Southern Centre for Energy and Environment

SADC.1990. Energy Statistics Yearbook

Sadelec, MEPC.1996. Electricity in Southern Africa: Investment opportunities in an emerging regional market.

UNEP.1995.Climate Change Mitigation in Southern Africa, Methodological development, Regional Implementation Aspects, National Mitigation Analysis and Institutional Capacity Building in Botswana, Tanzania, Zambia, and Zimbabwe.

ZESA,1996.System Load Forecast, 1995-2015.Corporate Planning Department. Harare

ZESA, Dec.1994. The Megawatt Bulletin. Issue No 16. Harare

REGIONAL COOPERATION: OPPORTUNITIES AND LIMITS

Using new financial instruments for improving oil trade across Africa: opportunities and limits

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(Comments and suggestions in this paper are made on a personal basis only, and do not necessarily represent the opinions of the World Bank or UNCTAD.)

Introduction

This brief paper discusses the potential for using new financial instruments for two purposes: improving intra-African oil trade; and improving the management of the financial flows that come with oil imports and exports. Although different, there are two significant similarities between these two issues. Firstly, the new financial instruments that can be used share some characteristics, and are often arranged/provided by one and the same department in trading companies and banks; they are often used together. Second, in both cases, the key problem that these financial instruments are meant to solve is that of risk. In one case, counterparty risk, in the other, price risk.

Improving regional trade

There is relatively little oil trade among African countries. There are several things that African governments can do to stimulate such trade. One is to streamline regulatory requirements with regards to the technical specifications of oil products. Now, despite discussions within regional groupings such as ECOWAS, these specifications tend to vary from country to country,

forcing oil refineries to produce relatively small amounts of different types of products (at high cost), and reducing the potential for regional trade. Secondly, there is much scope for coordinating taxation and pricing policies (at the very least, this may make part of the existing oil trade visible in government statistics).

One of the major obstacles to larger intra-African oil trade, however, is certainly counterparty risk. This is not a problem unique to Africa (in Latin America, for example, much trade between neighbouring countries passes through western trade houses), nor is it limited to the oil sector (transactions between an English-speaking and French-speaking African country may well require the intervention of two different western banks to arrange the payment). Exporters from one country are simply unable or unwilling to take on the counterparty and sovereign risks for a buyer from another country. Instead, they prefer to sell cash to a western trader, who then takes the risk on the foreign buyer. Experience in intra-African oil trade shows that this risk aversion is not without its reason; intra-African solidarity has extended to supplying importers with oil on credit, but not to the buyers then putting payment of the oil bill at the top of their priority list. Structured financing techniques can help to overcome these credit risk problems.

Structured finance is a technique whereby risks in a financing transaction (such as selling oil on credit) are systematically mitigated. They have so far rarely been used for intra-African trade (largely due to a lack of expertise on the techniques, and some remaining policy-linked barriers such as currency repatriation rules), but wider use should be straightforward. Techniques can go from the relatively simple (for example, one can "discount", or forfait, the payment obligation of the buyer with Afreximbank, the Cairo-based African trade finance bank set up by the African Development Bank, receiving immediate cash while Afreximbank takes on the payment risk on the buyer), to more complex (for example, certain export receivables from the importing country can be assigned for the payment of the oil purchases). In one case, a bank financed the export of bitumen from one West African country to another, arranging the reimbursement of the loan through the assignment of toll receipts from the road which was built with this bitumen.[1]

With the advance of the Internet, information on buyers' needs and sellers' availabilities has become easier to obtain, but this gives little comfort as to their reliability. Structured financing techniques can enable buyers to become creditworthy in the eyes of sellers, and thus enable sellers to benefit of the improved information. Large African oil firms producing products for which there is demand in other African countries, including parastatals, would benefit from having the knowledge and skills to understand and implement these techniques. Governments can help by improving awareness (which, as a start, would require government departments dealing with the oil sector to become familiar with structured financing techniques), and facilitating training.

Dealing with the vagaries of the oil market

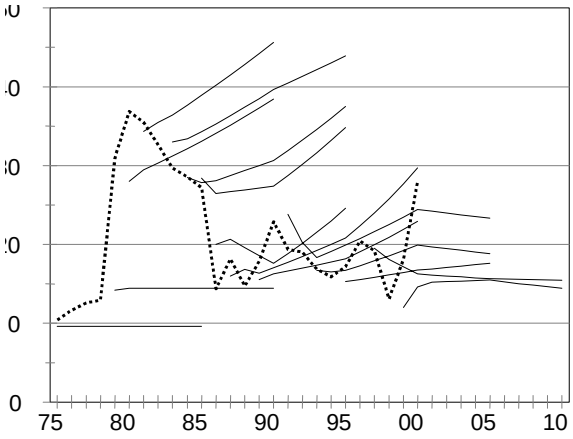
Just about the last thing a public official wants to hear is that a sudden swing in energy prices threatens to put an already tight budget into deficit. Unfortunately, this happens all too often. In exporting countries, the result can be that government officials remain without salary for some time, or that ambitious projects are left unfinished. In importing countries, the results have included a forced halt to public services, or even public riots in the face of announced price increases. Even if wood is still the major fuel source in most African countries, oil, and consequently its price, is now important to most of the continent's poor, who often use kerosene, depend on public transport, and/or see transport costs immediately reflected in the prices they pay, or the prices they receive for their products.

Oil prices are basically unpredictable. Figure 1 gives an impression of how difficult it has been for the World Bank to make price forecasts. Tracking the forward pricing curves on commodity exchanges would not have given a much better result. Nor did governments of oil-exporting countries do much better; for example, looking at Venezuela's budget assumptions on oil prices over the past decades, it was found that "on average", these forecasts were correct, but the average year-to-year error was US$3 per barrel. For purposes of budgetary planning, such errors are, of course, much too large. Saying that forecasts can safely be used for planning purposes because, on average, they correspond to realised prices is equivalent to stating that, as a river is "on average" only 1.5 meters deep, it can be safely crossed.

Not surprisingly, there have been many efforts to reduce this volatility. OPEC has, for relatively short periods, been effective in increasing oil prices, but has not been very good at keeping prices within price bands. Governments which were unwilling to rely on OPEC's ability to keep prices stable have at times set up stabilisation

[1] See also some of the presentations at UNCTAD's annual African Oil Trade and Finance conferences, www.commrisk.net/unctad/events/ index conferences.htm; eg Financing regional oil trade in Africa, by Okay Oramah, Afreximbank, 1997.

funds. And until 2000 there was, at least in theory, also a compensatory facility operated by the IMF. The experience with oil stabilisation funds will be discussed in the next section, followed by a discussion on "hedging", that is, laying off price risks on the financial market place.



Note: This chart shows actual price developments (dotted line) for a basket of crude oils from 1975 to 2000, and a range of forecasts made by the World Bank during this period (the thin lines, with the starting year of the line being the time that the forecast was made).

Figure 1: Oil price and World Bank forecasts: constant price forecasts (%/bbl)

Stabilisation funds – and why they usually do not work

Several oil exporting states and countries have, or had in the past, stabilisation funds of various types. These include Alberta's Heritage Savings Trust Fund, Alaska's Permanent Fund, Kuwait's Reserve Fund for Future Generations, Norway's State Petroleum Fund, Oman's State General Reserve Fund, Venezuela's Macro-Economic General Reserve Fund. A number of countries also have had funds to protect consumers from fluctuations in world oil prices – Chile, India, Mauritania and Morocco, for example. Some of the funds established by oil exporting countries were intended to save part of oil revenue for future generations. Others, like those set up in importing countries, were intended to stabilise year-to-year government revenue.

In general, these funds have not done well: there has been no discernible impact on government spending, no avoidance of price shocks, including Dutch disease effects, etc. There are multiple reasons for this. One is the actual behaviour of oil prices . Oil prices do revert to a long-term trend but, for all intents and purposes, this takes so much time that stabilisation funds which use a formula to determine when to pay into the fund, and when to transfer funds into the government budget, inescapably run into problems. If there are no clear rules, then actual financial transfers will become a politicised issue. A further problem has been the actual management of the funds: the pressure to spend accumulated savings can be very large (in Norway, for example, there are demands to reduce social security contributions and compensate the resulting shortfalls from the oil fund). By and large, stabilisation funds are not an advisable policy option.

Externalising risks to the market place

When one wishes to reduce price risk exposure, much of the problems with stabilisation funds could be avoided by using markets for the transfer of risk.[2] These markets have grown fast over the past decade, and even large exporters such as Mexico have found them liquid enough to hedge a significant part of their exports without much difficulty. Risk management markets (split over organised exchanges trading futures and options, and the so-called "over-the-counter market" where a range of tailored products such as swaps are traded) enable an exporter to fix a (minimum) export price over a certain time horizon, or an importer to fix a (maximum) price. This time horizon has expanded steadily in recent years, and markets are now rather liquid up to seven years.[3]

To simplify somewhat, futures and swaps enable exporters and importers to effectively lock in a price (but they will have to put up a certain collateral, which will fluctuate over time with prices, as a guarantee that they will perform their obligations). Options are very much like insurance contracts: they provide for a pay-out in case of a negative price development (such as a price increase over a certain level for an oil importer) and thus compensate the option buyer for his reduced export earnings or increased purchasing costs; when prices move favourably ("when the house does not burn down") the option buyer simply loses the premium paid.

While the private sector in developed countries has greatly expanded its use of these instruments, government entities have been slow in

[2] Such markets could be used in conjunction with stabilization funds: they would make it possible to have relatively small stabilization funds by externalizing large price risks. See for a discussion Stijn Cleassens and Panos Varangis, *Oil price instability, hedging, and on oil stabilization fund: the case of Venezuela*, World Bank Policy Research Working Paper 1290, April 1994; and *Macroeconomic risks in Nigeria: dealing with external risks*, Africa Region Findings No. 30, January 1995.

[3] Meaning that prices are an unbiased predictor of future prices – it does not cost a "risk premium" to transfer risks to another party.

their take-up. This has been the case in developed as well as developing countries.[4] In developed countries, one reason has often been that if necessary, risks can be shifted to others – there is room in the budget, or one can count on supplementary central government allocations, or cost increases could be passed on to consumers. Government entities and central governments in developing countries rarely have such luxury.[5]

For this reason, various expert forums (primarily in UNCTAD, which has the central mandate in the UN to deal with price risks involving commodity trade) have advised to expand international efforts to educate developing country governments and private sector entities on these financial instruments. One obvious problem is that within international organisations dealing with development, there is rather little expertise on these financial instruments either. Like many managers of western companies in the past, development workers tend to think that commodity prices are "God-given", like rain (or lack thereof). They therefore take little or no responsibility for development plans or projects that go wrong because of unfavourable price movements. They cannot really be expected to advise their counterparties in developing countries to manage price risks in a pro-active manner. Much of the required expertise is available in the private sector, though, and can be transferred to developing country policy makers in the public and private sectors – but this is likely to be more of demand-driven than a donor-driven process.

Needs for capacity building

An UNCTAD paper[6] noted that African countries should maximise the contribution that the oil sector can make to the national economy (or minimise the costs of oil imports) by improving their marketing and financing techniques, using some of the techniques which have proved their value in other parts of the world. It concluded that "if the continent wants to take its economic performance into its own hands, it will be necessary for practices in the oil sector, which is of primordial importance for the region, to be put on a new footing." There is no reason to believe sub-Saharan countries are incapable of adapting to the new conditions on world oil market, so as to make full use of all the possibilities now available. But as was also noted in the report, to do so, institutional reforms are necessary, policies need to be modified, and an effort needs to be made to build up the skills and the operational systems needed in today's oil trade.

With respect to institutional reforms, public entities face many hurdles. The US experience is exemplified in Box 1.

Box 1
Internal resistance to introducing price risk management

(Largely extracted from "Internal Resistance to Change: Experience with Public Entities", presentation by Robert A. Speir, Oil Policy Office U.S. Department of Energy, at UNCTAD's first African Oil Trade and Finance Conference, Harare, April 16, 1996, www.commrisk.net/unctad/events/1stoil/speir.htm)

Can a governmental body, usually a classic bureaucracy, adapt as the financial world changes around them? Examples point to a qualified yes, but counter-examples suggest that risk management in the public sector faces a struggle. For one, public sector employees are not likely to get together as a group, design a financial risk management strategy, and sell the idea to their department's political management. If the idea for such a program is raised, it is likely to be the product of a lone individual with singular initiative. Bureaucracies do not treat such people kindly.

[4] This is not to say that African decision makers have not considered the possibilities or have fully refrained from using these financial instruments. See for example *Adding value using risk management instruments: import, project finance and client-oriented applications,* by Tsatsu Tsikata, CEO, Ghana National Petroleum Corp. presentation at UNCTAD's first African Oil Trade and Finance Conference, Harare, April 16, 1996, www.commrisk.net/unctad/events/1stoil/tsiko. In this same conference, A.R. Oladele, Group Executive Director of the Nigerian National Petroleum Corporation stated that "in an era where investable funds are scarce, protection and efficient utilisation of value of any unit of resources makes risk management a necessity."

[5] Except for extra transfers from international organizations, which, however, need to be reimbursed. Such transfers are rare, and difficult to predict. For example, on 22 December 2000, the World Bank approved a total of US$155 million in supplemental credits to assist Madagascar, Mali, Mauritania, Niger, Rwanda, Zambia and Uganda mitigate the impact of "unexpected" oil price increases and other terms of trade losses, recognizing that these terms of trade losses were jeopardizing the sustainability of ongoing reform programs. For the individual countries, this represented one third to half of their terms of trade loss linked to oil price increases. Loans to other countries that had suffered similar losses were not forthcoming.

[6] *Sub-Saharan Africa's oil sector: situation, developments and prospects,* UNCTAD/COM/89, 13 March 2000

The main obstacles that must be overcome in a public sector environment are the following:

Personal risks: public sector officials who introduce a risk management programme may see it as a draw-lose proposal. If prices develop in an unfavourable manner, the risk management programme will protect the budget, so it looks as if nothing has happened – a draw. If prices develop favourably, there is a risk of criticism from parliament, the press and others that "money has been wasted" on an unnecessary hedge.

Lack of knowledge, coupled to the complexity of the subject: innovative financial techniques often do not feature prominently on the curricula of even senior government policy makers.

Budgeting/accountancy problems: the budgeting/accountancy procedures in many government entities (and indeed, private companies) are such that hedging and the underlying physical transactions are not part of the same account or line item. This creates problems to obtain funds for risk management (e.g., pay margins or option premiums), and can also result in one line item showing "losses" – even if these are in reality compensated by profits on another account, this looks bad for the department managing the programme.

Lack of clear legal authority: particularly in the case of parastatals, it may not be clear whether the company is allowed to enter into financial risk management transactions. E.g., there could be a general ban on "speculative transactions", and if there is then no widespread understanding about the difference between hedging and speculation, this can prevent the adoption of a risk management programme.

Lack of incentives: as long as government officials can blame the market for budget shortfalls, rather than being asked to explain why they had not managed their price risk exposure, they have little incentives to change. Such pressure could come from within the Government (e.g., why was nothing done to ensure that the budget for oil imports would suffice to cover needs even in the face of price rises?), or from the outside (e.g., IMF, World Bank and regional development banks could ask governments to explain their approach towards major price risks).

It is obvious that the hurdles are formidable, but they can be overcome. Like in so many other areas of development, building up good local skills and technical expertise is pivotal to the improvement of oil trading and the management of oil revenues and costs in Africa. Many training materials are readily available on the Internet.[7]

Equally important is good policy guidance. Policy makers (and managers/directors of parastatals and private companies) need to ask their staff how the country's/company's finances would be affected by certain price scenarios (irrespective of whether they actually predict these scenarios – as has been argued above, prices are notoriously difficult to predict with certitude). And if certain price scenarios have an effect that is difficult to absorb for the country/company, policy makers have to ask why nothing is done about this. With the fast development of financial markets for commodities, the excuses for not doing anything about price risk are fast running out (indeed, even risks related to crop shortfalls may shortly be manageable on international financial markets – markets for shifting rainfall risks are expanding rapidly).

In developing solutions to the problems of price risk – and also, for building up the skills for structuring finance for intra-regional trade – they can call on international support. The international community has already been urged to provide more assistance in this area. UNCTAD, which has been active in the area of African oil trade and finance since the mid-1990s[8], has in

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[7] See, for example, the NYMEX website (www.nymex.com), and UNCTAD's training materials in www.commrisk.net/unctad/training/fuels/index_fuels.htm, and /training/train_ppt. htm.

[8] UNCTAD's work in this area came out of the organisation's work on commodity price risk management and structured finance, which, up to 1994, focussed on soft commodities and metals. The countries in which it worked were generally exporting soft commodities and spending a very large part of the proceeds on importing oil and oil products. In 1994, the development of training materials specifically for the oil sector started. Then, the first African Oil Trade Conference was organised in 1996, in Harare, Zimbabwe, jointly with the Eastern and Southern African Trade and Development Bank (PTA Bank). This first conference was made possible through a grant of the Government of the Netherlands as well as private sector sponsorship. But its success made it possible in the following years to organise the African Oil Conferences as annual events, entirely funded by private sector sponsoring – over the years, more than 1 000 private and public sector policy makers have participated. Since this April 1996 conference, UNCTAD has received requests from more than 20 countries (mostly importing countries, including many LDCs) to assist in the identification of oil price risks, and the development of improved marketing, risk management and finance strategies for oil. However, as it is not a financing organization, it normally cannot meet these requests, unless when the requesting country

its most recent mandate a call to expand its efforts for

> Providing technical assistance and policy advice on relevant mechanisms, including financial risk management instruments, to producers and users of oil and gas in developing countries, in particular in the context of implementing privatisation and liberalisation schemes, aimed at protecting Governments as well as private users and consumers from the risks of high price volatility. (Bangkok Plan of Action, para. 144, 18 February 2000)

Note that this is an unfunded mandate, and that no resources were actually allocated to do this work.

In 1999, the World Bank created the International Task Force on Commodity Risk Management in Developing Countries, with a remit to "close the market gap" between the needs for risk management in developing countries and the inability of most players in these countries to access risk management markets. Other organisations, such as the IMF, are also starting to think about the possibilities of risk management markets to improve policy making. The African Development Bank has been considering the introduction of commodity-price linked loans, which would enable governments to link their debt service requirements to the prices of their major commodities. A similar facility was introduced by the World Bank in early 2000,[9] although it has not been used so far, due to limited awareness among developing country governments and a somewhat awkward negotiation mechanism.

Overall, however, support of the international community to improving the use of modern financial markets by African countries has been little and far between – a problem not only of limited supply, but also of poorly expressed demand.

Conclusion

Intra-African oil trade should not be promoted at all cost. But where such trade is now hindered by barriers that can be overcome, efforts in this direction make evident economic sense. Regional forums such as ECOWAS and SADC play a key role, particularly for coordinating policies. Furthermore, intra-African oil trade is now often not as beneficial to African economies because a western trader and/or bank interposes itself between the two countries, because of problems of information (which, in today's Internet world, is likely to be a reflection of incompetence from the seller or buyer), and more often, perceived counterparty risk. Exporters, together with their banks, can then benefit from building up skills in the structured finance area, an effort in which they can be helped by governments and international organisations.

With respect to the management of the financial flows associated with oil trade, a larger use of financial markets for the transfer of risks would have evident benefits for both exporters and importers of oil. Those involved directly or indirectly in the oil sector need to evaluate their exposure to price risk, and act accordingly – retaining only the risks which they can afford. Learning how to deal with these risks requires capacity building, for which external advice and assistance may be needed (an effort which may well be coordinated by the continent's regional organisations).

The international community should respond favourably to well-formulated requests for assistance in this area. Most commodity exporters and importers in Africa are exposed *each year* to economic shocks of the magnitude equal to or larger than that experienced by Southeast Asian countries during that region's 1997 currency crisis, and external support was readily available to assist in that crisis. Moreover, the link between oil export revenue or import costs is a fairly direct one, in sub-Saharan Africa more so than in other parts of the world. Exporters depend on oil to build up their economies. For importers, oil price increases have a direct impact on the prices that they receive for their exports (higher oil prices mean higher transport costs, and less left for exporters) and can have major consequences for the costs of living of the poor (for example, the urban poor commonly spend almost one third of their income on transport costs). Better oil price risk management even has a positive impact on the environment: wood is a major alternative source of energy, and when price peaks can be avoided, substitution of kerosene and other fuels by firewood can be reduced.

There are many aspects to Africa's energy sector development. Improving the ability of the continent's energy sector to deal with risk (whether it is counterparty risk or price risk) is admittedly only one of them. However, this particular problem can be solved relatively easily and at low cost compared to, say, problems in infrastructure. But it will require African policy makers to take the lead.

finds the necessary funds. And this can be difficult, as the allocation of donor funds is coordinated by government departments that have little to do with the oil sector.

[9] Basic information is given on the Bank's website: www.worldbank.org/fps/hedging.htm.

Regional cooperation for sustainable energy supply: Experiences with the development of the gas pipeline in West Africa

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1 Introduction

The West African region is made up of sixteen countries with a population of about 203 million and a total land area coverage of about 634.4 million hectares (6.344 million square kilometres). At about 32 persons per square kilometre, the region is thinly populated compared to Europe which is about 156 persons per square kilometre. However, with the population growth rate estimated to be as high as 3% per annum, the region's population is expected to triple over the next decades.

In the region, Nigeria has the largest economy, with about one third of the total GDP. The overall GDP growth of the region has been less than 3%, while per capita GDP growth in real terms has declined over the last three decades. All the countries of the region are classified as low-income economies, at per capita GDP of less than $500 per annum. Other socio-economic and political characteristics peculiarities of the region include the general heavy debt burden of the countries, which has become a major stumbling block to the development aspirations of most of them. In addition, several civil wars brought about by political instability has hindered regional economic cooperation and integration.

On the energy scene, all the countries have very low per capita energy consumption – probably the lowest in the world. However, the energy-GDP ratios of most of the countries are higher than those of developed countries; this may not be unconnected with inefficient energy utilisation.

In this paper, the rationale and prospects for co-operation in the region's energy sector are examined, and a status report of the West African natural gas pipeline project as an example of regional energy cooperation and integration is given.

2 Energy in the regional economy

2.1 Regional energy resources

The energy resource endowments of the West African region are considerable and sufficient to meet its short-, medium- and long-term energy needs, although at present just a small fraction of these resources is being exploited. This implies that the aggregate economic development objectives of the region should not be hampered by energy resource availability. However, the distribution of the resources is uneven, with a few countries like Nigeria, Benin, Ghana, and Côte d'Ivoire possessing most of the hydrocarbon resources. Most of the countries, particularly the Sahelian countries such as Burkina Faso, Gambia, Mali, Mauritania, Guinea Bissau have little or no energy resource base. Table 1 shows the major energy resources in the region in 1998. Updated figures on each resource are discussed below.

2.1.1 Oil and gas

The West African sub-region comes next after North Africa in terms of continental endowment for crude oil, accounting for 30% of the potential crude oil resource endowment of Africa. The total crude oil resource in the sub-region has been estimated at 28.2 billion barrels. This consists of a proven resource base at about 21.2 billion barrels, and a probable resource base (undiscovered) of slightly over seven billion barrels. However, its distribution is very uneven. About 99% of this resource base are in Nigeria: about 21 billion barrels of proven resource and a probable resource base of seven billion barrels. According to a World Petroleum Congress (WPC) resource estimate, undiscovered crude oil resources in Nigeria lies in a range of about 4.0 – 18.0 billion barrels with 90% confidence. The

remaining crude oil resource base of the region can be found in Benin (100 million barrels), Côte d'Ivoire (100 million barrels) and Ghana (37 million barrels).

Coincidentally, the region also has the second largest potential resource endowment of natural gas on the continent – again, after North Africa. Total potential natural gas endowment in the region has been estimated at 7.35 trillion m^3, or about 41% of Africa's total. Similarly, this resource is not evenly distributed as it is found in only Nigeria and Côte d'Ivoire. Nigeria accounts for over 98% of the sub-region's total natural gas resource, with a proven natural gas resource estimated at 3.4 trillion m^3 (20.4 billion barrels of oil equivalent (bboe)). About 50% of this proven resource base is associated natural gas. The mode of the undiscovered natural gas resources in Nigeria has also been estimated at about 3.85 trillion m^3 (23.1 bboe). According to a WPC report, undiscovered natural gas resources in Nigeria can lie between 2.27 – 9.63 trillion m^3 (13.62 – 57.78 bboe) with 90% confidence.

2.1.2 Coal

The coal resource of the sub-region, which is made up of mostly lignite and bituminous grade has been estimated at about 4.34 billion tons (21.9 billion boe). After Southern Africa, West Africa has the largest coal resource potential in Africa, though at just 1.5% of the total. The West African endowment is made up of 719 million tons (3.63 billion boe) of proven reserve and 3.62 billion tons (18.28 billion boe) of probable resources, made up mainly of bituminous, sub-bituminous, and lignite grade deposits in Nigeria. Only seven out of the sixteen countries of West Africa have proven or probable resources of coal. Nigeria has 640 million tons (3.23 billion boe) of proven coal resource and an estimated 2.06 billion tons (10.40 billion boe) of probable resources. This is followed by Niger with a proven resource base of about 70 million tons (353.5 million boe) and a probable resource base of over 1.4 billion tons (7.07 billion boe). Marginal proven resources of lignite also exist in Mauritania and Senegal, while significant or marginal probable resource potential of mainly lignite deposits have been identified in Benin, Mali, Mauritania, Senegal, and Togo.

2.1.3 Uranium

West Africa has Africa's second-largest endowment of uranium resources after Southern Africa. The total resource potential of the sub-region is estimated at about 478 490 tons, representing over 41% of Africa's total. All the West African potential is in the Republic of Niger, where total proven uranium resource potential is 172 720 tons, with over 96% of the proven resource recoverable at less than US$80/kg and the balance recoverable at between $80 and $130/kg of uranium. The probable uranium resource base in Niger has been estimated to be 305 770 tons, with over 96% of this recoverable at less than US$80/kg.

2.1.4 Hydropower

The hydropower potential of the region is estimated at 21 560 MW installable capacity, which is capable of producing an average amount of nearly 122.8 billion kWh of electrical

Table 1: Energy resources in the region, 1988

Country	*Crude oil (10^6bbls)*	*Natural gas (10^9m^3)*	*Hydro energy (Gwh/yr)*	*Coal (10^6tons)*	*Bitumen (10^6 tons)*	*Peat (10^3ha)*	*Forest (10^6ha*	*Uranium (tons U)*
Benin							1.1	
Burkina Faso								
Cape Verde				4			19	16 000
Côte d'Ivoire	118	100	68 000			32	5.1	
The Gambia								
Ghana	20		12 782				3	
Guinea (Conakry)						525	4.3	
Guinea Bissua								
Liberia							1.9	
Mali							1.3	
Mauritania								
Niger				70			0.3	172 910
Nigeria	16 173	2380	36 000	690	150			
Senegal							1.8	
Sierra Leone							0.4	
Togo							0.4	
Regional total	18 091	2 701	372 154	764	159	847	98.1	207 560

energy per annum. Nigeria has the highest potential of about 10 060 MW, about 47% of the regional total. Côte d'Ivoire has the second-largest potential of about 2 502 MW (11.6%), and Guinea has a potential of 2 399 MW (about 11.1%). Other significant hydro potentials are in Ghana (2 277 MW), and Sierra Leone (1 177 MW). All the countries of the sub-region have some hydro potential, down to 35 MW in Guinea-Bissau.

2.1.5 Biomass including fuelwood and charcoal

Out of the total of about 634.4 million hectares of land area of the West African region, about 78.3 million hectares are covered by natural forest, representing about 12.3%. The biomass potential of the region has been estimated to be about 10.2 billion tons, about 81% of which is in moist forests. The highest potential is in Nigeria with about 1.93 billion tons of biomass potential, about 18.9% of the regional total. The biomass potential is relatively more widely spread with Côte D'Ivoire having 17.3%, Ghana 12.8%, Liberia 12.4%, Guinea 9.8%, and Mali 7.3%. Burkina Faso, Senegal and Sierra Leone contribute a nearly equal spread totalling about 13.5%. Cape Verde and Gambia are only marginally endowed.

2.1.6 Renewable resources

Solar energy potential in the region is significant. The level of duration of radiation varies from 2 000 hours /year in the humid tropical climate part, 2 700 hrs/year in the longer tropical climate, 2 870 hrs/year in the Sahelian climate part, and up to 3 500 hrs/year in areas of desert climate, especially north of Niger. The radiation intensity varies between 3.0 and 6.2 kWh/m^2 year. Ghana has 5 982 MW of installed PV capacity, with an annual energy generation of about 39 MWh, and 45 MW of installed PV capacity with an annual energy generation of about 34 MWh.

The wind energy potential of the region is also significant with windspeed varying between 2.0 and 4.0 m/s. Higher speeds are experienced along the Coast and on highlands. A wind energy potential of 1.7 GWh/yr. (~ 15.90 TJ) has been identified in Cape Verde. No geothermal energy resource has been reported in any of the countries of the sub-region.

2.2 Energy production

2.2.1 Crude oil and petroleum products

In 1990, a total of about 668.9 million barrels of crude oil was produced in the region, about 28.4% of the continent's total production. Nigeria accounted for over 99% of this, and the remainder was produced in Benin Republic (2.1 million barrels) and Côte d'Ivoire (0.7 million barrels). There are ten refineries in the region with a refining capacity of about 606 400 barrels per day. Nigeria has the biggest refining capacity of 445 000 barrels per day (73.4% of the regional total); Côte d'Ivoire's capacity is 60 000 bpd (10% of the regional total). The remaining refining capacity in the region is in Senegal (29 800 bpd), Ghana (26 600 bpd), Mauritania (20 000 bpd), and Sierra Leone (10000 bpd). Most of the petroleum products refined are consumed locally, the exception being the illegal petroleum product sales across the Nigerian border to Benin, Niger, and Chad due to the huge price differential between what obtains in Nigeria and her neighbours. There are no reliable statistics on the magnitude of this trade.

2.2.2 Natural gas

A total of about 28 billion m^3 (168 million boe) of natural gas was produced in the region in 1990, almost all of this in Nigeria, with a marginal production in Senegal. Most of the region's natural gas production is as associated natural gas resulting from the crude oil production processes. As in many other parts of the continent, the production and utilisation of natural gas in the sub-region has been curtailed in the past due to the absence of markets, especially close to the producing region; to the capital-intensive nature of natural gas gathering; to transportation and distribution systems; and to the non-coordinated planning of national energy systems in many countries. There is 971 km of natural gas pipeline in Nigeria transporting the processed natural gas from Warri to the major use centres in the country. A gas processing plant owned by the Nigerian Gas Company is located in Warri to process raw natural gas from the fields to the quality required in end-use facilities.

2.2.3 Coal

Total production of coal in West Africa amounted to about 334 000 tons (1.69 million boe) in 1992, which represented just 0.2% of total production in Africa. Coal production occurred in Niger and Nigeria where about 134 000 (676.7thousand boe) and 200 000 tons (1.01 million boe) respectively were produced.

2.2.4 Electricity

About 29191 GWh of electrical energy was generated in the region in 1990, about 9.4% of the total production for Africa. Nigeria's share of this was 63.3%, Ghana's was 20.8%, Côte d'Ivoire's was 6.6%, with the remainder shared amongst the other countries.

2.2.5 Fuelwood and charcoal

About 210.3 million m^3 of biomass resources were utilised in 1990 for the production of fuel-

wood and charcoal in the region. This represented about 41% of the African total in that year. About 1.5% of this total was utilised in the production of charcoal, which represented about 28.9% of the African total. The highest forestry resource production for these fuel forms occurred in Nigeria with about 117.5 million m^3 (56% of sub-regional production). More than half of total charcoal production in the sub-region also occurred in Nigeria.

3 Rationale for energy co-operation

Although vast energy resources exist in the region, there are still some issues which need to be resolved in order to adequately and sustainably meet its future energy requirements. Some of these issues, identified and discussed below, also establish the need for energy co-operation in the region.

3.1 Major regional energy issues

3.1.1 Inefficient energy utilisation

Even though the region's energy consumption per capita is very low, energy utilisation is inefficient, as indicated by a high energy-GDP ratio. The associated implications of this include energy wastage, excessive investment in some energy supply infrastructure above actual energy requirement, aggravation of energy-induced environmental problems, and additional cost of consumable goods due to excessive energy consumption especially in the energy-intensive industries.

3.1.2 Inefficient and unreliable energy supply

There are serious supply-side inefficiencies in the region. For instance, its electricity sector is plagued by a combination of generation inefficiencies, high transmission and distribution losses, and a low level of reliability and generation efficiency which is as low as 22% compared to a possible 40%; the transmission and distribution losses in some of the countries could be in excess of 30% of total electricity generated. While in Nigeria electric power supply unreliability has led to a high level of installation of imported autogenerations, which amount to a good fraction of the total public system capability, Liberia has problems of low power factor, overloaded distribution systems and poor connections. Similar situations exist in the petroleum sector.

3.1.3 Environmental problems

The major environmental problems caused by activities in the energy sector are deforestation and pollution. Deforestation has caused disruption of the natural ecosystem resulting in soil erosion, loss of diversity, microclimatic changes and overflooding. Combustion of fossil fuels, especially in the transport and industry sectors, as well as continued flaring of natural gas (particularly in Nigeria) contribute immensely to air pollution. Oil spillage due to accidents during crude oil production and transportation and the more recent illegal tapping of petroleum products from pipelines constitute another major environmental concern.

3.1.4 Energy financing

Within the next three decades, energy demand in the region is expected to quadruple. Correspondingly, the associated energy supply infrastructures such as refineries, powerplants, pipelines, which are presently mostly publicly owned will have to be expanded to meet the future energy needs. The total capital investment requirements to meet these needs will amount to billions of dollars. This is mostly in foreign currency (because the technologies are imported, and daunting in the face of other equally important needs, as well as the countries' high external debt burden. Further, the resources of the multilateral and bilateral agencies which could fund the required energy supply infrastructures are limited and obliged to meet the financial needs of the huge number of developing countries.

3.1.5 Low technological capability

In the region, there is a seriously low level of technological capability, particularly in two major areas in the energy sector: the ability to operate and maintain plants and equipment efficiently (user capability), and plant and equipment manufacturing, leading to the poor operating performance of refineries and power plants. The major reasons for the low capability are the lack of a viable strategy for technology acquisition, dearth of high level manpower, and, where some exists, the lack of meaningful experience by learning by doing.

3.1.6 Weak institutional framework

Government ministries and parastatals are responsible for energy policy formulation and supply in most countries in the region; and there are also government owned energy research and development institutes and centres. However, the lateral linkages and communication between the various institutions dealing with energy matters are weak. There has been attempt to deal with this lack of coordination of policies through the creation of Energy Commissions/Boards in some countries like Nigeria and Ghana.

3.2 Rational for co-operation

Although, these problems have been tackled on a national basis in co-operation with donor

countries and multilateral organisations, limited success has been achieved. This is because the approach adopted has been ad hoc and does not recognise the multi-dimensional nature of, and relationship between, the various energy issues. Furthermore, individual nations do not possess the wherewithal (financial resources and technological capability) to tackle these problems successfully. Resolving these issues creates the opportunities for regional co-operation. While the energy resource base in the region is varied and impressive, its distribution is uneven, making co-operation imperative. In addition, some of the countries in the region have national supply infrastructures such as refineries and power plants, which are uneconomic because they lack economy of scale. They will face the problem of attracting adequate finance for their expansion. Presently, energy trade amongst the countries in the region is very small, and there is therefore a considerable scope for regional energy co-operation – which should enhance economic growth and development. The prominent areas where regional energy co-operation are immediately needed are the electric power grid, extension of gas pipelines, oil exploration activities, petroleum refineries and institutional capacity building.

4 The West African Gas Pipeline Project

4.1 Description of the Project

The West African Gas Pipeline Project (WAGP) is a six-company, four-country project. The participating countries are Nigeria, Benin, Togo and Ghana, while the companies involved include Nigerian National Petroleum Corporation (NNPC), Ghana National Petroleum Corporation (GNPC), Shell Petroleum Development Company of Nigeria Limited, Chevron Nigeria Limited, Societé Togolaise de Gaz SA (SOTOGAZ), and Societé Béninoise de Gaz SA (SOBEGAZ). The project involves the development of a pipeline to transport gas produced from fields in the western delta of Nigeria to three neighbouring countries – Benin, Togo and Ghana. It will be the first gas pipeline to cross international borders in the West African region when completed. It is also noteworthy that, of the four participating countries, two are anglophone and the other two are francophone. The 800 kilometre gas pipeline to Elfasu in Ghana has been estimated to cost US$500 million. The project will benefit from the over 3.4 trillion m^3 (20.4 bboe) of known gas reserves in Nigeria – about 50 times the quantity of energy Benin, Togo and Ghana will need over the next thirty years.

The daily throughout of the pipeline is put to be between 2.8 and 3.4 million m^3 of gas. The memorandum of Understanding between the four countries and the project developer, and the Inter Governmental Agreement among the governments of the four participating countries envisage that the pipeline shall be a commercially viable project which will serve as a vehicle for regional integration and sustained economic development. It is also envisaged that private investors will provide the funds for construction, since a commercially viable project must be self-sustaining.

4.2 Historical background

In 1975, the Economic Community of West African States (ECOWAS) was formed, with one of its main objectives being the promotion of regional economic cooperation and integration. By 1982, ECOWAS adopted a regional energy policy, which included the concept of developing a gas pipeline. Subsequently, a regional energy distribution plan was established in 1991 and in the following year, conceptual studies were undertaken by a consulting firm, funded by the World Bank. The conclusion of the studies was that a sub-regional pipeline to move Nigerian gas to growing markets in Ghana was feasible. An important event, which could be termed the bedrock of the WAGP, took place in 1995, when the governments of the four participating countries in the WAGP, Nigeria, Benin, Togo, and Ghana executed a Heads of Agreement. This gave a broad outline of the principles under which the gas pipeline could be developed.

Two giant steps were again taken in 1998 to further achieve the concept of the WAGP. Firstly, Chevron, GNPC, NNPC and Shell decided to form a consortium to develop the project. Although two gas companies of Benin and Togo later joined the consortium they have since relinquished their equity participation. The current equity stake holding of the consortium is now Chevron Nigeria (41.87%), NNPC (25.25%), Shell Petroleum Development Corporation (SPDC) (16.8%), and GNPC (16.38%). Secondly, an independent consultant, Pipeline Engineering of Germany was hired, in accordance with the Heads of Agreement, to carry out an engineering feasibility study (EFS) to determine the commercial viability of the project. The EFS was completed in March 1999, with the conclusions that potential demand for natural gas had been identified in the countries concerned; no major legal aspects had been identified which could obstruct project implementation, and that it was technically and commercially feasible to implement the project. A Memorandum of Understanding (MOU) between the four participating governments and the consortium of the six

participating companies was signed in August 1999. In the MOU, the four governments appointed the consortium of companies as the Project Developer, and Chevron was selected among the group as the managing sponsor of the project. Some of the framework catered for implementing the project and obtaining all the governmental authorisations needed; and a commitment to undertake an environmental impact assessment of the project in each of the countries in accordance with their respective regulations. The Ministerial Steering Committee executed an Inter Governmental Agreement (IGA) establishing the operational framework for the project on February 4 2000. The IGA sets out the fiscal and legal framework for the construction and operation of the WAPG across the four countries.

Consequently, the project has met two of three conditionalities, which will set the stage for the signing of a concession agreement for a public private joint entity to be known as the West African Pipeline Company (WAPCO). These conditions are the execution of an Inter-Governmental Agreement between the four governments and the negotiation, and the signing of a MOU between the Project Implementation Committee (PIC) and the Project Developer.

ECOWAS is the pillar and a catalyst for the WAGP and its secretariat is providing administrative coordination for the work of the ministerial steering committee (MSC) and the project implementation committee (PIC).

4.3 Present administrative set-up for the Project

Under a Heads of Agreement signed in 1995 by the energy ministers of the four countries, the project was adopted in principle and a Ministerial Steering Committee (MSC) made up of the ministers was constituted, to provide direction for the implementation of the project. Next is the Project Implementation Committee (PIC) which was created by the MSC. This is the government group made up of officials from Nigeria, Togo, Benin, Ghana involved in the project. The PIC consists of various multidisciplinary teams such as technical, environment, finance, regulatory and fiscal.

The Sponsors Management Committee (SMC), which consists of the executives of the six participating companies, was set up to direct the consortium's work. It continues to provide the needed direction for WAGP to ensure that a commercially viable pipeline enterprise is developed to serve as a vehicle fore regional integration and sustained economic development. The SMC meets regularly to receive reports from the Project Management Team and also provides periodic feedback to the MSC. The Project Management Team was set up by the SMC – a multi-disciplinary, cross-cultural, multi-national, and multi-corporate team, which is harnessing talents and ideas to help define the scope of this project. The Team is undertaking activities on the technical, commercial as well as environmental and social aspects of implementing the project. The diversity of talents, experiences, and cultural backgrounds of the project team is intended to ensure that the project is sensitive to the needs and concerns of the numerous stakeholders whose interest it is meant to serve. The team representing the commercial group is currently working with the representatives of governments of the four countries to determine the appropriate framework for implementing the project. The work of this team will help investors make the final investment decision. The Team members, located in Houston (USA), Nigeria, Benin, Togo and Ghana are currently working on definitional phase activities of the project. Their pioneering work will be the foundation of WAPCO, the Company that will operate the pipeline. Figure 1 gives an overview of the administrative structure.

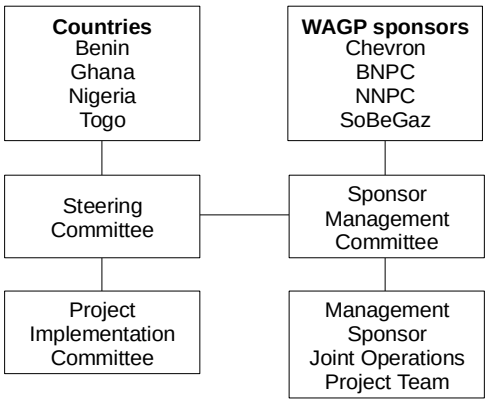

Figure 1: The administrative set up of the Project

4.4 Phases of the Project

The Project is divided into five phases: conceptual, feasibility, definitional, construction, and operational , each of which is briefly described in this section. Figure 2 gives a graphical overview of the five phases. While the first three phases are time-dependent on decisions and approvals, the fourth is expected to be executed within 24 months.

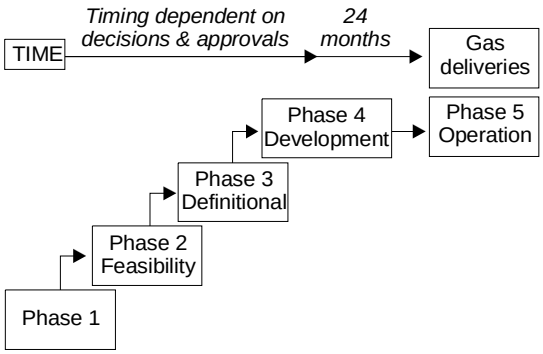

Figure 2:The five phases of the WAGP

Conceptual phase

This was the pre-feasibility stage of the project. It started when a study undertaken by Bain Cuneoe Association showed the possibility of the construction of a gas pipeline from Nigeria to Ghana. After this study, the Heads of Agreement was signed.

Feasibility phase

The current commercial Group (sponsors) which has been designated Project Developer invested in an engineering feasibility study between 1998 and 1999, establishing the commercial and technical viability of the project.

Definitional phase

This is the current stage of the Project. In this phase, the Project Developer is expected to fine-tune the feasibility study funding, reach agreement with the government that will facilitate the WAGP in order to make the final investment decision which will ultimately lead to the creation of WAPCO.

Development/construction phase

This occurs after the final investment decision has been made. In this phase, the Project Developer will engineer, procure and construct the pipeline. It has been estimated that this will take about 24 months to complete.

Operational phase

This is the final phase, during which the pipeline commences its thirty-year life of gas deliveries.

4.5 Present status of the Project

The Project is steadily progressing, having completed the first and second phases. The feasibility phase was completed in March 1999. Thereafter, the consortium of the six companies involved was mandated by the governments of the four participating countries to be the project developer.

Presently, the project is in the definitional phase. This started in August 1999 with the signing of the MOU between the four countries and the Project Developer. In this phase, the detailed framework for implementing the project will be established. This will involve agreements with the governments of the four participating countries on the legal and fiscal framework for the cross-border projects. It will also involve agreements with foundation customers in the four countries involved to ship gas through the pipeline. This phase will also lead to the final investment decision which involves the creation of WAPCO as the entity that will own and operate the pipeline.

In achieving the objectives of the definitional phase, some landmark activities have been undertaken. For instance, the WAGP Health Safety and Environmental Advisor have visited regulatory agencies in Nigeria, Benin, Togo and Ghana to determine and understand environmental impact assessment requirements and approval processes. This is part of the determination of the project team to ensure that the assessment conforms to the requirements of all stakeholders.

One of the main objectives of the definitional phase is to ensure public understanding and support of the project. In achieving this, the External Affairs Programme has been launched for the WAGP. Though this, External Affairs Representatives from Ghana, Togo, Benin and Nigeria have been engaged to go about WAGP and seek people's views. They are expected to engage in community-governmental relations and communications activities in the four countries. In order to achieve meaningful communication and engagement with the public, the project team has been engaging various external constituents of the project to identify issues that need to be addressed among them and to determine their information needs. The team has also internally undertaken project issues/stakeholder identification exercises and also reviewed comments about the project from various stakeholders. Some stakeholder engagement has also begun with project team members meeting with NGOs, government officials, etc. Furthermore, the project team is in the process of undertaking a knowledge, attitude, acceptance and perception study on the project among the general public in the four countries. Four educational institutions in the four participating countries have been commissioned by the project team to undertake this task. The initial public education programmes seeks to create awareness, and educate the public about the project and also collect ideas and concerns relating to the project from the public.

4.6 Potential users and benefits

The benefits of the WAGP are both regional- and country-specific.

4.6.1 Aggregated regional level

At the sub-regional level, the project will

- serve as an instrument for breaking down artificial barriers created by national boundaries, which often prevent close economic interaction among countries in the sub-region;
- help the peoples of the sub-region to work together to meet their common needs and aspirations;
- result in significant regional economic integration which will enhance greater interlinked efforts by the governments to pursue sustainable economic development;
- facilitate more extensive access to cheaper, cleaner and readily available natural gas resources and electric power in the region;
- facilitate stable electric power supply, which is not subject to the uncertainties and rapid changes arising from dependence on rainfall for hydropower or liquid fuel alternatives, and hence promote energy security in the region;
- promote investments in strategic projects and a variety of other industries such as the development of power plants;
- generate numerous primary sector and service sector jobs in all the four countries;
- help improve the regional air quality through the reduction of flared gas, and through the reduction of air pollutants by the substitution of natural gas as fuel for power generation and eliminating the use of less desirable crude oil;
- stimulate the expansion of electricity supplies as a substitute for wood and charcoal-based energy;.
- enhance conservation of forest resources of the region, which are currently the basis for meeting the energy needs of most of the populations of the sub-region.

4.6.2 Country-specific level

At the country-specific level, benefits accruing to each country participating in the project are as given below.

Nigeria

Amongst other benefits, the project will:

- provide hard currency sales of Nigeria's gas into the sub-region and thereby accelerate the diversification of the country's foreign income earnings and help it become less dependent on oil for foreign income earnings;
- create a commercial demand for natural gas, which will result in new investment in the petroleum industry with corresponding creation of new jobs, trailing, technology and tax revenue;
- Help eliminate gas flaring and the attendant greenhouse gas emissions; through the Project, 100 million tons of greenhouse gas emissions will be saved from being released into the atmosphere over twenty years.

Ghana

In Ghana, this project will:

- help substitute oil with gas at the Takoradi Power Plant and thereby make electricity cheaper and also reduce emissions of greenhouse gases;
- facilitate the construction of an independent power plant at Tema which will make use of the cheaper gas that will be supplied;
- enhance the development of the country's bauxite and iron ore industries;
- lead to creation of new jobs in the primary and service sectors, training, technology and tax revenue.

Benin

In Benin, the Project will

- facilitate the establishment of an independent power plant at Cotonou;
- Facilitate the development of new industries;
- enhance creation of new jobs.

Togo

In Togo, the Project will:

- facilitate the development of the country's phosphate industry;
- enhance creation of new jobs, training, technology, and tax revenue;
- facilitate refurbishment of the existing electrical generating facilities in Lomé.

5 Conclusion

There is a sound economic basis and rationale for regional energy cooperation and integration in West Africa. The pipeline project is a good example of a project that can foster energy supply integration. A major lesson learnt so far from this project is that a step-by-step approach based on economic interest offers the best prospect for integration.

Energy cooperation between governments and a balanced cooperation between the private sector and public corporation can provide a suitable vehicle for attracting the much-needed financing of the energy supply infrastructure in the region. This is very important, given the fact that energy requirements to support the region's modest economic growth is expected to quadruple over the next three decades.

To the best of our knowledge the only documented concern of some environmental NGO's is the lack of information.

References

Adegbulugbe A.O (1994): Regional Energy Cooperation and Integration: The West and Central African Case. *International Journal of Global Energy Issues* Vol. 6, No 6 pp 342 – 352.

The West African Gas Pipeline Project Newsletter Vol. 1 no.1 May, 2000

The West African Gas pipeline project Newsletter Vol. 1 no. 2 September, 2000

Oil and gas in Africa's energy future – prospects and opportunities for intra-African trade

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The oil and gas industry is the one which attracts the highest level of foreign direct investment into Africa. The international companies participating in the industry have found it possible to obtain significant returns on their investments even in the midst of the usual claims of political instability and high political risk. For Exxon, Mobil, Shell, Chevron, Total, et al, the trade in Africa's oil and gas resources is a major component of their profitability, whether or not Angola is at war, whether or not there are religious tensions in Nigeria or Algeria creating instability. Profits from petroleum exploration and production in Africa have remained very robust, rewarding the perceived 'high risk'.

Paradoxically, however, even as the enormous potential of the continent continues to attract large investments, most African countries, including those achieving increasing oil and gas production, are amongst the countries in the world with the lowest levels of commercial energy consumption. Nigeria, Africa's leading oil producer, is often faced with severe shortages of petroleum products, and regularly resorts to imports of refined products from Europe even as it produces two million barrels of oil a day. The amount of natural gas that is flared in Nigeria's oil fields – estimated at about three billion cubic feet a day – could generate enough electricity literally to light up every village in sub-Saharan Africa! Yet most of Nigeria's own population does not have access to electricity; even in urban areas power supply from the national grid is limited and erratic, whilst rural areas simply do not feature on the grid that is meant to be national. Both Angola's rising crude oil production as well as Nigeria's production are mainly destined for foreign markets, notably the United States, where stringent environmental regulations increasingly make low-sulphur, light crudes from West Africa the preferred feedstock for refiners.

On the other hand, South Africa's significant oil requirements are mainly served with imports from outside Africa rather than from nearby Angola. Nor are opportunities for South Africa's refining capacity being oriented to meet product needs on the continent, or being addressed as actively as one would have wished to see in the post apartheid era. For instance, West African crude oil could be refined in South African refineries to provide products for the region, instead of Nigeria, for instance, resorting to product imports from outside the continent at higher costs.

Essentially, trade in Africa's oil and gas resources has an outward orientation, hardly touching the needs of even the producing countries, much less others. Crude oil from Nigeria, Equatorial Guinea, Angola, will be headed, if not for the USA or Europe, then for India or South Korea – probably passing tankers that are bringing crude oil from Iran or elsewhere in the Middle East to South Africa. The transportation and related costs that are involved in the movements of African resources are a not insignificant part of the net outflow of resources from the continent. A realignment of some of these trade directions, to take into account the internal synergies on the continent and to focus on meeting the energy requirements of the continent, would be of immense benefit to both oil-producing and oil-consuming economies in Africa.

It is basically this external orientation of the oil and gas industry in Africa that makes over 70 per cent of the population of sub-Saharan Africa still depend on wood fuel for meeting their energy needs with severe consequences for the African environment. Whilst liquefied petroleum gas (LPG) from oil-producing countries on the continent could easily provide a more energy-efficient – and indeed cost-effective – fuel for meeting household needs, there has been little investment in the infrastructure required to make this happen, since the market opportunities being pursued by the oil companies are outside the continent. Thus, investments are made in LPG production from fields in Nigeria that focus exclusively on meeting specifications for the US market and cannot meet the requirements in Nigeria itself or in neighbouring countries. This is often tied to project-financing requirements which make companies look for "credit-worthy"

offtakers outside Africa to secure financing from banks that typically would not wish to take "African" risk even on resources of African origin.

It is worth observing that countries in Africa which have been successful in establishing significant national infrastructure for petroleum products (such as LPG distribution) are those like Egypt where national oil companies have invested in national distribution networks and where local private sector investors, as well as foreign investors, are also being encouraged to engage in distribution activities on the basis of national infrastructure largely created by public sector investment.

The reduction of wood fuel dependence is clearly a national imperative, and indeed a continental one, for countries in Africa. To achieve this, the need for clear policy directions that enable the required public and private sector investments to be made is of crucial importance. Since the issues cross national boundaries, the creation of common regional approaches would not only facilitate requisite infrastructure creation, but would also establish larger market perspectives for the required investment to yield expected returns.

I use the example of the West African Gas Pipeline Project to illustrate this point. Nigeria's abundant natural gas resources could provide energy for the sub region if a pipeline connecting the resources to the markets in neighbouring countries were in existence. For investors in Nigeria's oil and gas industry, the establishment of a regional market for gas would make the investments in the infrastructure for distribution in the region more likely to yields returns, thus justifying the investments. That Chevron and Shell, together with the Nigerian National Petroleum Corporation, the gas companies of Togo, Benin and the Ghana National Petroleum Corporation, are developing this regional gas transportation project is because of the recognition of the enormous opportunities available in local markets looked at regionally.

The example of regional electricity interconnection in the Southern African Power Pool provides an indication of the possibility of working towards creating regional energy markets. This is an especially relevant example in the light of the potential of the West African Gas Pipeline Project to stimulate increased supply of electricity to be transmitted across borders.

It is not only in West Africa that such regional perspectives are vital especially for gas projects. The gas resources that have been found in Mozambique, Namibia and Tanzania, for instance, have tremendous potential for improving access to energy in those countries and their neighbours; but it is more likely that investors will be willing to develop them if regional market perspectives and regional infrastructure systems become firmly established as the framework for their development and utilisation.

It is necessary to emphasise the important role that governments have to play in the realisation of such regional infrastructure. There is an unfortunate tendency to imagine that the current emphasis on privatisation and deregulation and the movement away from public monopolies in the energy sector means that governments must simply acknowledge that they do not have the resources for investing in the oil and gas sector and therefore must adopt a hands-off attitude that leaves private sector companies to their own devices. This is wholly unrealistic, as current experiences in California's power sector bear testify. Private sector investments themselves will benefit from a clear road map that emerges from the plans that governments establish for meeting energy requirements. Indeed, the setting of clear governmental priorities is essential for the outlook of private investors. In some cases, public investments may even be needed as catalysts for new directions that are being launched. For a regional project like the West African Gas Pipeline, it has been essential for the governments of Nigeria, Benin, Togo and Ghana to agree on a common legal and fiscal framework for the realisation of this major ground breaking project.

The Inter-governmental Agreement signed in Abuja in 2000 established key principles governing the implementation of the West African Gas Pipeline project, following the earlier Heads of Agreement of September 1995. The Commercial Group, especially the multinational companies, have made it clear that final investment decisions will only be made when a clear regulatory framework exists for the construction and operation of this cross-border pipeline, enabling suppliers of gas and consumers to reach agreements with the pipeline company on long-term take-or-pay arrangements. No doubt the participation of the two national petroleum corporations of Nigeria and Ghana, and the support of the government of Togo and Benin for the formation of the two gas companies to participate in the consortium, has had a positive impact on the interest of Chevron and Shell to pursue the project.

As has also been illustrated in the experience of Ghana’s attempt to encourage private sector investment in establishing a gas-fired power generation in Ghana to complement the existing hydro-electric capacity, the need for a clear regulatory framework and for government leadership in creating a level playing field are critical. There will often be hesitation on the part of the independent power producers pending clarity on how existing state monopolies will be made to play according to the rules, and on tariffs. In some

cases, the guarantees that might be sought by the private sector from the government could create significant liabilities for the government especially if it is the offtaker of power, and if tariffs are set at levels required by the private investors for their profitability.

The low level of commercial energy use in sub-Saharan Africa (apart from South Africa) means there are huge market opportunities close to areas of significant production. Even in South Africa, significant sections of the population have no direct access. Having the international oil companies recognise the real commercial opportunities that such a low level of generation presents and allocate resources accordingly is important if the huge resources being deployed by the industry in Africa are to meet the needs of the continent, and open up profitable new markets.

For the governments in these countries, no effort should be spared in having operating companies pay close attention to what is required for meeting these domestic supply needs, especially as obvious commercial opportunities can be demonstrated. Oil demand in Africa may be to the oil industry in the first decade of the 21st century what demand in Asia was to the industry in the 1990s, when rapidly increasing Asian demand shored up oil prices as demand growth in the developed world was declining. But this will require clear direction by governments as to their outlook, and the forging of public/private partnerships that enable investment in the required infrastructure to be seen as relatively low risk.

STATEMENTS AND BACKGROUND

Statement by the Executive Director of the United Nations Environment Programme, Dr Klaus Toepfer

(read by Mr Bakary Kante)

Your Excellencies, Ministers, distinguished delegates and friends,

On behalf of the Executive Director of the United Nations Environment Programme, Dr. Klaus Toepfer, it is my great pleasure to welcome you all to Gigiri – the global headquarters of the United Nations Environment Programme. Dr Toepfer has asked me to apologise to you for his inability to welcome you personally. His simultaneously urgent commitments elsewhere have prevented him from doing so. But he has asked me to convey to you his full support to all your endeavours in this meeting.

The importance of this meeting to consider energy and sustainable development cannot be underestimated. It comes just before the 9th session of the Commission on Sustainable Development – which has the theme of energy on its agenda. This meeting provides us the opportunity to reflect on a common African position on the issue as well as chart a new way forward, taking into account the special needs of the African continent.

That there are close linkages between energy and other major global environmental issues is a fact that is clear to everyone. At the same time, we are faced with the need to address the issue of meeting the basic energy needs of low income populations, especially in the least developed countries. There is also the challenge of sustaining the rapid increases in energy supplies and energy services required for their development. This is an issue that needs to be addressed in a comprehensive manner with due consideration to environmental and health aspects.

Access to energy is crucial to economic and social development, and alleviation of poverty. Improving accessibility of energy implies finding ways and means by which energy services can be delivered reliably, affordably and in an environmentally sound and socially acceptable manner, particularly in meeting the energy requirements of developing countries, including their rural areas.

Ladies and gentlemen, it is clear that the deliberations of the CSD-9 has important implications for the African continent. Nine out of ten Africans have no access to electricity and rely on traditional sources of biomass for their energy. These sources themselves are under threat from

overuse, creating additional environmental challenges. The actual living conditions of a typical rural family in Africa have been aptly described by the NGO Global Aid: In this family: Everyone lives in three one room huts without a toilet, running water, or electricity. There are few possessions and just a few acres of unirrigated land on which to raise sorghum, vegetables and groundnuts. The work is seasonal and involves all family members in the physically demanding tasks of tilling, sowing and harvesting at peak periods. The women bear a significant part of the total workload. The wife has to not only work in the fields, she has to fetch water, collect firewood (which is increasingly scarce), and feed the family. They must travel to the market town fives miles away to sell their small amount of cash crops and buy essential items. The town is reached by dirt tracks and an unsealed road that is washed away every time the rains come.

We can ignore these problems no longer. The situation stands in stark contrast to the fact the technological solutions are available. But the fact that the problems persist points to one inescapable fact: technology, per se, is not the problem. Perhaps nothing illustrates this more than the compact fluorescent light bulb and a module of solar PV cells. A modern compact fluorescent light globe is four times as efficient as an incandescent bulb and much cheaper over its useful life. However, it is the reduced electricity demand needed to power the bulb that actually enables the compact fluorescent light to be part of an economic PV system.

For rural households in developing countries, the combination of an efficient appliance and a small solar electricity system offers the benefit of electric lighting with a much lower capital cost than extending the electric grid. The combination of PV and an energy efficient compact fluorescent bulb is five times more efficient that PV with incandescent bulbs, 100 times more efficient than a kerosene lamp and 500 000 times more efficient than candles. Consequently, it is a superior alternative to both capital-intensive and low tech options.

And PV is just one of an ever expanding range of other energy solutions. Ladies and gentlemen, there are solutions that would allow Africans to leap past the dirty energy path of developed countries. We all agree that, from a technical point of view, the key to supplying energy services to people in rural Africa lies in a shift of thinking away from large, centralised power grids towards smaller, decentralised systems - particularly systems based on renewable energy.

But now, we need to reflect on why much of Africa suffers from energy poverty. And we must take to CSD-9 a clear and unambiguous African explanation of what we intend to do about the present situation. We need to present an unambiguous statement on the way in which we intend to realise a sustainable energy future for Africa.

In the Programme for the Further Implementation of Agenda 21 adopted by the General Assembly at its nineteenth special session, emphasis is placed on the critical importance of mobilising much needed investments for sustainable energy development in developing countries. Creating the necessary enabling environment for promoting investments in energy by domestic as well as foreign investors through appropriate policies is critically important for governments. Concrete actions are needed to achieve this important objective as well as those relating to the strengthening of institutional and human resource capacities in these countries. The development and transfer of sustainable energy technologies and systems to developing countries also constitute an important and integral part of proposals for action.

Actions are needed at the national level to strengthen the capacity of community-based organisations and institutions, including women's groups, to facilitate participatory approaches to energy for sustainable development. As part of this capacity building effort, assistance needs to be provided in the form of information resources, organisational support, training, planning and management tools, and entrepreneurial skills so as to facilitate access to modern energy services.

The international community can play a vital role in catalysing further targeted action at the national level so that the global problem of people still without access to modem energy services could receive much deserved attention. Building local capacity is also vital for the development of local energy resources and deployment of decentralised energy systems, thereby enhancing energy security.

For the sake of rural Africans, I believe that you will translate your discussions here into both insights for CSD-9 and specific actions that support sustainable development and the provision of clean energy services in Africa.

Statement by Mr Bakary Kante

at the Opening of the Experts Segment of the African High-Level Regional Meeting on Energy and Sustainable Development

His Excellency, Ambassador of Denmark to Kenya; representative of the government of Kenya; colleagues from UN/DESA, colleagues for the UNEP Collaborating Center in Denmark, distinguished experts, representatives of the press, ladies and gentlemen.

It gives me pleasure to address this experts segment of the African High-Level Regional Meeting on Energy and Sustainable Development. I am indeed very pleased to observe the impressive attendance, despite the short notice. This shows the level of commitment of the international community to the issues of concern to Africa. I need to thank the government of Denmark for their generous support to the United Nations which has enabled us fund most of the African participants represented here today. Of course, I should also acknowledge the wonderful work done by our colleagues at the United Nations headquarters in mobilising human and material resources for this important consultation. Very importantly, let me thank the government of Kenya for taking it upon themselves to join hands with us in organising and hosting this meeting. I am sure that their involvement has encouraged many other African countries to send their representative at senior level.

I need not emphasise the importance of energy in the socio-economic development equation. At a global level it goes a long way in determining the very survival of the modern economy, while at regional and national levels the role of energy in pivoting various sectors of the economy cannot be over-emphasised. However, what is of primary importance these days is not concern over what to do with energy, but in what way we reach and utilise it. In the developing world like Africa the problem is compounded by the fact that most people and sectors of the economy lack access to energy. This in effect means that any genuine attempt to deal with the full range of problems surrounding energy in Africa should begin with a transparent examination of the very causes of poor accessibility to energy.

Some experts do argue that per capita use of energy in Africa is low because of the low industrial and commercial bases. However, it is also a known fact that, in many cases, it is the unavailability of energy that has impeded Africa's economic growth. This is a vicious cycle to which we have to put an end if Africa is to make any headway in its quest for development as well as in its attempt at getting its impoverished people out of the shackles of economic underdevelopment. Let me quickly acknowledge that there is a lot that should be done on various fronts to enable countries to move ahead in terms of economic development. This includes questions of governance, capacity building, command and control of appropriate technology, and so on. However, we can say with confidence that the inability to reach and utilise adequate energy for domestic and industrial purposes are direct symptoms of those factors inhibiting development.

Distinguished guests, ladies and gentlemen; We cannot talk of development in the absence of societal peace and political tranquility. Still on the same doctrine, there is no way humanity can successfully embark on sustainable development without lasting peace and sensitivity to the environmental consequences of the way in which we use natural resources. Whereas we are able to manage the so-called renewable resources, the task before us becomes more Herculean when we are dealing with non-renewable ones. Furthermore, the quest for a worthwhile recipe to this monumental problem is rather more elusive under unstable political and civil environments. If we are to look at the above vis-à-vis situations in Africa, you will all agree with me that our search for the promised land can only materialise if and only if some key issues of governance are put in order. While agreeing that Africa needs to leapfrog on development programme, the international community should also play its rightful role through forward-looking cooperation and assistance.

I do not want to veer off the main thrust of this meeting. In this regard, I would like to challenge you distinguished experts and colleagues to focus upon those issues that are relevant to sustainable development. There is also the need to see how the problems and possible solutions can be analysed and productively approached by stakeholders. As is obvious, there is serious bias against the rural areas in Africa. This means that a lot needs to be done to redress the problems of

neglect and poor infrastructure in the periphery. In doing so, we need to be mindful of the essence of paying desirable attention to environmental concerns so that the mistakes of those countries that have attained certain development goals are not repeated in Africa. While talking about the problems of the rural areas, we should not forget that these days the urban areas are getting over-subscribed in terms of people and investments. These are done at the expense of their rural counterparts. The product of rapid rate of increase in urbanisation is environmental deterioration at a rate beyond the command and control of experts and policy makers. Pollution from energy sources is one of the major problems of African towns and cities. It is therefore a challenge to stakeholders that this matter is addressed within the framework of the need to balance resources between the urban and rural areas.

Of course, I trust you are all aware of the socio-cultural dimensions that are to be introduced at various levels. In other words, we should be mindful of the importance of different cultures as well as variations in social attributes. In the same light, we need to see how African countries can mutually cooperate in exchange of energy-related goods and services. This is where the question of trade and transnational economic cooperation come in. African experts need to find a way in which countries can improve on their level of cooperation in exchange of power across boundaries. Again, we need to see how this can be done in a productive and environmentally friendly manner.

Concerns over energy issues have been expressed by African countries in various fora. What perhaps has not been well articulated is the environmental dimension of these problems. This is the reason this high level consultation is especially important, as it gives an opportunity for experts and government officials to move somewhat closer to the beginning of an energised environment community. We also hope that this will be the journey towards close dialogue between energy stakeholders and their environment counterparts in Africa. We also have to realise that plans for cooperation at national and regional levels should include various regional and sub-regional organisations, as they are key actors in intergovernmental cooperation. It is therefore also important that we see how whatever we do converges with the activities of these organisations.

Ladies and gentlemen, I do not intend to preempt the outcome of your discussion; I would therefore like to end my speech by wishing you all a successful deliberation and a happy stay in Nairobi.

Cleaner fossil fuel technologies for Africa's sustainable development

Status of World Energy Council Cleaner Fossil Fuels Systems Committee Action Plan

Barbara N McKee

Chairman, World Energy Council, Cleaner Fossil Fuels System Committee;
Director, Office of Coal and Power Import and Export, Office of Fossil Energy,
US Department of Energy

I want to touch on several topics that are important for us at the World Energy Council (WEC).

I have been asked to report on results of an important conference in Dakar Senegal held last June 26 to 28. The theme involved sustainable development. That conference was cosponsored by the United Nations and the WEC's Committee on Cleaner Fossil Fuels Systems, of which I am the Chairman.[1]

The UN considered the Dakar conference to be one of the vehicles, and part of the process, for obtaining information for the ninth session of the Commission on Sustainable Development. I'll update you on the Dakar conference shortly.

Clearly, Africa is entering the second millennium with some very serious issues still to be resolved. The magnitude of those problems is enormous, so the efforts to address them must be great. The UN has been among the first to recognise this truth.

Poverty

One-fifth of humanity lives in absolute poverty. And Africa is, unfortunately, the poorest continent on earth. The UN General Assembly estimated in 1996 that more than 1.3 billion people in the world, a majority of whom are women, live in absolute poverty, especially in developing countries, and the number of such people continues to increase.[2] That poverty creates a vicious cycle that sometimes seems inescapable. Thus, worldwide, children often die young from disease and malnutrition; many adults are illiterate; and the potential for political instability is high. Problems are particularly acute in many rural areas.

Demand and need for clean energy

There is a vast need for more energy in Africa. And we know it doesn't come free. Worldwide, 2.8 billion people have no access to commercial forms of energy. Africa is energy starved. The majority of people in Africa need clean, affordable energy for healthcare, education, agriculture, transportation, and manufacturing. The demand for energy to help resolve problems is great, and people like us can play a key role in energy development. Because the world's population will double in the next 50 years, with as much as 90% of that growth in Latin America, Asia, and Africa, a great amount of energy will be needed to meet the needs of those increasing populations. In sub-Saharan Africa, with a population of 770 million, birthrights are increasing by 3.8 percent each year. While there is room for improved opportunity with this growth, problems may also grow unless we plan ahead. And in the next 20 years, the worldwide use of *all* energy sources will increase. But how much in Africa?

Accessibility, availability, and consumption of energy

The availability of clean, affordable energy of all types is a major problem for the poor in many countries throughout the world. Africa's share of

[1] Among other conference cosponsors were Gaz de France, International Gas Union, Senegalese National Committee of the WEC, Sonatrach, World Bank, World Coal Institute, World Liquid Petroleum Gas Association, U.S. Department of Energy, U.S. Energy Association, and other WEC groups.

[2] Within the United Nations system, there are several indicators of poverty: "Income poverty is the lack of minimally adequate income or expenditures. The indicator for this can be the poverty headcount ratio--the proportion of the population whose income or consumption falls below US $1 per day."

world energy consumption is only about 3% (11.4 quads), but 13% of the world's population lives there. In fact, electricity is accessible to only about 10% of the population in sub-Saharan Africa. Many of those without electricity live in small, isolated villages, thus they lack access to electricity grids.[3] Even where power *is* available and affordable, it often is rationed because of limited supply.

Africa used only a total of 356 billion kWhs of electricity in 1998, while America and Western Europe used 4.0 trillion and 2.6 trillion kWhs, respectively! This disparity, ladies and gentlemen, must be remedied. But it will not be easy. So, compared with the rest of the world, Africa has very low levels of electricity consumption per person (EIA, 1999). The people simply cannot afford it.

Energy, particularly electricity, is used so little in Africa because:

- energy is too expensive for most people who are poor and survive on pennies each day; and
- energy sources and electricity-generating equipment (e.g., electricity grids) are located too distantly to be tapped into by the many rural-living people.

Five African nations (South Africa, Egypt, Algeria, Nigeria, and Libya) account for nearly 80% of its energy consumption (1997).[4] Imagine how little the rest of Africa uses.

Dr. Hisham Al-Khatib, Honorary Vice Chairman of the WEC, said at the Dakar conference that: "What Africa needs more than anything else is accessibility to commercial forms of energy--particularly electricity. Without wider accessibility to electricity, sub-Saharan Africa will remain outside the modern age."

With respect to energy for home heating and cooking, sub-Saharan Africans largely rely on traditional biomass fuel (primarily wood). But wood burning is polluting and can be dangerous. In some sub-Saharan countries, over 90% of energy is derived from wood and other biomass, because that's all there is or that is affordable (EIA 1999). The problem with using biomass is that when wood is used for heating and cooking, the inefficient combustion process releases CO_2 and particulates, which are highly polluting – both indoors and outside. Also, such cooking can be unsafe, causing fires that can get out of control in homes, which can spread. Furthermore, the vast amount of wood used is causing deforestation, which in turn increases soil erosion, accelerated climate instability, and threatens biodiversity. The biomass fuel alone cannot be used much longer. But help already has arrived: cleaner fossil fuel systems.

The WEC and US Department of Energy strongly believe that clean, affordable energy must be made available to *all* people of the world--to supply heating, cooking, cooling, and transportation to improve people's day-to-day quality of life.

Barriers to development include poverty, complex rural geography and weather, disease and malnutrition, and the willingness and resolve of people like us to take giant steps forward. Like the links in a chain of bondage, these issues are all connected to one another and we must work on all of them.

Solutions: technology and investment

To implement real, large-scale change, we need to reach a consensus, develop a new blueprint for action, and then take the actions needed. Pilot energy development programmes show some promise. Investment is key.

Fossil fuels are strategically valuable because they are plentiful, usable, reliable, affordable, flexible, and convenient. They can be used in many energy sectors, including agriculture, industry, and at home. Clean fossil fuel technologies for petroleum, gas, liquefied petroleum gas (LPG), and coal are available today. And they are bolstered by advanced technologies. Coal use is now supported by the many modern clean coal technologies. Some of these fossil fuels can combine with biomass to efficiently and cleanly produce energy.

Distributed generation is particularly promising for Africa. In the many areas where no electricity infrastructure exists, where there is no access to electricity grids, distributed generation applications could hold the key to creating new economic opportunities and raising prosperity. Equipment includes turbines, engines, and fuel cells. Gas turbines (or combustion turbines) are available in a range of sizes. Some key attributes of distributed generation are:

- The systems can use fossil fuels.
- Biomass feedstock can be used to power small distributed generating systems. Animal waste can be gasified to produce energy.
- Applications are small modular generation units located close to electric power users to cost-effectively extend energy services. "Distributed generation strategically applies relatively small generating units (typically less than 30 MW). Reliability of service and power qual-

[4] *Energy in Africa,* U.S. DOE/EIA, p.25 (1999).

ity are enhanced by closer proximity to the customer."[5,6]
- The systems have environmental benefits and high efficiency.

Of course, the bottom line is that real investment is needed to distribute energy more widely to ensure economic, political, and social development for the continent. Obtaining financing to pay for energy development and system deployment remains a major challenge. Governments try to subsidise energy but often cannot because of finite funds; businesses need to find a return on investment in supplying energy; and consumers ultimately need to be able to pay for some of the energy. In the latter case, we have learned that citizens, though poor, who have taken loans to pay for some electricity, have made good on those loans. For example, microlenders like Grameen Bank specialise in making loans to the poor, has done a lot for Bangladesh. It is "committed to bringing about positive changes in the lives of the bottom half of the population, and within this, more specifically, in the lives of women and children."[7,8]

Private investment plays a vital role in sustainable development. Colin McClelland, Director of the South African Petroleum Industry Association said some time ago that:

> We can achieve a "win/win" situation in Africa whereby a climate is created in which both efficient energy investors will be able to earn good returns on their investments and appropriate economic growth and development in Africa will be fostered." This is a viable way to help alleviate the poverty that haunts the African continent. It is also simply good business strategy for energy investors in Africa, who are necessarily long-term investors, to nurture the well being of the continent in which they are making their investments.

How can African nations attract these funds? When making large, long-term investments, investors look for stability. Investors want predictable pricing and returns, so customers need to be able to pay. The best way for Africans to encourage the needed private investment is to create a stable political and social environment to minimise risk. Today, in much of Africa, risks are simply too high. For example, warring is a major risk But I think we are all here because we know that such hurdles can be overcome. I know we *can* live in an era when it will be brighter through increased energy distribution, economic prosperity, national security, and peace. We will go forward together in a spirit of cooperation and collaboration until the time comes when there is energy for all and, we pray, peace for all.

It is conferences like this one and the Dakar conference that are building bridges on the road to that peace.

Dakar Conference update and results

I have been asked to report on an important conference I attended in Dakar, Senegal last June. The theme involved sustainable development. That conference was cosponsored by the World Energy Council's (WEC's) Committee on Cleaner Fossil Fuels Systems (CFFS), of which I am the Chairman. Among other cosponsors was the United Nations. I have been asked to report on results of the Senegal conference.

More than 150 delegates from 30 African countries attended the conference, along with delegates from other nations. And 187 Senegalese students attended, as well. Good ideas were proposed there to further the assessment of technologies and sustainable development.

From input received from the citizens of African nations, the WEC developed what we call an "agenda for action." Four major elements comprise that agenda:
- energy in rural development;
- liberalisation of the energy market,
- development of a broad-based "e-society," relying on internet use, and
- cross-cutting capacity building.

After assessing the most appropriate issues to tackle, the WEC decided to pursue two of these as pilot projects: rural energisation (distributed generation), and capacity building

First, with respect to rural energisation, delegates scoped a project plan that will be submitted to various organisations for funding. In activating the plan:
- We intend to identify the best viable, modern, and economical technologies that will provide electricity to rural villages in Senegal. We also

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5 (*DOE Fossil Energy - Distributed Power Technologies,*www.fe.doe.gov/coal_power/distributed_power.htm)

6 Robert S. Kripowicz, Acting Assistant Secretary for Fossil Energy, has said that "Distributed generation has the potential to change the topography of this Nation's electricity supply. That change could be as revolutionary to the power industry as the introduction of the personal computer was to the computing industry." (www.fe.doe.gov/remarks/98_krip_dpca. html)

7 http://www.citechco.net/grameen/poverty_research /anrep97.

8 Others sponsor metering programs in which the public can buy limited access to a certain minimal amount of electricity, say, enough just to run a refrigerator.

will assess LPG bottles for cooking. Then, the selected technology will be pilot tested in a few Senegalese villages. The WEC will make its findings widely available.

- The cost of the effort is estimated to be about $1 million (U.S), to be incurred by various organisations.
- The government of Senegal will be responsible for implementation.

Second, with respect to capacity building, the students at the youth "round table" were particularly keen on becoming entrepreneurs themselves. These students want to be trained, and to find ways to obtain energy- and development-related information. In response, the WEC intends to mobilise retired business people from WEC member countries to help youth develop entrepreneurial skills. After all, these young people are the future leaders. We are currently identifying business professionals who have the time to share their many years of experience with the African students. Just think of, say, how mentoring and broad internet access could quench the thirst of these creative young minds, who are so anxious to learn more about energy to help their respective countries.

We realise that villagers want to, and must, take ownership of the projects we implement so that the solutions are appropriate for their real needs, and so they will carry on and maintain those projects well after we are gone.

We hope the UN can help join with us on these projects.

Before I conclude my remarks, I'd like to say a few words about women's plight in Africa. I've talked about this at other conferences, but, it is so important, I want to repeat it. The African woman is suffering. This human suffering must be alleviated. And uplifting women is particularly essential for sustainable development. Yet, too many women are treated poorly. Action to enable women and girls to be free from violence is a central feature of the struggle for sustainable development. Improving women's social positions strengthens African society as a whole and enhances the continent's broader development prospects. Despite some positive moves, there has been insufficient political will and sustained commitment to meeting the needs and interests of women. If women are set free, the continent will develop and grow more quickly. Those empowered African women will keep the momentum going for themselves! For example, a literate mother would never allow her child to grow up illiterate.

Conclusion

We know that access to electricity would improve the quality of life of most Africans. The people of sub-Saharan Africa need clean, affordable energy to help free them from abject poverty. And we know we can't necessarily try to resolve one societal problem without simultaneously attending to others. Providing electricity to the many underdeveloped regions is good for Africa because it is good for Africans. The poorest people need it most. What can electricity do for the people? Electricity, giving light and power, begets industry and agriculture, which beget jobs, which in turn enhance purchasing power, all of which improves the quality of life. Clean and cost-effective energy must be made available at the grassroots level. The more access to clean energy that African nations have, the more they can sustain themselves and their sovereignty.

African nations can benefit from more advanced nations who have already got past the learning curve and incurred the research and development costs. The technologies and insight are available now.

It is vital for world stability that "globalisation" does not leave the poorest behind. We must take the necessary steps to eliminate the "digital divide," so Africans have access to the world of information available on the internet. But concrete actions must be taken to activate plans after we lay out what needs to be done at conferences like this.

This conference gives us the space and time to talk freely and make some serious decisions on how to move forward in Africa. But we need to think outside the box, so to speak. We need to be creative. We need some new approaches.

Questions still remain unanswered. That's why we're here today. What is the most cost-effective method for improving accessibility to electricity for the masses of Africans still deprived of this essential service? How can we ensure a win-win result? Work will be needed to answer this question, which must be addressed, to ensure sustainable development. Among other viable technologies, cleaner fossil fuel technologies have a place in the solutions to improve sustainable development in Africa.

Again, we need to focus not just on "action plans" but also on really taking action. We must see that the actions needed are interconnected. We all have a role. And giant steps need to be taken by all of us. I know we can start a few initiatives that will further problem resolution after this meeting.

Let us be ready to face the challenges of the coming millennium, however great they may be. I hope our actions here can help lift the shroud of poverty and the yoke of conflict in much of Africa. And we can measure our success by how much the *quality of life* has improved for the people of the African continent.

Energy for sustainable development in least developed countries

Statement by Ms Yvette Stevens, the Special Coordinator for Africa and Least-Developed Countries of the United Nations Department for Economic and Social Affairs

Excellencies, distinguished delegates, colleagues, ladies and gentlemen.

The ninth session of the United Nations Commission for Sustainable Development, which will meet in April this year, will focus on energy and the energy-related topics of atmosphere and transportation. This will mark the first time that an intergovernmental political body of the United Nations will consider the topic of energy in its entirety, from nuclear power to oil, from electric grids to decentralised renewable systems, and from deregulation to gender participation. Therefore, the coming session of the Commission provides a valuable and important opportunity to begin a debate at the global level on the various sources and issues within energy.

The report of the Secretary-General on "Energy and sustainable development: options and strategies for action", which has already been prepared for the ninth session, focuses on seven substantive key issues that were identified by an Intergovernmental Group of Experts advising the Commission. These issues include accessibility of energy, energy efficiency, renewable energy, advanced fossil-fuel technologies, nuclear energy technologies, rural energy, and energy and transport. The report considers these issues in depth and gives serious consideration for each to the overarching issues of: technology transfer, capacity building, mobilisation of financial resources, and international and regional cooperation.

Other regions have identified their own perspectives with regard to each of these issues for use by the Commission. It is now Africa's turn. This High-Level Meeting has been organised, in cooperation with UNEP and with the assistance of our generous host, the Government of Kenya, to provide an opportunity for the development of such a perspective for Africa. The energy situation in Africa is clearly different to the other regions. An African perspective with African positions on various issues to be discussed at CSD is therefore critical as the region seeks to benefit from decisions taken in intergovernmental fora.

This regional meeting is particularly important. Africa, more than most regions, has an abundance of energy resources, both conventional and renewable. However, with the exception of oil, they remain largely unexploited. It is also clear that Africa, more so than most regions, continues to face an alarming spectre of poverty. In this region, the absolute number of poor has grown five times more than in Latin America and twice that of South Asia and today, at least 45 per cent of the population are living on less than one dollar a day. As energy is critical to virtually every aspect of economic activity, a more intensive and sustainable use of energy is key to helping African countries meet the two most important challenges facing the region today, that is, becoming competitive in the global economy and reducing poverty.

For the most part, poverty is concentrated in the rural areas where, as Messrs Sokona and Davidson describe in their paper on "Energy and sustainable development: Key issues for Africa", there is an overdependence on "low quality energy sources", including firewood and other forms of biomass, candles and kerosene. Farming is done largely by hand and occasionally using animal power, and walking is the primary means of transportation. Improving access to more efficient and cheaper energy services is critical to freeing the poor, especially women, from subsistence tasks, allowing them to use their limited disposable income and time for more productive activities, including the development of micro-enterprises and small businesses, and in joining the market economy. As the Department within the United Nations responsible for the monitoring the implementation of the programmes of actions coming out of some of the major global conferences, including the United Nations Conference on Environment and Development, the World Social Summit on Social Development, the Fourth World Conference on Women and Development, we are convinced that increased access to energy by the poor can play a key role in achieving international development targets,

the main one being the reduction of absolute poverty by half by 2015.

The Sokona and Davidson paper shows that, while there has been a slight increase in Africa's share of global commercial energy from two per cent in 1970 to three per cent in 1997, as they point out, these shares are low because the continent hosts 14 per cent of world population. To further complicate the picture, 80 per cent of consumption of commercial energy is concentrated in Northern and Southern Africa. Clearly, a more intensive use of energy is also critical to the ability of African countries to diversify their economies and become more competitive in the global economy. A consistent and reliable source of energy is one of the major bottlenecks to expanding production of current goods, improving productivity, diversifying into new products and niche markets and becoming competitive at the level of exports and, in the context of a liberalised global economy, to become competitive in the domestic economy vis-à-vis imports as well. As I have said in many fora, including at the earlier technical meeting, while African countries continue to seek increased market access, without the ability to supply the products in demand, at high quality and on time, we, as Africans, will continue to bury our heads in the sand.

Much is being done and said about closing the digital divide and using information and communications technologies to leapfrog certain infrastructure put in place by industrialised countries during their "take-off" stage. At a high-level meeting of the Economic and Social Council of the United Nations last year, commitments were made by member-states to put in place policies at the national and global levels to close this digital divide. Clearly, despite the increase spread of wireless technologies, there will still be need for access to electrification for computers and therefore the more intensive use of modern energy has to be a *sine qua non* for any programme of action to bridge the digital divide in Africa.

Investing in Twenty-First Century Africa will mean major investments in energy. This will require clear strategies at national and regional levels, strong political support and leadership, innovative financing mechanisms, a stronger reliance on public-private partnerships and the full support of the international community. I was pleased to hear that the Danish Government is reviewing its energy sector strategy with a view to providing stronger support to the development of long-term sustainable energy sector programmes and is focusing on rural energy needs in its bilateral and multilateral development cooperation. I hope that this will encourage other partners to focus on this sector as well. Increased and more efficiently used official development assistance in this sector can help to leverage private sector investment.

There was consensus at the technical meeting that, because of the uneven distribution of energy resources in the region and in view of the opportunities for increasing efficiency and cost-sharing, regional energy cooperation and planning is an essential element of national energy strategies within the continent. Support by African partners will be essential to give a push to the fledgling regional energy institutions that are now being created.

I also take this opportunity to remind you of upcoming Third United Nations Conference on the Least Developed Countries which will be hosted by the European Union and which will be held Brussels from 14-20 May 2001. The Conference will review the Programme of Action for the LDCs for the 1990s, which came out of the Second United Nations Conference on the LDCs held in Paris in 1990. This programme called for, among other things, "the development of energy capacity, based on conventional and alternative energy sources". A draft of the new Programme of Action will be considered at the next intergovernmental preparatory meetings of 5-9 February 2001 and 2-6 April 2001 and adopted at the end of the Third Conference. Some of the issues discussed here this week may find a useful place beyond the Ninth Session of the CSD to the Third Conference where the focus will be on delivering concrete outputs for the LDCs. Your support for specific proposals on the LDCs emerging from the Ninth Session of the CSD will greatly contribute to making the Third Conference on LDCs a success.

As a result of the technical meeting which preceded this meeting, you have before you a Draft Ministerial Declaration and Programme of Action for your consideration, modification and endorsement.

Please join me in extending our thanks to the Government of Kenya for shouldering the responsibility of hosting this African regional meeting. Moreover, we are grateful for the financial support provided for this meeting by DANIDA, the Danish technical cooperation agency, and the Government of Sweden, and for the general support of the Government of the Netherlands.

Mr Chairman, distinguished delegates, ladies and gentlemen, I wish you every success in rising to the challenge that we have before us and hope that this meeting will provide an important step in the development of a regional, and indeed global, effort for improving sustainable energy services for all Africans.

APPENDIX 1
Agenda of the Meeting

Day 1: Wednesday, 10 January

9:30-12.30	**SESSION 1 – INTRODUCTION AND BACKGROUND** *Chair: Mr Ambassador M Ngali (PS, Ministry of Energy, Kenya)* Welcome *– Mr Ambassador M Ngali* Statement by UNEP *– Mr Bakary Kante (UNEP)* The CSD9 process and the need for options and strategies for action to promote energy for sustainable development *– Dr. W. Shearer (DESA)* Energy and sustainable development *– Mrs M.L. Wandel, Counsellor, Deputy Per Representative (DANIDA)* Cleaner Fossil Fuel technologies for Africa *– Ms Barbara MacKee (DOE, USA, WEC)*
14:00–15.30	**SESSION II: REGIONAL PERSPECTIVES** *Chair: Dr John Christensen (Head- UCCEE)* Energy and sustainable development –Key issues for Africa *– Prof Ogunlade Davidson (EDRC) and Dr Youba Sokona* (ENDA) Renewable energy technologies for Africa: key issues *– Dr Njeri Wamukonya* (*UCCEE)*
16:00-17:00	Energy for sustainable development in least developed countries *– Ms Yvette Stevens (UNDESA)*

Day 2: Thursday, 11 January

8:30–9:30	**THEME: ACCESS TO ENERGY - PART I** *Chair: Dr Yinka Adebayo (UNEP)* SADC rural electrification experiences and future strategies *– Mr Norbert Nziramasanga (Southern Centre, Zimbabwe)* Financing frameworks to facilitate sustainable development *– Prof Francis Yamba (CEEZ-Zambia)* The South African non-grid electrification programme process *– Mr Chris Lithole (DME/Eskom, South Africa) andDr Njeri Wamukonya (UCCEE)* Rural electrification reform and programme in Cameroon *– Mr Jean-Pierre Ghonnang Zekeyo (MMWRE-Cameroon)*
9:30–10:15	Discussion
10:45–11:30	**THEME: RENEWABLE ENERGY PROSPECTS AND LIMITS** *Chair: Mr Djibil Salifou (MME, Benin)* Renewable energy for regional sustainable development *– Dr Faouzi Senhaji (Morocco)* Barriers to use of renewable energy technologies for sustainable development in Ghana *– Dr Abeeku Brew-Hammond (KITE-Ghana)* The role of renewable energy technologies for sustainable development in Morocco *Dr Mohammed Berdai (Morocco)* Barriers to the use of renewable technologies in Egypt *– Dr Elmoud Mohamood (Egypt)*

11:30–12:00	Discussion
12:00–12:45	**THEME: RURAL ENERGY** *Chair: Belhamel Maïouf (Algeria)* Overview of regional wood energy situation *– Mr Daniel Gustafson (FAO)* Overview of the regional biomass energy issues *– Mr Kofi Ekouevi (World Bank)* Challenges in meeting the biomass energy needs in West Africa – Experiences of the RPTES programme *– Mr Mamadou Dianka (RPTES Senegal)*
12:45–13:15	Discussion
14:15–15:15	**THEME: ACCESS TO ENERGY – PART II** *Chair: Dr Jonas Redwood-Sawyerr (Sierra Leone)* Overview of the regional power reform programmes *– Mr Dibongue Kouo (IEPF, Canada)* SADC Initiative to meet electricity needs for sustainable development *– Dr Shakespeare Maya (SBSS, Zimbabwe)* Restructuring power utilities: the Case of Eskom, South Africa *– Ms Alix Clark (South Africa)* Power reform in Senegal *– Mr Alioune Fall (Regulator- Senegal)*
15:15–15:45	Discussion
16:15–16:45	**THEME: REGIONAL COOPERATION OPPORTUNITIES AND LIMITS** *Chair: Ms Barbara McKee (US-DOE)* Regional co-operation for sustainable energy supply: experiences with the development of the gas pipeline in West Africa *– Dr AO Adegbulugbe (Nigeria)* Oil trade across African countries; opportunities and challenges *–Mr Tsatsu Tsikata (GNPC Ghana)*
16:45–17:30	Panel discussion *Chair: Mr Frédéric Nguime Ekollo (Cameroon)* *Mr Sibusiso N. Dlamini (Swaziland)* *Mr Djibril Salifou (Benin)* *Dr Jonas A S Redwood-Sawyerr (Sierra Leone)* *Prof. Salome Misana (Tanzania)* *Ms Wendy Poulton (South Africa)* What form of regional and international cooperation is needed for provision of energy to attain sustainable development? How can Africa extend useful and sustainable energy to rural communities to meet sustainable energy objectives and alleviate poverty? What is the role of national governments in ensuring universal access, energy for economic growth? How can gender specific concerns be integrated in the initiatives aimed at improving access?

Day 3: Friday 12, January

9:00–12:00	**SESSION I: TECHNICAL SEGMENT – DRAFT STATEMENT** Chairs: Mr Tsatsu Tsikata (Ghana), Mr Eng. Paul Mubiru (Uganda)
	Presentation of draft statement *– Presenter*
	Discussion on draft statement
	Close of technical segment
	HIGH-LEVEL SEGMENT - MINISTERS MEETING
14.00–15:00	**PART I**
	OPENING SESSION *Chair: Hon. Celestino K Chibamba (Zambian Minister)*
	Welcome address by Hon. Minister Masakhalia (Kenya)
	Welcome address by Mr Bakary Kante (UNEP)
15:30–17:00	*Chair: Hon. Jesaya Nyamu (Namibian Minister)*
	Address by DESA *– Ms Yvette Stevens*
	Review of key issues specific to Africa*
	Review of options and strategies for action for promoting energy for sustainable development *Prof. Ogunlade Davidson*

Day 4: Saturday 13 January

10:00–13:00	**PART II** *Chair: Hon. Minister Masakhalia Kenyan Energy Minister*
	Presentation of draft statement on African regional perspectives on energy and sustainable development for the ninth session of the Commission on Sustainable Development *– Presenter**
	Consideration of the draft statement
	Adoption of the statement
	Closing statement by Mr Bakary Kante, UNEP
	Closure by Hon. Minister Masakhalia

APPENDIX 2
List of participants

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Paper	Reviewer
Energy and sustainable development: Key issues for Africa Ogunlade Davidson and Youba Sokona	Koffi Ekouevi, World Bank
Renewable energy technologies in Africa: An overview of challenges and opportunities Njeri Wamukonya	Jean Pierre Ghonnang Zekeyo, Cameroon
Rural electrification: A challenge for improving access to energy by the poor N. Nziramasanga	Njeri Wamukonya, UCCEE
Rural electrification reform and programme in Cameroon Jean Pierre Ghonnang Zekeyo	Douglas Banks, RAPS South Africa Njeri Wamukonya, UCCEE
The South African non-grid programme process Njeri Wamukonya and Chris Lithole	Woolsey Bernand, NER South Africa
Financing frameworks to facilitate sustainable development: Experiences in the AREED project F D Yamba	Lawrence Agbemabiese , UNEP
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Sustainable development in Africa through renewable energy Faouzi Senhaji	Njeri Wamukonya, UCCEE Mamadou Dianka, Senegal
Renewable energy in Morocco: limits and prospects Mohamed Berdai	Njeri Wamukonya, UCCEE Mamadou Dianka, Senegal
Barriers to the use of renewable energy technologies for sustainable development in Ghana Ishmael Edjekumhene and Abeeku Brew-Hammond	Elmoud Mohamood, Egypt
Renewable energy technologies in Egypt: Opportunities and barriers Elham Mahmoud	Ishmael Edjekumhene, Ghana Abeeku Brew-Hammond, Ghana
An overview of biomass energy issues in sub-Saharan Africa Koffi Ekouevi	Njeri Wamukonya, UCCEE
Challenges in meeting biomass energy needs in West Africa Mamadou Dianka	Anthony Williams, South Africa
Botswana biomass energy projects: The challenge of mainstreaming biomass energy plans to facilitate sustainable development Fanile Mathangwane, Michael Utke, Sam Bok, Masego Kealotswe and Gayle Best	Njeri Wamukonya, UCCEE Godfrey Ndawula, Uganda
Overview of the power reform programmes in sub-Saharan Africa Dibongué Kouo	Mamadou Dianka, Senegal Njeri Wamukonya, UCCEE

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Using new financial instruments for improving oil trade across Africa: opportunities and limits Lamon Rutten	Njeri Wamukonya, UCCEE
Regional cooperation for sustainable energy supply: Experiences with the development of the gas pipeline in West Africa A O Adegbulugbe, J-F K Akinbami and F I Ibitoye	Njeri Wamukonya, UCCEE
Oil and gas in Africa's energy future prospects and opportunities for intra-African trade Tsatsu Tsikata	Anthony Adegbulugbe, Nigeria