A new sustainable energy path for African development: Think bigger act faster

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INTRODUCTION

Africa has abundant, diverse and unexploited renewable and non-renewable energy resources that are yet to be used for improving the livelihood of the vast majority of the population. Financial resources, social infrastructure, human and institutional resources are inadequate, largely for historical reasons, but major policy shifts in the energy and related sectors are urgently needed if Africa is to exploit existing and potential opportunities in achieving its goal of providing reliable, affordable modern energy services to the majority of its inhabitants.

An important feature that distinguishes many African countries' energy systems from those in 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 and unsustainable, especially coupled with equally inefficient cooking devices. Changing this situation, either by increased efficiency or by substituting these fuels, provides significant opportunities.

An important feature that is shared with other developing regions is unevenness in the production and use of energy. On average, about 40% of Africa's total modern energy is used in six countries in North Africa, with a similar share in Southern Africa (where over 80% is used by South Africa alone). The other 45 or so countries share the remaining 20%. The major oil and gas producers are found in about 10 countries, concentrated in a few areas, and 96% of coal is produced in South Africa. This skewed distribution in energy production and consumption is not only due to the occurrence of energy sources, but represents levels of industrial and other economic activities; it has a profound impact on the overall energy situation of a continent that also suffers from limited infrastructural linkages between countries.

This short book provides some insights in developing a new energy growth strategy that addresses the urgency for Africa to depart from current paradigm that do not address the major challenges of the energy sector which calls for not only satisfying energy needs but to assist the continent's overall productivity. The first chapter discusses the past imperatives that govern energy and development and then traces the origin of sustainable development before linking these thoughts to the African situation. Chapter 2 looks in some detail at the energy sources of the continent, and with the way energy is produced and used. The general energy policy environment is presented, with some comments on energy institutions. The third chapter looks at the major emerging issues facing

the energy sector, which include the energy-environment dilemma, widening access to the majority of rural Africans, financing energy investments and regional cooperation and trade. Chapter 4 identifies the key lessons learnt from past energy initiatives in the continent: in energy institutions and reform, transitions in energy for cooking, oil and natural gas development, renewable energy development, modern biomass development and regional cooperation and trade. Chapter 5 contains the different components of the suggested strategy, which was based on the call for thinking for bigger energy projects and cutting down on the long lead time in developing and implementing energy projects in the continent. The main components are wider use of petroleum fuels, intense use of natural gas, optimal production and use of electricity, expanded use of LPG in households, more use of modern biomass, and converting flared gas to modern energy. The book concludes by looking at the future prospects in achieving the goals of the suggested strategy.

CHAPTER 1

Energy and development: Perspectives from the past

For all human existence, developmental activities have aimed at improving the overall quality of life. History teaches us that this striving has been accompanied by a growth in demand for energy services, leading to the search for different energy sources over the past millions of years.

This linkage between development and energy can be seen most clearly when observing the major landmarks of human history (see Figure 1). At each one there has been significant increase in energy use – from satisfying domestic needs to those brought about by modern transport and industry. Primitive humankind in East Africa about a million years ago is estimated to have used 2000 kilocalories (kcal) daily, excluding food intake, and this increased to 6000 kcal daily among animal-hunters in Europe 100 000 years ago. Agriculturalists around 5000 BC growing crops and using animal energy consumed 12 000 kcal daily, as activities spread beyond the household. As agriculture advances in Europe in about 1400 AD, the farmer now uses 20 000 kcal daily, because of the level and type of agricultural methods and new mobility needs. By the time of the industrial revolution (in, say, 1875 in England) when human energy was heavily supplemented by the machines used for industry and movement, 'industrial man' used about 77 000 kcal/day. As energy sources became more diversified and demand for goods and services increased, especially after the Second

three continue to dominate global energy supply. It can be noted that hydropower and wind power have been used for a long time, though their share remained marginal.

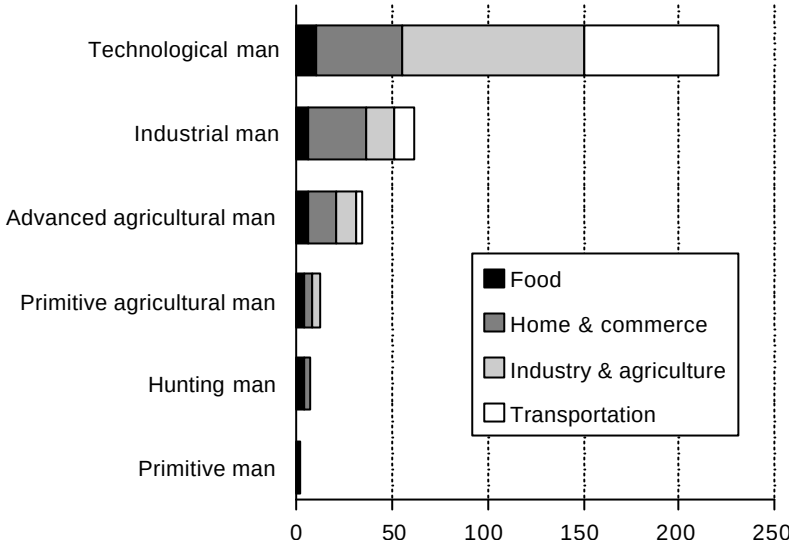

Figure 1.1: Stages of human development and energy consumption
Source: Cook (1976)

This sketch of development and energy use does not reflect the inequalities within countries and regions. Currently, someone in a rich country in the region normally referred to as 'developed countries' uses, on average, four to five times the primary energy used by someone in a 'developing country'. Within many countries, the poor uses about a fifth of the primary energy used by the rich. There are also disparities in the distribution of sources and associated energy technologies, depending on many factors. These disparities have serious economic and social impacts and must be considered in any development of energy provision if poverty is to be reduced.

Another hidden feature in the development of energy is the environmental implications of energy production and use; for, although energy has been a major driver for human development it has also contributed to local and regional environmental degradation and, more recently, to global environmental threats. In looking at energy development, social and environmental dimensions are as important as economic considerations. This thinking has led to the concept of sustainable development.

Defining sustainable development

Several definitions of sustainable development have been proposed, all of which are variations over the classic statement put forward by the WCED: "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." A major challenge is to integrate the notion into energy policy especially that the above WCED definition is subject to divergent and often contradictory interpretations, each of which implies a different orientation for energy policy.

The main basic theme of the WCED definition is that a certain amount of environmental damage is unavoidable in the development process; and conserving a generalized intergenerational capacity to produce economic well-being is the essence of sustainability. This is important for Africa countries that is yet to go through its industrialisation need acceptance of less-than-the-best environmental conditions can be made such that the "rents" from doing so are translated into productive investment. This can lead to the accumulation of physical capital which is capable of compensating for the decline of material assets though it can lead to unlimited substitution of the elements that constitute the natural environment for goods produced and that are accumulated in the form of capital.

As human practice continues to exceed the ecological space the world can accept, even with renewal of its ecological qualities, the call for sustainability in all aspects is becoming louder. Energy, being so closely tied with the natural systems, is connected with this call, as is equity, which takes into account fairness now and in the future in the production and use of resources. Different aspects of sustainability should be fully integrated in energy growth policies: environmental sustainability, that refers to the capacity to withstand environmental shocks and stresses; social sustainability, referring to social equity, poverty reduction and resilience to social shocks; and economic sustainability, which implies maximising income to ensure that capital stocks and assets are protected. These pillars of sustainability provide the basis for designing future energy growth paths.

The African situation

The energy situation in Africa diverges from the later development stages described above in both the amount of energy used and energy sources consumed. The average daily consumption of primary energy in Africa varies between 25 000 and 30 000 kcal, which means that the 'average African' is still using less energy than the 'average' person used in England in 1875. This is mainly because many African countries are yet to undertake industrialisation and full modernisation of their economies; their energy consumption is still largely for satisfying household needs. A large portion of agricultural activity is

peasant in nature, using little modern energy. Car ownership is low (about 20 cars per 1 000 people), as is use of energy-intensive household equipment. Various developments in the energy sector since the 1960s deserve some comment, however.

Most African governments after independence, some 40 years ago continued to a large extent similar development thinking as that of their colonial leaders, hence despite the change of leadership, the urban elite continued with relatively higher energy consumption and little attention given to the majority rural Africans. However as in most parts of the world energy development was a government led supply-oriented agenda. The governments then viewed industrialization as the key to development and putting into place the basic energy infrastructures and communication networks. In this regard, there was no distinction between ideologies of governments such Nkrumah in Ghana that was preaching socialist model of development, and Houphouet-Boigny in Côte D'Ivoire which adopted the capitalist development approach. Throughout Africa, energy decision-makers were committed to increase the capacity for energy supply that led to the construction of large hydroelectric power stations such as Owen Falls, Kariba, Kafue, Akosombo, Cabora Bassa, Inga and they were seen as symbols of progress. As a result, the installed capacity in both Ghana and Côte d'Ivoire increased from under 1GW to nearly 2GW between 1980 and 1999 (Agbemabiese 2002). Similar increases were recorded in all sub-Saharan African countries, where installed capacity increased from nearly 44.5GW in 1980 to about 94 GW in 1999. With regard to the emphasis on energy supply during this period, in the 1960s, the development of the energy sector was confined to increasing the supply of conventional fuels such as electricity and petroleum. Major refineries were built in several countries. Another sector that experienced significant development was the power sector, whose expansion was thought a priority because of the optimistic assumption that the region was set to experience substantial growth in its industrial and agricultural sectors(Davidson & Karekezi 1993). In general energy institutions evolved around a top down paradigm in many countries that were based on the universal trend towards dominance by large, complex, centralized and non-transparent energy producers energy regimes installed in the 1960s and 1970s continued to cast a shadow over energy thinking during the 1980s and 1990s.

Another development was that independent African governments started borrowing from external financing institutions to establish their energy sector and further most of these countries lacked indigenous oil and gas resources and had to import to meet growing demand. Hardly any country imported from its African partners, however: oil imports originated from the Middle East and Europe, and had to be paid for in expensive foreign currencies. Surging oil prices in the 1970s and the collapse of prices of primary products, from which

the larger part of Africa generates the bulk of its foreign exchange, forced Africa to borrow heavily, mainly on commercial terms, to pay for oil and other needs. Overall the global economy was such that the terms of trade were very unfavourable for Africa.

With increased external dependency, Africa found itself obliged to accept the conditions of lenders to the energy sector. After failing to recover from the economic downfall emanating from the 1970s oil crisis, most countries have depended on loans, grants and direct investments from the developed countries and the World Bank for developing the energy sector. Recently, there have also been Asian investors in the continent. The largest share of these investments went to oil and gas exploration and electricity generation, predominantly large hydro. Consequently, shifts in policies in the lending and donor agencies are reflected in the African energy sector, a phenomenon that is apparent in the overall economies of African countries. Policies in Africa have been influenced by following World Bank and donor fads: 1960s 'development planning' gave way to 'basic needs' in the 1970s, followed by 'structural adjustment' in the 1980s and 'good governance' in the 1990s.

Today Africa's energy-related debts remain high in comparison to its earnings, because its foreign revenues have dwindled substantially as prices for raw materials fluctuate and slide. Yet most of the people lack access to the modern energy necessary for economic and social development. Meanwhile, countries are being forced to undertake a reform agenda that is neither increasing investment nor considering improved access. These circumstances present major challenges for the energy sector of Africa.

CHAPTER TWO

Energy in Africa

This chapter describes the energy situation of the continent, including its energy resources, production and use, and briefly looks at the energy policy environment, against a background of interactions between energy and economic development. The following chapter will concentrate on the key challenges facing Africa.

Energy and economic development

In recent years economic growth in Africa has been improving after a long period of slowdown in the 1980s, and this has had some impact on the energy sector, especially in the use of petroleum fuels. Several factors affect the growth, including the fact that about 70% of the petroleum produced is exported to North America and Europe, while many African countries are constrained because they cannot afford petroleum imports, or cannot refine fuels. The uneven distribution of its petroleum resources and the lack of a regional framework for trade (such as has benefited many regions, like Europe) prevents African countries from realising the benefits of self-sufficiency. The production of electricity has shown some growth but in some parts has been limited by the drought in the mid 1990s and a lack of capital inhibiting new energy investments.

The use of modern fuels has been growing faster than GDP in Africa for the past 19 years, as Figure 2.1 shows. Between 1980 and 1999, electricity increased by 2.3 times, and consumption of modern energy by 1.8 times, while GDP increased only by 1.6 times. However, rising annual population growth rates, which increased 1.7 times in the same period, and the low starting base of energy consumption have minimised any impact of the growth in modern fuels consumption which led to a per capita energy use growth of 10% for nearly two decades. There has been a slight increase of Africa's share of global commercial energy consumption, from 2% in 1970 to 3% in 1997 –representing a rise from 2.7% to 3.8% for coal, from 2.7 to 3.4% for oil, and from 0.1% to 2.4% for natural gas (USDOE 2000).

Modern energy use per of unit GDP (energy intensity) is higher than the world's average. In 1997, Africa's energy intensity was twice the world's average of 0.014 GJ/US$ (using 1997 dollars), and in fact increased by 71% between 1970 and 1997 while the world's average declined by 28% (USDOE, 2000). However, it is expected that the intensity will reduce as industrial

demand increases and more activities are captured by the formal sector; this indicator cannot be used to describe the region's energy-intensity because of the dominant use of biomass, and furthermore, the large number of informal production activities that use biomass are usually not captured by GDP calculations.

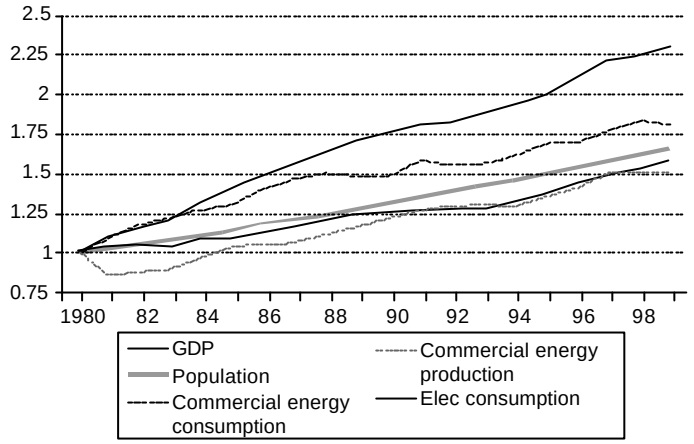

Figure 2.1: Growth in energy and development indicators, 1980-1999
Source: IEA (2001a); FAO (1999)

Africa is a major exporter of energy (mainly fossil fuels) and its share of exports to production is growing. However, the major exporting countries of these fossil fuels are yet to reap the full benefit of such transactions, as export earnings of crude materials including energy on the average is declining, reflecting Africa's worsening terms of trade. Africa has been a net exporter of its fossil fuels for some time now, with over 60% of all commercial energy produced leaving the continent, while well over half African countries import petroleum and have been forced to devote ever larger portions of their funds to oil purchases. Every region is a net exporter of commercial energy except the East, while the North 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. The region as a whole used significant share of its export earnings for oil imports and this share keeps increasing. The increase is more dramatic for certain countries, which in 1992 spent about 30-60% of their export earnings to purchase 30% less oil than they imported in 1972 (Davidson 1992). The share of expenditure is likely to have increased in 2001-2002 due to unexpected oil price hikes.

The debt burden of Africa is not as large as that of other developing regions,

but servicing it is difficult, and this has a serious impact on the energy sector. Significant amounts of debt were incurred for development and maintenance of the power sector, and repayment of energy loans remains a key challenge, as energy services are paid for in unstable local currencies while the loans have to be repaid in financially stronger foreign currencies. Energy assets have been continuously neglected, leading to poor performance and unreliability, and so to vital economic sectors being denied their energy requirements. One strategic coping measure is the use of private electricity generators, powered by diesel, by those who can afford them. The impacts have been on the overall costs of providing energy; on the environment; and on the foreign exchange burden for oil-importing countries (Davidson 1992).

Higher prices for energy services as a result of the devaluation of local currencies have seriously affected the prices of other goods, and declining personal incomes further aggravate the situation. The energy share of disposable income continues to rise as real income declines – in some countries by as much as 20%. For poor households, firewood and charcoal accounts for about a quarter of these energy expenditures. Current signs indicate that this percentage is growing, and in some countries higher energy prices have led to curtailment of other household activities.

Energy resources of Africa

Africa is endowed with vast quantities of both fossil and renewable energy resources. At the end of 2000, its shares of technically and economic proven reserves of coal, oil and gas were 5.7%, 7.1% and 7.4% respectively, and if exploited at current rates they will last long, as Figure 2.2 shows, and for longer than the world average for coal and gas, though below that for oil. Furthermore, it is one of the few areas in the world with substantial new finds of oil and gas – in new countries as well as those with presently exploited deposits. In the past 20 years, oil reserves grew by over 25%, while those of gas grew by over 100%. Exploiting these huge fossil fuel reserves in a sustainable manner for the benefit of more Africans is crucial to the future development of the continent.

As noted before, however, these significant resources are not evenly distributed. Oil and gas are concentrated in Northern and Western Africa – mainly in a few countries: Algeria, Libya and Nigeria, as Table 2.1 shows. Elsewhere Angola, Equatorial Guinea, Gabon and Congo have significant oil and gas reserves, and, some countries are reporting smaller but significant oil and gas reserves, including Sudan, Cameroon, and Tunisia for both oil and gas, and Mozambique, Namibia and Tanzania for gas reserves only. Coal reserves are dominant in the south, with over 95% in South Africa. Because of this skewed distribution, over 70% of African countries import oil and gas – much of their scarce foreign exchange earnings going on oil imports being a major drain on

their economies. In Tanzania, for example, oil imports constitute only 7% of the total energy consumed, but accounts for over 60% of the country's total export earnings. 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.

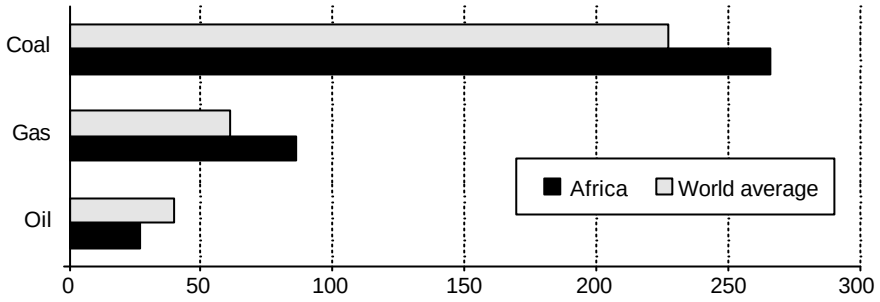

Figure2.2: African fossil fuel reserves to production ratio
Source: BP (2001)

Table 2.1: Regional fossil fuel reserves (January 1999)
Source: USDOE (2000)

Region	***Petroleum*** *(1000 bbl/d)*	***Natural gas*** *(bcf)*	***Coal*** *(billion ST)*
North	1 151	1 534	6.11
West	471	221	0.263
Central	83	4	0.261
East	149	0	0.12
South	588	85	176.97
All Africa	2 442	1 844	183.7

Geothermal energy deposits are limited to Eastern Africa along the Rift valley and concentrated in Kenya and Ethiopia. And Africa has over 17% of the world's known low-cost uranium, mostly in Namibia and South Africa, with 7% and 9% of the global resources respectively.

As for renewables, Africa has over 10% of the world hydro resources and significant other renewable energy resources. Two large areas 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, lying between the zones, has nearly 60% of African hydro resources, with an estimated capacity of 1 100 TWh, of which 46% is technically

exploitable, and 27% economically exploitable. West Africa, mainly Ghana, has almost 34% (Davidson & Sokona 2001).

Natural forests in Africa are significant, with forest area cover now estimated at about 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 tons *(ref) – more than sufficient to cover current use. This aggregation does, however, conceal major differences in distribution and production between and within sub-regions. For example, the North is mostly desert and Central Africa has the major share of forest cover; in Southern Africa, the forest cover of Malawi is only 0.38% as against 53% for Swaziland (FAO, 1999). Although biomass is a renewable resource, its pattern of use can easily lead to major shortages as was witnessed in the crisis in the Sahel in the 1980s. Though similar crises were predicted for other areas, nothing of that scale has yet occurred. Vast areas that were once highly productive in biomass have now been completely depleted, however – although this could be from factors other than firewood production. Data on biomass loss should, anyway, be treated with caution: in many countries the reported data on deforestation, for example, have been later found inaccurate, as in recent studies on Mali, Burkina Fasso and Kenya, which tend to invalidate the trends forecast in the 1980s of a major shortage of biomass supply, and even suggest that the number of trees might have actually increased (Sokona, 1999).

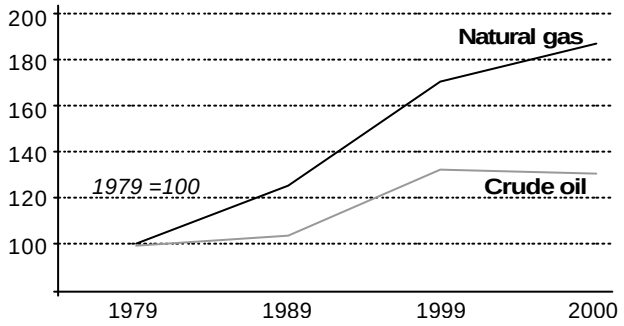

Figure 2.3: Growth of oil and gas reserves in Africa, 1979-2000

Africa being mainly within the tropics, most of it has long hours of sunshine, with significant radiation that can be exploited. Wind resources are available in selected sites, mostly on the coastlines in the North, West and South.

To generalise from the above description, it can be seen that Africa is in a good position to exploits fossil energy reserves using well-developed technologies and associated services in a sustainable manner for the benefit of its peo-

ple, as well as exploiting feasible renewable energy technologies.

Energy production and use

Energy production

Consumption of modern energy by African countries has been growing on an average of 2.7% annually between 1980 and 1997, although it grew faster between 1990 and 1997 by 3.1%. Crude oil dominates modern energy production, though its share has declined: in 1970 it had 86%, with coal, gas and hydro having 11%, 2% and 0.5% respectively; but in 1997, oil had declined to 63%, while coal increased to 19% and natural gas to 15%, hydro staying the same (USDOE 2000). However, higher growth rates are required for the continent to compete with other world's regions, though it should be noted that 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.

Table 2.2: Regional modern fuels production and consumption, 1997
Source: Adapted from USDOE (2000)

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
South	7.42	5.22	2.21
All Africa	27.93	12.02	15.91

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 2.2). 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, which also accounts for their relatively low share.

Electricity production and use

Electricity generating capacity in Africa with respect to the population is low; in 1997 it was only 94GW, only 3% of the global total. Thermal sources form 76% of the continent's total. As shown in Table 2.3, generating capacity varies across regions, 88% from thermal resources in Northern Africa and 81% in Southern Africa, while hydro, accounting for 22% of total electricity production, is sig-

nificant in Eastern and Western Africa. Also, energy resource use for electricity production varies, while oil and gas dominates production in the Northern Africa, coal dominates in Southern Africa, and hydro mostly in Central and Eastern Africa. Hydro is very important and responsible for over 80% in certain countries, such as Cameroon, Zambia, Democratic Republic of Congo, and Ghana. Nuclear accounts for only 2%, and is only in South Africa. Geothermal accounts for only 0.1% of total installed power; Kenya has a plant of 45 MW and an almost-completed one of 64 MW, with another of 100 MW ready in the next few years.

Table 2.3: Electricity generation in Africa, 1997
Source: USDOE (2000)

		Percentage share (%)			
Region	***Capacity (GW)***	***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
South	43.83	81.2	14.6	4.2	0
All	93.5	75.8	22.2	2.0	0.1

The use of electricity is heavily skewed, reflecting levels of industrial activity and incomes, as well as infrastructure in the power sector. As a result access to power vary significantly, as shown in Table 2.4, which gives estimates of access to electricity for most African countries. Northern Africa stands significantly apart, with an average of 85.5% access (this figure rising to 95.5% if Morocco is excluded). The rest of Africa averages only 14.4%. Various countries, including South Africa, Ghana, Uganda and Zambia are net exporters of electricity, even though the access figures given are under 30%. Electrification in Africa is extremely low, with correspondingly low per capita consumption. The Northern and Southern regions combined use up to 82% of the total. Eskom, the electricity utility in South Africa is the world's fifth largest. Countries with relatively higher electricity consumption outside these regions are Kenya and Nigeria.

The performance of the power sector in general has been poor, which can be attributed to a variety of factors, such as lack of institutional structures, and inefficiencies and other weaknesses in the sector. Most African governments operate struggling economies that are overwhelmed with competing developmental needs, so that the power sector has not always attracted the attention it requires. Another factor responsible for poor performance is the dearth of skilled professionals, in utilities and in government institutions, to undertake the nec-

essary technical requirements and to formulate and monitor policies that will improve the sector's performance. Some governments have now established regulatory bodies, which may be a separate entity as in South Africa, or part of an existing ministry as in many other countries. These bodies are expected to control prices and monitor the performance of power utilities, especially those involving the private sector. As the power sector in most countries, with the exception of Egypt, Nigeria, South Africa, is very small, the role of regulation may need investigation, to ensure that it effectively contributes to the overall performance of the sector.

Table 2.4. Household access to electricity for African countries, 2000
Source: O'Sullivan and Hamaide (2002)

R***egion***	***Country***	***Est. population (m)***	***% Access***
Central Africa	Cameroon	14.9	31.0
	Central African Republic	3.6	5.0
	Chad	7.7	3.0
	Democratic Republic of Congo	51.1	5.0
	Congo	2.9	5.0
	Gabon	1.2	5.0
Average			9.0
East Africa	Burundi	6.8	5.0
	Eritrea	4.1	5.0
	Ethiopia	63.9	12.0
	Kenya	30.3	11.7
	Rwanda	8.5	5.0
	Sudan	29.6	5.0
	Tanzania	33.4	8.9
	Uganda	21.9	27.4
Average			10.0
West Africa	Benin	6.2	22.0
	Burkina Faso	11.2	6.0
	Côte d'Ivoire	15.0	38.5
	The Gambia	1.6	5.0
	Ghana	19.3	35.0
	Guinea	7.4	5.0
	Guinea-Bissau	1.2	5.0
	Mali	11.2	7.6
	Mauritania	2.6	50.0
	Niger	10.8	7.9
	Nigeria	126.9	20.0
	Senegal	9.5	32.2

	Sierra Leone	5.0	5.0
	Togo	4.6	12.0
Average			17.9
Southern Africa	Angola	12.7	5.0
	Botswana	6.2	22.0
	Lesotho	2.1	5.9
	Madagascar	15.4	11.1
	Malawi	11.0	5.0
	Mauritius	1.2	50.0
	Mozambique	17.6	5.8
	Namibia	1.7	20.2
	South Africa	42.3	66.0
	Swaziland	1.0	20.0
	Zambia	10.0	18.0
	Zimbabwe	11.9	20.0
Average			20.75
North Africa	Algeria	30.9	96.0
	Egypt	63.2	96.0
	Libya	5.5	95.0
	Morocco	28.6	46.9
	Tunisia	9.6	95.0
Average			85.8

Another issue in the power sector that deserves comment is the cost of electricity production and the high transmission and distribution losses in many utilities. The cost of grid-supplied electricity in urban areas ranges from 2-3c/kWh (off-peak) to 15-25c/kWh (peak) (World Energy Report 2000). The tariffs computed from these production costs are quite often kept to a minimum to protect the poorer segment of society and increase overall access to high quality energy. Despite consumer tariffs not necessarily being cost-reflective, they are still relatively high for the poor, who also tend to find the cost of associated appliances prohibitive. Thus, poor consumers are rarely able to take advantage of social tariffs. However, if a tariff structure does not reflect this concern, low prices can be mis-used and benefits go to those who can afford to pay more. Revenue collection by utilities is very poor, though, and debt by customers (including government) continues for long periods. Failure by utilities to collect revenue using modern banking methods contributes to this problem. Revenue collection must be improved, to enhance the utility's capacity to re-invest and expand access. Programmes aimed at increasing access to the majority should take these concerns into account.

There is significant cross-border electricity trade in Africa. Ghana, Zambia and South Africa, for example, in 1997 exported 0.3, 1.2 and 6.6 TWh respectively.

Energy use

Of all world regions, sub-Saharan Africa is almost the world's lowest consumer of electricity (WEC 2000). There are large disparities in African energy use, especially modern energy, per capita consumption of which. vary by a factor of more than 10. Enormous disparities also exist between poor urban and rural users and higher-income groups throughout the region. Furthermore, because of economic policies such as 'structural adjustment' which have led to reduced income, reversals in the energy ladder can be observed in several African cities, as people revert to traditional fuels; per capita modern energy consumption has been declining in the last ten years.

Energy consumption patterns reveal the imbalances. Oil still accounts for roughly 60% of commercial final energy consumption, with 53% going to transport, 13% to industry, and 13% to residential sectors (IEA 2001). Industry is responsible for the major share of total modern energy consumption between 1980 to 1996, with Southern Africa dominant, largely because of South Africa. With the exception of South Africa, industry, in fact, largely refers to mining, and the expected multiplier effect on the economy is not as expected. The transport sector consumes a large share of modern energy, despite the relatively low ownership of cars in Africa (about 20 cars per 1000 people, varying from about four in Sierra Leone, to 17 in Côte d'Ivoire and 50 in South Africa), and public transport is responsible for a significant share of the total.

Table 2.5: Trends in sectoral modern energy consumption in Africa (EJ)
Source: USDOE (2000)

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

On average, 54% of Africa's total final energy consumption is consumed in the household (IEA 2001), and in some countries, such as Burundi and Burkina Faso, the share 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. The use of this low quality traditional energy is far from uniform, with a small fraction used in the North and large quantities in West, Central and East Africa. High biomass use raises serious problems because of its low conversion rate, high wastage, and poor quality method of production. Associated health and other environmental problems are also significant. Reliance on traditional biomass varies in different regions of the continent. For example, traditional biomass accounts for 14% in South Africa as compared 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 included this reliance declines to 58%, illustrating the influence in the sub region. In North Africa, biomass (largely agricultural residues) represents about 30% of the total primary energy use in a country like Morocco.

Despite the dominance of biomass fuel, other fuels are used in African households. A number of factors influence the choice of fuel used – household income, availability, task at hand, etc. In general, the higher the income the more likely that the household will choose modern fuels and use multiple fuels, such as electricity, and LPG for cooking. Poor households consume least energy, and consumption rises with income, but multiple fuel use is also common in poorer communities, though this is for reasons of poverty and scarcity rather than choice even in those households that have access to electricity, This correlation is largely manifested in urban areas, although 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 high share of household budget used for energy services in both rural and low-income urban areas. While it is common to spend on average less than 5% of household income for energy services in most regions of the world, African households spend much more – 9.5% of household income in Burundi, and 22.3% in Equatorial Guinea. This 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, which explains the continued dominance of traditional energy in both poor urban and rural households, despite the many efforts that have been made to reduce the demand for fuelwood. Lack of physical access to modern energy may be a major constraint (even if the user can afford it), while it may be accessible to some who cannot afford to it.

It is also notable that Africa's energy intensity in comparison to the rest of the world is high. In 1997, Africa consumed 28MJ/US$, when the world's average was 14 MJ. This intensity increased by 71% between 1970 and 1997 while the world's average declined by 28% (Davidson & Sokona, 2001)

Despite energy consumption being lower, the energy used to produce GDP in Africa is much higher. The high use of inefficient traditional energy that is poorly linked to the economy, and the weak industrial sector, are contributing factors to this. In many developing countries whose energy system has a large amount of energy-intensive activities and products, intensity is higher than in developed economies which may have shifted those industries to developing countries, and have also introduced energy efficiency measures in their energy sectors.

Energy institutions, policy and planning

The development of the energy sector in Africa has followed general world trends, particularly those of Europe, and as a result its energy sector institutions are based on European models, which have concentrated on modern energy sources and largely supply oriented as described in the first chapter. Moreover, institutions and utilities were inherited from colonial governments, initially as units of state departments, and later became separate departments. African countries in which the utility services were developed to advanced stages before independence took over European-style vertically integrated, state-owned and government-controlled utilities, as happened in Kenya, Côte d'Ivoire, Zambia, Nigeria, Zimbabwe, and South Africa, for example. Other countries, which did not inherit any commercial utilities at independence, developed systems in which generation and transmission were separated from distribution, and where, although these were generally state-owned, the structures were purposefully commercial in nature and in some cases have performed as such. An example is Ghana, where the Volta River Authority controls generation and transmission, while the Electricity Company of Ghana and the Northern Electrification Department undertake distribution in different parts of the country. In general, the European model in Africa has not always been successful, often resulting in complex institutions, plagued with bureaucracy, and inefficiency.

Energy policy and planning is relatively recent in Africa, generally dating to the mid 1970s and early 1980s as a result of the oil crises. Most governments were forced to set up ministries of energy, usually as a part of an existing ministry; this 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 a high policy-making medium for 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 research and development and a few disjointed pilot projects. Few countries integrated these into their mainstream energy planning, so the initiatives were not fully evaluated for their contribution to the economy.

Energy policies in African countries have suffered from several features which have contributed to their ineffectiveness. A major weakness is the lack of suitable regional and national energy policy analysis institutions, which has meant that most of energy policies have bee externally conceptualised, often through the use of 'technical assistance' from donor countries. In the relatively few institutions that exist, their agendas are also not in line with government's interests. Another problem is the lack of adequate data for effective policy analysis. Most 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.

Financing the African energy sector has been accompanied with technical assistance and technologies from the donors and financiers. In nearly all countries national energy policies and plans have almost always been developed with donor technical and financial assistance. In fact, providing technical assistance is highlighted as one of the main services offered by bilateral and multilateral agencies. An increasing number of developed countries are establishing trust funds within the World Bank which, while generally intended for poverty eradication programmes, stipulate that a proportion of the funding per project has to be spent on technical assistance and technologies sourced from the benefactor country.

CHAPTER 3

Emerging issues in the energy sector

There are several issues emerging in the energy sector of Africa that will present major challenges to the desire to increase access to modern energy services for most Africans. Among these issues, some require special comment, including: the energy-environment nexus, widening access to rural areas, financing energy investments, regional cooperation and trade and gender implications.

Energy-environment nexus

Energy production and use in African countries has resulted in serious impacts on the environment as in most parts of the world, but Africa has some special features because of its dependence on natural systems for many economic activities. Generally, there has been major imbalance in the natural use of resources. Soil and vegetation in some areas are overexploited, while water, energy, minerals and organic resources are underused, or exported in their crude state. As a result, expanding the use of these resources to satisfy developmental needs, especially energy resources, presents major challenges because optimal use is required while minimising environmental impact. The current high dependence on natural systems makes this task more difficult because of the inter-linkages between development and environment.

Expanding energy provision substantially in Africa, for both survival and developmental needs, will have both direct and indirect linkages to central environmental concerns – land degradation and desertification, protection of forests, water security and management, drought and air pollution. The extensive use of biomass energy can be related to land degradation and forest damage; greater use of fossil fuels increases air pollution; and more severe and frequent droughts have negative impacts on hydro resources.

Africa's use of firewood and charcoal as energy sources (about 67% of primary energy use) is the highest in the world. If current population pressure continues and use patterns do not change, satisfying future demand will pose a major environmental problem because of the contribution to deforestation, which leads to erosion and affects biodiversity. A greater use of firewood and charcoal for cooking can also lead to serious health problems. Biomass for cooking is often used inefficiently and emits a large amount of smoke; if done in poorly ventilated surroundings it can be a significant source of indoor pollution, with dangerous amounts of toxic substances like carbon monoxide, sulphur, and nitrogen oxides. Recent research confirms a cause-effect link between

exposure to smoke and diseases such as chronic bronchitis and emphysema ref). The poorest populations are most exposed to these risks, although less so where cooking is done outside and the smoke is immediately dispersed.

Greater use of fossil fuels can also pose environmental challenges, both in increasing air and water pollution and increased greenhouse gas emissions, if mitigation measures are not taken. Air pollution (lead, particulate and sulphur emissions) will rise from increased oil consumption, especially in the transport sector (IEA, 1993). Petroleum extraction, processing and transport has serious attendant environmental problems, especially the danger of oil spills, when there is a lack of capacity to control the companies undertaking these activities. Offshore oil spills are also a danger. Flaring of gas also contributes to greenhouse gas emissions.

With few exceptions (such as South Africa), most African countries are net sinks of greenhouse gas emissions and the continent's share of global emissions is under 3% – but this share could grow significantly, depending on how energy is produced and used (ref). Furthermore, given predictions of the likely severity of the impacts of climate change in Africa, it is important to minimise the environmental effects of energy sector activities, as these can only worsen environmental fragility.

Repeated droughts, especially in the Western and Southern regions, not only have implications for food shortage, but also cause serious water shortages for dams generating hydropower. As a result of the 1997 drought in West Africa, for example, the Akosombo dam, the main supplier of power in Ghana and also a source of power to neighbouring countries, lost two thirds of its capacity, which led to major disruptions in Ghana's industrial and domestic sectors. Recurrent droughts have also resulted in high load-shedding at great costs, as in Kenya and Uganda in 2000 (World Bank 2001). Between 1994 and 2000 Tanzania suffered three major electricity shortages due to drought and sub-optimal operations of the hydro/thermal system (World Bank 2000).

Widening rural access

A major challenge is to overcome the lack of access by the vast majority of both urban and, especially, rural Africans to modern energy services. This lack is a major obstacle to tackling poverty and sustainable development issues. Improved access would improve the standard of living and also boost overall industrial and agricultural development. The discussion here will focus on the rural situation, because of the intensity of the energy problem there, although it must be noted that urbanisation is projected to increase and access issues in urban areas should not be underestimated.

Supplying modern energy services that are economically efficient, environmentally sound and socially equitable to rural areas is a major challenge

because 60-70% of the population there are unable to mobilise the financial resources needed for such services, and prospects for future development of existing energy systems are gloomy unless major changes are made (Sokona, 2000).

Despite local and regional specificities, rural Africa shares common energy parameters, including a heavy dependence on biomass, limited use of modern forms of energy, and low per capita energy consumption. Energy demand is scattered, reflecting the relatively small size of African villages. Poverty, lack of skilled labour, and socio-economic deficiencies and environmental instabilities are key constraints that limit any prospect of improvements in the short and medium terms in rural areas. Most rural Africans are peasant farmers or pastoralists, with low productivity levels. With a shrinking natural resource base, a decline in soil productivity and commensurate reduction in agricultural output, villagers across Africa have consistently migrated to urban areas, resulting in urban sprawl and related problems.

Modern energy forms, mostly kerosene and occasionally electricity, are used mainly for lighting. Production activities, notably agriculture, rely primarily on human and animal power. Electricity grid extension to rural areas is often difficult, because of the required major investments and the unprofitability of serving the poor. Rural access to electricity is low, with grid connections to rural households not exceeding 25%. These characteristics of rural Africa require innovative solutions. Although income is also low in rural Asia, for example, population density is higher there, and the marginal cost of installing electricity networks lower. In the developing countries in Asia, per capita incomes grew at an average rate of 4.4% between 1970 and 1990 compared with a rate close to zero in Africa for the same period (ADB 1994).

It is widely accepted that poor Africans spend more on a unit of energy than their rich counterparts, and this is often used as a basis for justifying cost-reflective tariffs for modern energy carriers to rural communities. It is important to note, however, that these Africans generally rely on diverse sources of energy that are purchased in fragments depending on the availability of money and are used for specific activities: one fuel for cooking, another for lighting (and little for productive activities). As a result, the real costs of these energy sources are often high relative to if they were purchased on a larger scale. Surveys have shown that for the same energy service rural people pay more; for example, a kerosene lamp is 35 to 40 times less efficient than fluorescent lamp, and for cooking there is a big difference between the efficiency of gas stoves and firewood stoves (Sokona, 2000).

Energy practices in rural Africa can perhaps be illustrated in two points:

- types of energy that are accessible to everyone (e.g. biomass) lead to environmental degradation and cause other serious related developmental diffi-

culties;

- in the modern energy sector (electricity, coal, gas, etc), market mechanisms principally determine what quantities and type of fuels are used.

There are barriers that militate against the widespread increase of access to modern energy in rural Africa. These include the following:

(i) Low-income households are unable to fund the high connection costs of grid electricity (US$50 for the simplest single-phase connection), nor can they afford much expensive electricity or electric appliances and fittings. Given low densities and low demand, rural areas cannot be grid-connected without substantial subsidies.

(ii) Where no network exists, installing alternatives is also costly.

(iii) Sustainable improvement in energy services requires investing in technology, and also in developing major ancillary services, such as mechanisms for handling the relationship between suppliers and customers - from billing and payments to responding to customer complaints. Traditional mechanisms for handling these are ill-suited. because they are largely informal.

(iv) It is difficult to improve a household's ability to afford new connections and associated services through credit financing, due to the non-cash-operating economy and lack of traditional forms of collateral. There are also limited opportunities to use the energy for income-generation.

Attempts have been made to address these barriers, mostly through initiatives originating beyond the continent, but they have largely failed or made only marginal gains, mainly because of the misleading perception that Africa's rural energy problems are so serious and need immediate or urgent solutions, hence long term issues are ignored as well as proper reasoning. In addition, there was little or no local ownership of these initiatives, and a weak implementation capacity.

Financing energy investments

As a result of the weak economies in most African countries, significant investments in the energy sector have been financed from foreign sources, so that the investing donors and multilateral institutions have greatly influenced activities in the sector. This influence can to a significant extent be summarised as the call for reforms of the sector and private sector intervention. The call started in the petroleum sector, largely a private sector operation where governmental role is generally reduced to the area of pricing. Apparent success in the transport sector led to suggestions for calling for private intervention in the electricity sector. To facilitate this suggestion, institutions such as the World Bank provided targeted loans and set up special programmes to increase private sector participa-

tion, which was seen as central to electricity reform. It must be noted that the response from recipient countries has been mixed; a statement from the Uganda World Bank representative, for example, advocated slowing down the privatisation pace, since the sale of the remaining 38 state firms (electricity distribution and generation included) could have a negative impact on the economy.

Investment in the energy sector has been significant, however, although it is difficult to establish the exact amounts of loans and other resource inflows. In general, commercial banks and energy institutions have invested significantly in the energy sector, but mainly in the upstream oil and gas sectors. That investment has been skewed as was shown in 1995 when out of the total US$318 million invested in Africa, US$141 million was on only two projects in Congo and Côte d'Ivoire (IFC 1995). Foreign direct investment to Africa has been modest compared with that to other developing regions, at less than 2% of the developing countries' total, but it has an impact on the sector. It increased from an annual average of $1.9 billion between 1983 and 1987 to $3.1 billion between 1988 and 1992, and to $6 billion in 1993-1997 (UNCTAD, 1999), but has been falling since then. Some official development assistance (ODA) has been directed to the energy sector. The Development Assistance Cooperation (DAC) countries spent on average 3.4% per annum between 1990 and 2000 on energy. (DAC database 2002). But Africa has been suffering from a decrease in foreign aid, including energy investments: in real terms aid has been falling, with net transfers per capita dropping from US$32 in 1990 to US$19 in 1998 (World Bank 2000).

The main financiers are, as mentioned before, external: the World Bank and its member institutions, ESMAP, African Development Bank, and bilateral ODA sources. Financing from local sources has been limited and hence has minimal influence in directing the development of the sector. The foreign private sector is diversifying its focus from large-scale oil and gas exploitation to include the electricity sector. It is notable that the foreign private sector has operated in the African energy sector before and after independence, particularly in the petroleum sector. While the large investments in this sector have been in the exploration and exploitation, the proliferation and dominance of foreign-'owned' retail outlets illustrate their control.

The overall goal of the work of the World Bank is poverty reduction and they have a Special Programme for Assistance to Africa, which mobilises targeted funding for countries in particular need. The Bank's strategy on energy has been market-based efforts to improve access to cleaner energy, energy tax reform to promote fiscal stability and cleaner fuels, good governance and private sector development. Globally, by the end of 2001, electric power and other energy, oil and gas, and mining, only received 14% of the total US$105 billion invested. (World Bank, 2001). While the total share to energy may be small, the depend-

ency level was high. In most cases, the Bank loan accounts for more than half of the total project cost and in others 100%.

The Energy Sector Management Assistance Programme (ESMAP) was established in 1983 under joint sponsorship of the World Bank and UNDP as a global technical assistance programme. And has been fairly instrumental in shaping the African energy sector. ESMAP mainly undertakes targeted technical studies aimed at informing policy makers and the World Bank on energy decision-making. It focus mainly on three areas: market-oriented energy sector reform and restructuring, access to efficient and affordable energy, and environmentally sustainable energy production, transportation, distribution and use. The Programme has undertaken numerous strategic studies on household energy, rural electrification and, more recently, on power sector reforms and renewable energy. Recommendations from these studies are sometimes the basis for funding or World Banks loans to the energy sector, as was the case in the RPTES project that started in West Africa and has expanded to Zimbabwe.

The African Development Bank (ADB) is a multinational development bank supported by 77 nations from Africa, North and South America, Europe and Asia, and established in 1964 to promote economic and social development through loans, equity investments, and technical assistance, on both concessional and non-concessional terms to African countries. From 1967 to the end of 2000 ADB had approved a total 2416 loans and grants amounting to US$36.62 billion. The top seven countries in terms of the total amounts received between 1967 and 2000 are Morocco, Tunisia, Nigeria, Algeria, Egypt, and Côte d'Ivoire (ADB 2001) The power supply sector, which includes projects on production and distribution of electricity, gas, solar, coal, petroleum, and other usable energy sources, received around 9% of the total amount from 1967 to 2001 as can be seen from Table 3.1.

Table 3.1: Cumulative lending by African Development Bank, 1967-2001
Source: ADB (2001)

Region	% Power supply share
Northern Africa	14.9
Western Africa	5.4
Central Africa	5.5
Eastern Africa	8.0
Southern Africa	7.3

Regional cooperation 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, and

its successor the African Union, but trade among African countries is low at about 6% of total trade – lower than in other developing regions such as Asia, where the figure is 40%. The low manufacturing base, poor communication facilities and limited commodities for trading are some of the factors responsible (Davidson & Sokona, 2001).

Alhough energy trading is progressing between countries in respect of oil, hydropower and natural gas, it needs to continue with greater intensity, as most countries in the continent are too small cannot to develop markets that are economically viable. Also, most countries in the region find it difficult to cope with the requirements to conduct transactions with the world's major economic blocs. Thirty-nine African countries are now members of the World Trade Organisation, and five are observers. Several African trading blocs have also emerged within the continent in recent times, including:

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

There are some overlap between COMESA and SADC with eight states being members of both, and between ECOWAS and UEMOA, also with 8 countries in common.

A major challenge to regional cooperation and trade is lack of 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. Another challenge is a fear for loss of sovereignty which can tend to prevent trade among countries.

CHAPTER 4

Lessons learnt from recent initiatives

Since the intensification of energy activities in African countries in the 1970s, several energy initiatives have been undertaken and many more are ongoing. These activities range from research and development projects to development projects only and major investments projects. A close look at these projects can provide insights to re-orient them as well as develop new projects and programmes, especially in relation to increased energy access for the majority – an issue that has so far received little attention by many energy initiatives. This chapter attempts to identify factors that have contributed to poor performance of initiatives with respect to widespread provision of modern energy services, and to isolate lessons from past initiatives that would lead to substantial increased access of modern energy services in Africa.

As was explained in earlier chapters, the low economic and technological base of most countries in the continent has resulted in the dominance of the multilateral and donor agencies in the energy sector from project conceptualisation to implementation and, in some cases, monitoring. The discussions in this chapter will therefore look at the performance of these institutions with a view to mapping out strategies for effective use of external contributions to the energy sector.

The areas of energy interventions are many, including policy, planning and institutions, both fossil and renewable energy institutions, and issues connected to the energy sector – water, climate change, food security, etc. Most of these areas fall outside the scope of the book, which concentrates on direct energy issues. Further, due to the scope of direct energy initiatives, the ensuing discussions will be limited to the following:

- energy institutions and reforms;
- energy transition in cooking;
- oil and gas development;
- renewable energy technologies;
- modern biomass technologies
- regional cooperation and trade.

Energy institutions and reforms

The belief that African energy institutions, especially power utilities, are performing badly and are inefficient and corrupt has been used widely by donor

and multilateral institutions to legitimise the call for privatisation, sector reform or de-regulation in the energy sector in almost all African countries (including the Gambia, whose total electricity generation capacity is 30MW and whose population is barely one million). Interestingly, case studies used to support this claim have always been outside the continent. Also, the conditions under which African state-owned utilities perform badly are hardly mentioned (Ofusu 2001). Clearly macro-economic factors beyond the control of the energy sector have played a significant role in the performance of the sector. The incoming private sector is provided with terms that are extremely favourable and make the local utility uncompetitive (See Box 4.3). Further, the objectives of these supposed solutions to the energy sector were largely oriented around efficiency, cost-effectiveness, and managerial performance. These factors are important, but the crucial one for African energy economies is increased access to modern energy services by the majority. This factor has been completely ignored so far in the prescriptions provided by the financiers – especially coping with increased access under private ownership. Notably, as illustrated in Boxes 4.1-4.2, African utilities have not always been poor performers, a fact that calls proposed reforms into question. Africa's energy sector is unique and complex, and it is difficult to replicate experiences labelled as 'best practice' from elsewhere. The majority of African energy markets are too small to attract competition and thereby lead to lower prices and enhanced efficiency. To illustrate this: the capacity of the United Kingdom is 77 000MW and its electrification level is about 100%. Africa, on the other hand, has a total capacity which is less than 80% that of the UK (Ofusu 2001). With small electricity markets and perception of 'high risk', most investors are mainly looking for sovereign guarantees to buy out risks and for quick returns – which results in higher service delivery cost to poor Africans.

There are many factors that characterise the African energy economy, but four important features that militate against suggested reforms are:

- lack of a clear-cut policy framework;
- inappropriate legal framework and ambiguous regulations influenced by political and donor interventions;
- lack of well-trained and motivated personnel for effective management;
- inadequate equipment and processes to monitor and manage market systems.

These inadequacies call for a moderate pace of change and a reform that builds on existing frameworks. The need for 'home-grown' solutions is crucial. The recent Californian power crisis clearly demonstrates some problems of liberalisation and the complexities of privatisation in energy markets and their vulnerability to manipulation. In general, energy sector restructuring and privatisation

require institutional structures and monitoring mechanisms that are presently absent in most African countries.

Below are three case studies which illustrate performance of African utilities. The first illustrates an energy planning and policy analysis facility which performed well which others can learn from. The second shows a utility that performs as well as other utilities in the world in terms of institutional efficiency and performance. The third shows how the incoming private sector provider are given favourable conditions at the expense of the local utility. Also a fourth case study is shown to illustrate the successful commercialisation of a public company using local initiatives.

Box 4.1: National Energy Board, Ghana

The National Energy Board (NEB) was set up in 1985 to advise the Ministry of Fuel and Power and the Government of Ghana on overall national energy policy planning, by covering policy formulation, assessment of natural resources, monitoring of energy public sector bodies, and collecting and organising data for decision-making. The Government appoints a 15-member Board as well as an Executive Director that leads a Secretariat of NEB. In addition, a Technical Committee advised the Board on all technical matters including financial management. However, NEB was given only an advocacy role in regulating and on energy pricing.

NEB had seven programmes based on Government's energy priority objectives and programmes. These included the following:

- *Electricity programme – rehabilitating dilapidated electricity supply infrastructure and extension to all areas not electrified.*
- *Efficiency and conservation programme – to create awareness of opportunities and benefits of energy conservation and savings while developing local capacity.*
- *Petroleum planning and monitoring programme – rehabilitating petroleum production infrastructure, ensuring fair distribution of products and reducing the oil import burden by looking at indigenous resources.*
- *Renewable energy development programme – ensuring the efficient production and use of renewable energy, including wood fuels, and demonstrating promising renewable energy technologies.*
- *Policy and information analysis programme – ensuring consistency in programmes and policy and examining impacts of policy in vulnerable groups.*

In addition, there were two directorates, for Project Management Monitoring and Evaluation, and for Finance and Administration. The government instituted a special 'Energy Fund' made up of levies on petroleum products and electricity, together with external donations and grants to support activities of NEB's

operating budget and work programmes.

Unfortunately, in 1991 the NEB was dissolved, under unexplained circumstances, and the Ministry of Energy, as its Technical Wing, absorbed its staff and programmes. However, NEB operated on a budget of about US$1million and should be credited with the first energy policy framework for Ghana and the establishment of institutional, human resource capacity and financial structures and programmes that have provided the basis for Ghana's energy sector.

Box 4.2: The Volta River Authority in Ghana

The Volta River Development Act established the Volta River Authority (VRA), 1961, as a corporate body. Its primary functions include hydropower generation, construction and operation of transmission system and development of Volta Lake. VRA has a government-appointed six-member Board and Chief Executive. The composition of the Board ensures competence, reputation and integrity and has membership that include major power consumers. The Authority's first hydro-electric plant at Akosombo was completed in 1965, with a total installed capacity of 1072MW. A second hydro-electric plant, at Kpong, completed in 1981, added 160MW to the installed capacity, while a rehabilitated diesel generating station at Tema, with an installed capacity of 30MW, was commissioned in 1992.

In 1995, the VRA started a new 330MW combined cycle thermal plant and in 1989 entered into a joint venture with CMS Generation of Michigan, USA and added another 220MW to the Takoradi plant, increasing its capacity to 550MW. The VRA is a well-maintained and efficient utility, and total losses in VRA transmission system are less than 3.5%, which is comparable with utilities in the developed countries. The unit availability factor at the Akosombo power station is about 98%, the highest in Africa. VRA provides technical advice to other utilities in Africa. such as the design of the expansion of the Owen Falls Dam in Uganda. VRA has not been allowed to have an internal rate of return of 8%, but when it entered into a joint venture with CMS Generation, the latter was granted a rate of return of 19.5%, at a time when the VRA was granted only 4%. If VRA had been granted the same high rates of return, the Authority could have raised revenue to undergo the investments needed for Takoradi and there would have been no need for foreign investments (Ofusu 2001).

Box 4.3: The Songo-Songo gas-to-electricity project, Tanzania

The Songo-Songo gas to electricity project involves the development of the Songo Island gas fields in South-Eastern Tanzania and construction of a gas pipeline to the Ubango power plant in the mainland for a gas-operated 111MW plant and the supply of gas to the Wazo Hill cement plant. The US$325 million funded project involves US$79 million equity and US$249million from

Government of Tanzania, financed by the World Bank, European Investment bank, and the Swedish International Development Agency. The state-owned electricity supply authority (Tanesco) has only 1% equity in the project. The current agreement is such that Tanesco will purchase all the electricity produced from this plant at US$0.12 per kWh under a power purchase agreement, and then retail it to its customers at about US$0.075 per kWh. Songas, the consortium undertaking the project is led by AES Corporation of Arlington, USA, which has US$50 million in equity, negotiated the tariff with the government. This case demonstrates that foreign investors obtain huge rates of return under complex power purchase agreements, which sometimes are drawn with loan and assistance by the World Bank at the expense of the poor consumer (Ofusu 2001).

Box 4.4: Commercialisation of a state-owned petroleum company: Mossgas, South Africa

Mossgas is a state-owned company that manufactures liquid fuels and chemicals from natural gas and condensate as a subsidiary of the Central Energy Fund (Pty) Ltd, which is the holding company for the South African state petroleum sector assets. After the democratic election in 1994, the government decided to commercialise Mossgas as part of its objective of transforming state-owned petroleum companies into profitable ventures (as clearly stated in the White Paper of 1998). The previous government had embarked on heavy investments in upstream petroleum exploration and established Mossgas, the largest gas-to-liquids plant in the world, as a way of reducing reliance on imports. Since its establishment, the plant had failed to generate revenue to cover capital and operating costs, and was subsidised by government.

The change in Mossgas was done within the broad economic and political environment of the Reconstruction, and the Development Programme; and the Growth, Employment and Redistribution strategy. Since commercialisation, Mossgas has made positive contributions to the national economy, requiring no more additional state financing for investment since 1994. The company is now sustainable in the medium term, with gas supplies until 2008, and has been declaring dividends for the past two years; in 2001 it contributed to the country's balance of payment and local human resource development. Mossgas has already expanded to value-added chemical products and environmentally friendly distillates for export. Also, through Mossgas, the gas-to-liquid technology is becoming viable in the continent in countries with natural gas, such as Algeria, Angola, and Nigeria. The general lesson from this project is that state-owned companies can be turned from liabilities to assets.

Lessons learnt:

The discussion above and the case studies provide some useful lessons which are summarised below:

- The energy sector continues to be evaluated in a de-linked manner from the economy, and only recognised in times of energy crisis; it is hardly ever factored into the overall long-term decision making process and, in the prevailing environment, energy reform.
- The ailments of government-owned power utilities cannot be entirely attributed to poor management. Macro-economic factors and other poorly understood institutional factors have been instrumental.
- Models of power sector reform advanced so far have been mainly oriented to increased efficiency, creation of competitive power markets and participation of the private sector. This agenda has failed to recognise the experiences of well-run African power utilities, or to increase access for the majority of the population at affordable prices.
- Preliminary results from both internally and externally driven power sector reform programmes have been mixed. While some positive lessons in terms of improved quality of service can be drawn from the case of Côte d'Ivoire, with access beyond 60% before the reform, Senegal's second reform process seems to be paralysed after the abortion of the first one 20 months into the process with hardly any improvements. These results warn against replication of experiences and confirm the need to take heed of national circumstances. Countries with small power supply systems, a weak institutional framework and insufficient infrastructure, along with low managerial capability, require special attention.
- Private sector intervention in the power sector requires improved control, efficient market structures and monitoring and evaluating mechanisms – as shown in the recent crises of ENRON and VIVENDI, which are among the major private participants in the African power sector shows. This is true for the newly formed independent power producers (IPPs).
- Reform leading to private sector participation in the power sector does not necessarily translate into cheaper electricity, especially where little or no subsidies are available and the market is monopolistic. Ideally, the more competition there is in the sector by IPPs or other forms of suppliers, the greater the possibility of lowering tariffs to attract consumers, but the small market sizes render competition impossible.
- Efficiently run state-owned monopolies are preferable when affordability is the primary consideration. Governments can use tariffs to address access issues by differentiated tariffs and diversified fuel options. Lifeline tariffs can be useful, provided transmission and distribution losses are reduced in order

to lower the cost of supply.

- Energy sector reform as practised presently and privatisation do not increase access; they could improve supply reliability but in the imperfect and small and uncompetitive African power market, these programmes only lead to market manipulation, speculation and eventual price hikes.
- Given the right political climate and the financial incentives being demanded by and given to foreign investors, African institutions could achieve equal levels of effectiveness.
- African governments should support indigenous investors to avoid the emerging situation in which energy security are exclusively in the hands of a foreign private sector. In Cameroon, for example, AES, a private US Company owns 56% of Societé National d'Electricité, the national utility, but has exclusive management responsibilities for generation, transmission and distribution assets for the next 20 years.

Energy transition for cooking

In Africa, as in many parts of the world, domestic cooking is particularly significant. The provision of modern energy for cooking is, however, a major problem – especially in rural areas where there is little in the way of energy support structures. The main reason is that few innovative interventions have been advanced in the household sector for cooking. In general, African household fuel options for both urban and rural areas have remained predominantly the same for many years now. Rural households use mostly wood, cow dung and crop residues in open-hearth or three-stone stoves, while urban dwellers have a wider choice of options, ranging from firewood and charcoal to kerosene, LPG and sometimes electricity (ref). Choice everywhere is influenced by availability, cost, energy efficiency, cleanliness and convenience. The irony of the situation is that poor households spend more on energy as a proportion of their income, for lower quality fuels, than do middle-class households, as shown in Tables 4.1 and 4.2 below. There has been a limited degree of switching from traditional sources to modern energy carriers, but not enough to make the overall impact significant.

In the last 20 years, many programmes have been introduced in Africa, focusing on promoting improved biomass stoves to provide households with more efficient cooking devices. Some progress has also been made towards the use of LPG and electric stoves. Some programmes succeeded in achieving the intended objectives, whilst a lot failed, although all offered a useful learning curve for future disseminations. In general, these efforts were aimed at undertaking transitions in the energy provided for cooking and have shown that there are many factors involved in the success or failure of building and scaling up

the transition to more efficient energy for cooking. These factors are: economic (state or private involvement, competition, subsidies and taxes); financial (access to, and type of financing, involvement of local financial institutions); institutional (R&D support and marketing strategies – government and donor institutions, legal and policy framework); social (poverty reduction, income diversification, convenience level, gender concerns); and environmental (local pollution, global – greenhouse gases).

Table 4.1: Energy cost for different fuels in household for cooking
Source: Yamba (2001)

Type of stove	*Unit energy cost (US$/GJ)*	*Energy intensity (GJ/HH/yr)*	*Total energy cost (US$/yr)*	*CO_2 emissions (tonnes/yr)*
Traditional	2.37	87.142	206.53	6971.36
Improved	2.37	48.26	114.38	3860.8
Paraffin	7.48	42.6	318.65	3062.9
Electric	2.41	33	79.53	0

Table 4.2: Percentage share of household expenditure spent on energy
Source: Yamba (2001)

Stratum	*Charcoal*	*Electricity*	*Firewood*	*Kerosene*
Low-cost areas	26	12	2	7
Medium-cost areas	9	23	1	2
High-cost areas	5	27	0	1

In recent times, there have been other initiatives aimed at using modern energy systems for cooking in both urban and rural areas. Zambia and South Africa, for example, have programmes to enable cooking with electricity on a wide scale. Zambia, with significantly large hydropower, resolved to electrify 15–20 000 households per year over the next five years, mostly low-income urban households with power lines nearby but not connected to their houses. Experience shows, however, that even when electricity is available it is not necessarily used for cooking, because of the cost of electricity and the necessary appliances needed. For such a programme to be successful, it is essential that an innovative financing mechanism be put in place. Table 4.1 shows that traditional energy (firewood and charcoal) takes a major share of the household expenditure in low-income electrified households where electricity is mainly used for lighting as they cannot afford to switch to electric stoves. A recent study in Zambia showed that a switch is from traditional charcoal stoves to improved charcoal and electric stoves could significantly reduce total annual costs per

household – by 45.0% and 62.0%, respectively (Yamba 2001). The fuel switch to some of the fuels higher up the energy ladder is cost-effective.

Internationally there has been a rapid expansion in the use of LPG, which has doubled its growth in the last 15 years in residential and commercial markets in many developing countries; and globally it grew at nearly twice the rate of world petrochemical demand including jet fuel in the same period (Purvin et al 2001). This accelerating demand is creating investment opportunities in the downstream LPG industry, including storage, distribution and marketing. Growth in Africa is particularly significant. During 1990-1999, the world average annual growth rate was approximately 3.7%; in Western Europe it was 2%, in North America 3%, and in Africa it exceeded 5% (albeit from a low base). In Botswana the rate was in excess of 20% (Zhou et al 2000). However, even countries with refineries (such as Zambia, Kenya, and Tanzania) are not taking advantage of the situation. Another feature of the LPG industry is the growth of small companies involved in its distribution, competing with the multinational oil companies. The case study in Box 6 offers lessons in relation to LPG.

Box 4.5: Accelerated use of LPG, Botswana

An urban survey in Botswana showed that between 1996 and 2001 urban fuelwood use reduced from 55% to 43% and LPG use increased from 45% to 76%, with some government institutions especially in Gaborone switching from fuelwood to gas, electricity and coal. This change has been largely influenced by the healthy performance of the economy, boosted by diamond exports, along with responsible management, which resulted in higher household incomes. This economic 'boom' had a major effect on the demand and supply of LPG, which was favoured over wood and paraffin as income roses. Also as a result of the 'boom', improved road communication to rural areas facilitated LPG supply, and accessibility also made more areas financially and economically viable for business investment from both the private and state sectors. Relaxed regulations enabled investment in new petrol stations on the network of roads now covering most of the country. Government contributed indirectly to the accessibility of gas by increasing infrastructure in villages, in the form of clinics, schools, police stations and other social amenities. A factor that contributed to the switch to LPG has been the increasing firewood scarcity in major villages and towns. The mushrooming of small home delivery traders in the industry also assisted the dissemination of LPG.

The Botswana government legislated for health and safety. In 1997, the Botswana Bureau of Standards developed standards on the handling, storage and distribution of LPG. The people of Botswana seems supportive of the LPG project as evidenced by the fuel shift in both urban and rural areas to the use of LPG for cooking.

Box 4.6: Wider LPG use in Ghana

The LPG industry in Ghana grew as a result of direct government intervention through government-sponsored programmes. The Ministry of Mines and Energy, in conjunction with the National Petroleum Corporation and retailers, in 1990 started promoting LPG use in households to replace charcoal and wood. As a result of this programme, LPG consumption increased by seven times between 1989 and 1995 refs. Growth could have been more, but most households cannot afford LPG stoves and cylinders. With the support of a new programme, AREED a World Bank initiative, a plan is being finalised to assist in designing a financing mechanism and providing working capital to launch the scheme to provide credit to such households. This new programme will assist in identify an entrepreneur, local sources of capital, and a guarantee to establish a line credit with a local bank.

Based on the different discussions above and the case studies given, the lessons relating to cooking are as follows:

- The Kenya Ceramic Jiko (KCJ) in Kenya shows that these stoves has resulted in some commercial success and poverty reduction amongst manufacturers. However, this may not be the case of among users as energy savings are small, ranging from 4% for low incomes to 1.5% for high incomes. The Upesi stove seems to have had similar benefits, but also addressed gender issues, as the primary beneficiaries were women.
- LPG use in Botswana was solely promoted by the private sector, with competition between the bulk providers and small LPG retailers. There was also no government involvement in pricing. The majority of the small LPG traders were local, and conceptualisation, design and implementation were through local expertise. Owners of businesses did monitoring in the normal commercial manner. There was no formal training, although on-the-job training was offered by the bulk suppliers in handling and safety aspects.
- Dissemination of improved stoves has been largely supported by donors and governments and only in rare cases, as in Kenya, have some of these been commercialised.
- Technically, LPG produced in Africa can satisfy a large share of household energy requirements, particularly for cooking presently dependent on wood and charcoal; but unmatched specifications between producer and user, mostly caused by the export orientation and policy weaknesses, limit the penetration of LPG.

Renewable energy use

As discussed in Chapter 2, Africa has abundant renewable energy resources,

including solar, wind and biomass, but several internal and external factors mean that these are yet to be fully exploited. Since the early 1980s, however, there have been several initiatives in regard to all of these. Here we look only at solar energy, because of its pervasiveness and the significant number of initiatives in this area.

Africa has an annual solar insulation of 2000-2500 kWh/m2, which translates into 100-300kWh – sufficient theoretically to satisfy the energy needs of the continent, but, conversion and storage is a major issue. Several applications have been tried out in most African countries, including solar PV systems, solar powered wind pumping systems, small and large-scale thermal systems, solar water heating, passive solar building designs, cookers and drying equipment. In general, the dissemination of all these technologies has been limited for technical, economic, institutional and social reasons. In Africa as in other developing regions, solar energy still accounts for less than 1% of the primary energy supplies. The discussions here will be limited to the use of solar home systems (SHSs), by far the most common solar project in the continent and increasingly advocated as the solution to rural electrification problems.

Solar PV in Africa has received both multilateral and bilateral funding for demonstration and community projects, including eight of the 23 SHS projects funded by GEF. Despite the international funding, African countries have been contributing significantly, in both kind and cash. The contribution of African countries to GEF-funded projects makes this clear, and is a measure of the commitment of these countries to solar technology (Wamukonya 2002). Generally, SHS have been used for mainly rural electrification to satisfy needs such as lighting, radios and television. The capacity of these systems in Africa is not known but was estimated to be 5MWp in 1997 (Davidson & Turkson 1998), since when it has been growing: estimates for the potential market in East Africa was put at 65MWp, based on market surveys and estimates of annual sales in that region, although even if this is correct it would satisfy less than 2% of households not electrified. Many African countries have, however, embarked on SHS programmes to realise their dream of rural electrification, including Morocco, South Africa, Uganda, Ghana, Namibia, Botswana, and Zimbabwe. The growth in global terms of these systems, from 48MW in 1990 to 201MW in 1999 and estimated to be 1700MW by 2010 could have contributed to this move. Other contributing factors may include the emergence of the sustainable development debate and the search for energy sources with minimum environmental hazards, and the low grid connectivity and unreliability of power supply in Africa, especially for poor and remote communities.

SHS are often justified on the basis of poverty reduction, rural development and environmental management. However, as Villavicencio (2001) notes, these objectives are never met, and projects in Africa show that prospects of meeting

objectives are limited. The typical SHS normally supplies energy for lighting, operating a small radio and a black and white TV, at a significantly higher consumer cost than the conventional energy sources it substitutes for (Wamukonya 2002). Experience has shown that capital costs of the PV systems for both individual households and communities have been paid for through multilateral, bilateral or national financing as a form of subsidy. In some cases, these projects have to involve significant national funding in addition to multilateral or bilateral financing, either through direct payment or removal of import duty (Mzezewa 2001; Villavicencio 2001). There are cases when, even with a subsidy, the system cost is still higher than conventional energy sources, as in South Africa (Afrane-Okese & Thom 2001; Wamukonya 2001).

The use of SHSs can reduce the risk of fires caused by kerosene and candles for lighting. With regard to GHG emission reduction, the impact is questionable because the amounts involved are quite small and the cost per unit reduction high compared to other mitigation options (Wamukonya 2002; Villavicencio 2001). It has also been noted that the full cycle of delivering and maintaining SHS leads to more emissions from the use of vehicles in rural areas than emissions avoided by PV system (Afrane-Okese & Thom 2001).

The SHS market has many difficulties. Systems are promoted outside the cash economy, as they are intended for remote communities. Suppliers perceive SHS as a highly risky venture with doubtful economic viability, and mainly sustain their operations with subsidy. The users see the technology as foreign and second-rate, and indeed benefits beyond lighting have not been adequately demonstrated. The loans provided to users for acquiring the systems have proved difficult to service since the systems are consumer goods generating no income. Specific case studies to illustrate the features of SHS in African countries are given below.

Box 4.7: Solar home systems in Botswana

The National PV Rural Electrification Programme (NPVREP) was initiated in 1997, based on a government policy since the 1970s to promote solar energy to complement grid electrification in rural areas. The project started as a pilot in Manyana, a village close to Gaborone, which confirmed the technical and economic feasibility of the project for both households and institutions. A government-financed credit facility for both capital and operating costs was offered to rural communities at 14% interest per annum payable over four years, and the project was implemented by a parastatal, the Rural Industries Promotions Company. Maintenance is now limited to two technicians servicing PV systems scattered in 86 villages in 8 districts, posing challenges for effective servicing.

Only 328 SHSs, totalling 43kWp, were installed between 1997 and 2000. The impact of the project on income generation is limited, as only 17 of the sys-

tems were for productive uses. PV contractors and equipment suppliers have doubled from five to 10, but are small operations with three or four employees per contractor. A major setback is that extension of the grid is more favourable than the SHSs in cost terms, and people are prepared to wait for a grid connection which can provide vastly superior energy services. The project shows that the provision of credits should be complemented with institutional and technical capacities and that SHS should be integrated into other systems, as it cannot meet all the energy requirements of the communities.

Box 4.8: South African off-grid electrification programme

This project followed the South African democratic election in 1994 in accordance with national policy to widen access to electricity, leading to 2.5 million grid connections between 1994 and 1999. The Department Mineral and Energy (DME) opted for a concessionary model for delivery of off-grid systems to remote areas. A 50:50 joint venture between Eskom and Shell Renewables of South Africa in 1998 undertook to electrify 50 000 households with 50Wp systems over five (later reduced to three) years. The process was then opened up to other players. Six further private sector investors have joined, and are receiving a government subsidy for capital equipment procurement .

The Shell-Eskom Joint Venture project, which started in February 1999, achieved 6000 PV systems by March 2000. The systems are installed after an installation fee has been paid. The installer receives a subsidy from government and a monthly fee paid by the user to cover call-in service for maintenance. The 50Wp systems had smart switches to prevent theft and provided three inside lights, one outside light, and three plugs; points for a radio, black and white TV, and a cell phone charger were available at extra cost. Customers are not happy, because of breakdowns and the expense, and the installers complain of late payments of subsidy and the maintenance turning out to be very expensive, as SHS sites are far apart and not easily accessible, meaning that response to complaints is slow. The customers are mainly pensioners, public servants, and business owners; they want enough energy to power colour TV and thermal appliances. A major setback is non-payment of the government subsidy, without which the project is not commercially attractive, as the rental paid to the installer is small. Apart from problems of poor transport infrastructure, other factors such as a lack of clean water, sanitation, and accessible and affordable health services, have a negative impact on the project. However, the positive impacts of SHS lighting include longer business hours and study time for schoolchildren. A major lesson is that off-grid utilities require subsidy to make the venture attractive to the private sector.

Box 4.9: The Kenyan PV experience

The Kenyan experience of a commercially driven SHS programme is often quoted as a success story. It began in the early 1980s after the UN conference on renewable energy in Nairobi in 1981 resulted in interest from the private sector, NGOs and consumers. Initially PV modules were available off the shelf and used in telecommunications, demonstration projects in water pumping and vaccine refrigeration, but not the SHS market. A company started marketing PV for households and businesses, such as PV-powered sewing machines but later switched to PV lighting systems for schools and homes. Technicians were trained. The customer base was among high-income households, such as coffee and tea growers. Initially, systems were limited to DC appliances but later were adapted to allowed the operation of radios and TVs. This led to substantial growth in the market, along with consumer education programmes and marketing at agricultural shows. The locally made balance of systems consisted of ballast inverters, fluorescent lamp holders, DC amplifiers and charge regulators. Between 1990 and 1997, systems ranging from 12 Wp to 75 Wp came onto the market. Supply shifted from service to do-it-yourself installations that omitted charge controllers. Although system performance was compromised, overall system costs came down. From 1998, small amorphous PV systems dominated the market, with over half of the systems being 20Wp or less. Government duty and tax exemptions on PV modules also contributed to growth. Credit facilities and hire purchase schemes emerged; bigger operators entered the market and component prices decreased. In 1996, the World Bank/ESMAP had set up a credit facility for financiers and solar companies with tea society [??] and rural-based micro-finance institutions. The demand for loans exceeded supply and installations, but the Kenyan banking sector could not continue after the project ended. In 1998, the World bank, IFC/GEF's Photovoltaic Market Transformation Initiative (PVMTI) provided funds with low interest for local consortiums to develop innovative finance packages to grow the PV market. Only one PVMTI project was approved by 2001 for the tea farmers. Although it will continue to offer loans till 2007, the loan conditions have not been favourable, whence the poor performance.*

The overall lessons of the renewable energy experience in Africa can be summarised as follows:

- SHSs cannot be the basis for developing a rural energy system for development.
- The promotion of renewable energy technologies has been selective and driven by supply rather than demand. As a result, emphasis has been on PV technology, with less attention paid to modern biomass, mini-hydro and wind. There has been too much emphasis on technology and not enough on

service.

- The use of SHSs for rural electrification has been largely focused on providing lighting services, and have not met energy services for productive activities; therefore it has had no impact on poverty alleviation.
- SHSs require substantial subsidy as the costs are not competitive and the intended users have limited capacity to afford systems. The cost is not commensurate with the quality and level of service provided.
- Most of the renewable energy technology initiatives have been ad hoc, donor-driven, and with an uncoordinated project base; their impact on the overall energy system is marginal.
- Most SHSs are imported, and attempts to produce ancillary equipment locally are largely undermined by bulk foreign suppliers, so the contribution to local technology capacity building remains marginal.

Oil and gas sector

As mentioned in Chapter 2, Africa has vast resources of oil and gas to meet the continent's short-, medium- and long-term energy needs, although only a small faction is being exploited at present. Apart from uneven distribution of oil and gas resources, there is a relatively low level of oil and gas trade between oil exporters and importers on the continent. Security of affordable oil supplies is a precondition for steady development and should be a major issue on the regional energy agenda. Generally, the oil and gas sector plays a pivotal role in the continent's development policy by fulfilling three functions: it is the main source of foreign exchange earnings; making a contribution to the budget; and providing liquidity for the banking sector. In Algeria, for example, oil and gas accounts for 97% of exports, 17% of GDP, and 56% of the national budget (Hanifi 1997), and in Nigeria oil export revenue accounts for 90% of foreign exchange earnings. Oil price instability or volatility makes revenue projections and budgeting difficult for these countries (Idemudia 1997). The paradox is that these resources hardly touch the needs of even the producing countries in the continent, as some of them are still among the world's poorest nations and have a high debt burden. In Nigeria, sub-Saharan Africa's leading oil producer, the economy has essentially stagnated since independence: GDP per capita was $329 at constant 1987 US$ in 1960, rose to $361 at the end of the civil war, peaked at $426 in 1980, and fell to $359 in 1990 and $355 in 1995 (UNDP 1998); as a result absolute poverty has not only increased but also widened significantly now as compared to 1970s (Iwayemi 2001).

The oil and gas industry attracts the highest FDI into Africa, but due to the capital-intensive and high-technical requirements, high associated risks, poor access of funds for indigenous oil companies, the major players in both oil and

gas upstream and downstream sub-sectors are international oil companies – though there is some cooperation with African national companies. The Nigeria National Petroleum Corporation has various agreements with Shell, Mobil, and Chevron, for example. Recently, however, some small companies, such as Arakan Energy that raises money from the external capital market, are becoming involved in oil and gas production. It should be noted that the international oil companies have been obtaining significant returns on their investments, in excess of 30%, despite claims of political instability and high political risk.

Investments in the downstream industry (refining, distribution and marketing) is limited compared to the upstream industry. However, petroleum products represent approximately 70% of sub-Saharan Africa's total commercial energy and 33% of foreign exchange earnings, and therefore have a major impact on the region's trade balance. Also, taxes from petroleum products constitute an important source of revenue for most governments in the region – on average, about 38% of total indirect taxes. This sub-sector displays a high level of inefficiency, however, with an annual estimated loss of over US$1.4 billion (Cuneo e Associati 1993). Major causes for the inefficiency are sub-optimal procurement procedures, small-scale refining operations, and inadequate and poor transport infrastructure and institutional arrangements.

Gas flaring and venting is done in oil-producing countries where operators are not interested in developing gas markets. In Africa, this is a major issue, as most of its gas resources are flared. Of the world total amount of flared or vented gas, Africa's contribution is in excess of 35%, of which North Africa accounts for 24% and sub-Saharan Africa the remaining 76%. On average, oil operators in sub-Saharan Africa flare over 70% of overall regional production compared with the worldwide average of 4%. In only a few cases does small-scale gas development occur. In the industrial market, gas flaring represents an economic cost of US$3 billion annually in sub-Saharan Africa (AGI 2001). Furthermore, gas flaring and venting represents an environmental threat in increasing the release into the atmosphere of greenhouse gases.

The lessons emerging from the oil and gas sector include:

- A substantially increased use of oil and gas in Africa is crucial for its overall social and economic development; a majority share of present production should be used within the continent.
- The oil and gas sector attracts a large part of Africa's FDI, but nearly all of these investments are geared to exploration, extraction and development of infrastructure for export. The downstream infrastructure needed for local development is ignored or receives marginal attention.
- Perceived political instability and high risks have not deterred oil and gas investments in Africa; on the contrary there have been very high rates of return on investments, in excess of 30%.

- Oil and gas production methods are oriented towards satisfying foreign markets, with stringent environmental regulations which may be at variance with local demand. If tapped, the flared gas in Africa could be used to produce electricity accounting for almost 50% of the total produced
- Restructuring of the oil and gas downstream sector, as with Sasol and Mossgas in South Africa, can lead to a positive impact on the consumption of oil and gas locally, as well as a reduction of inefficiency in the sector .
- Most African countries lack the technical expertise and equipment needed to estimate oil and gas resources, which weakens their bargaining positions with the dominant foreign investors.
- More than half of the estimated savings from improved efficiency in the oil downstream sector can be achieved without investments in infrastructure but just by changing policies and procedures, such as opening regulated markets to competition and providing adequate pricing systems to foster transparency and efficiency.

Modern biomass technologies

Past modern biomass initiatives were aimed at using biomass energy as an alternative to oil and gas and contribute to energy diversification and enhance energy security, but they had different objectives. Blending of petrol with ethanol was for energy security and coping with foreign currency shortages though ethanol can act as octane enhancer. The landfill gas project in Sierra Leone was to assist with electricity production as an alternative to the stand-by diesel plants and in Mauritius, the steady decline in the price of sugar in the late 1980s and the government decided to promote sugar by-products, like bagasse and molasses. The multi-functional platform activity in Mali was an intervention by a NGO, the Mali-Folkecenter in cooperation with government to remove organisational and technical barriers to the sustainable operation of platforms fuelled by vegetable oil in rural communities.

These projects provide some lessons for replication and further development. Details of these projects are given in boxes , however in all these projects the strong support of the government was the key input to their success.

Box 4.10: Ethanol as a transport fuel in Zimbabwe

The ethanol project in Zimbabwe involved the local production of ethanol from sugarcane by Triangle Limited, a private firm, for blending of imported petrol, and distribution by private oil companies. The National Oil Company of Zimbabwe (NOCZIM) bought the ethanol from Triangle Limited and sold it to various oil companies for blending. The Zimbabwe Iron and Steel Company (ZISCO) sold benzol to Triangle Limited for use in the final stages of ethanol pro-

duction and as an additive to render the ethanol non-potable. The target blend ratio was 20% ethanol in petrol, but was never achieved largely due to insufficient ethanol, the highest ratio achieved was 15%.

The expected outputs were production 40 million litres of ethanol per annum, blended petrol up to 20% ethanol content, reduction of petrol imports by up to 20%, and savings of foreign exchange. The NOCZIM estimated in 1990 that by importing regular petrol for blending, about US$2.5million was saved annually, and cutting down petrol imports by 15% equivalent to US$2.5million in foreign exchange savings.

The project was funded by the Government, in response to a national crisis of transport fuel shortages and foreign exchange constraints soon after its independence in the early 1980s. The Government coordinated the involvement of the private sector and other agencies, a broad range of stakeholders comprising the Zimbabwe Government, other Government agencies (National Oil Company of Zimbabwe, Department of Energy), a German fabrication firm Messrs Gebr Hermann Company, and a number of local private firms (Triangle Limited, Mobil Oil, Caltex, BP, Shell).as well as the mobilisation of funds and a commitment to create a market for ethanol in the transport sector.

Box 4.11 Bagasse-based electrification programme

In Mauritius, the Government embarked on the bagasse-based power plants project in response to a national concern to ensure the continued viability of the sugar industry in the face of decreasing export prices of sugar by setting policies, established institutional structures and fiscal measures to facilitate the promotion of electricity generation from bagasse. The Government, in partnership with the private sector, initiated the Bagasse Energy Development Program in 1991 to address the Sugar Sector Action Plan's agenda on the use of by-products in the sugar industry. 10 bagasse-based power plants were installed between 1998 and 2000, and three firm power plants operate all year round using only bagasse during crop season and coal during the off-crop period.

The Government facilitated the regulatory framework to promote private sector investments in power production and sugar factory modernisation, and to encourage an efficient market for bagasse. The key element of this framework was energy pricing and contracting, which involved electricity, bagasse and coal. It also included project management, co-ordination, monitoring and evaluation strategies. An Ad-Hoc Technical Committee was set up at the Ministry of Energy, as part of the regulatory framework, to carry out the above activities and it comprised of representatives from the Mauritius Sugar Authority, the Ministry of Finance, and the Ministry of Economic Planning and Development.

The enabling environment by government such as the Sugar Industry Efficiency Act in 1988, which offered incentives facilitated investments in elec-

tricity generation by the private sector and a platform for an efficient and viable sugar industry, while promoting agricultural diversification and product diversification within the industry. The Act include reduction of the export duty rate and increase in duty exemption. A major innovation was a reward system that linked export duty to improved sugar recovery, enhanced use of bagasse for electricity production and use of marginal lands for the production of crops other than sugar. Removal of foreign exchange control. Enabled investors to offset losses incurred in capital expenditure in energy production from bagasse, by revamping of sugar factories and a performance-linked rebate on export duty was extended to producers of firm electricity who saved and used their own bagasse, and also to millers which sold bagasse to continuous power stations.

With respect to the bagasse-based power plants project in Mauritius, a Management Committee with representatives from the Mauritius Government and the Sugar Industry was formed to undertake detailed planning of programme implementation. The aims of this Committee were to ensure that the Government's policy directives related to the Bagasse Energy Development Programme (BEDP) were followed and to effectively integrate Government's policies affecting the sugar and energy sectors. The Management Committee occasionally needed to review and revise policies and, through the Minister of Agriculture, sought the approval of the Economic Sub-Committee of the Cabinet. A BEDP Co-ordination Office was established at the Mauritius Sugar Authority to assist the Management Committee in the tasks of planning and monitoring the implementation of the BEDP and its project components. All the parties, relevant Government Ministries and agencies, the Utility, the private sugar industry stakeholders fully participated in the project right from inception through all stages right from project conception to implementation, through constant interaction and participation.

Box 4.12. Multi-functional platform for rural areas

The multi-functional platform project in Mali was implemented and coordinated by the Mali-Folkecentre (a non-governmental agency), in close collaboration with the National Directorate of Energy, the technical arm of the Ministry of Energy and the National Centre for Renewable Energy. These agencies maintained close consultation with the project target groups – women's' associations responsible for the platforms, the village associations and the equipment operators – to develop an operational and effective management structure.

The multi-functional platforms in the five project villages involves four major activities, a revamping and repair of platforms, technical training on maintenance and repair, training workshops on basic management skills and accounting methods, support and follow-up and production of the first Malian jatropha press. In two villages – Falan and N'Tjila – underwent revamping and repairs,

mainly on the motors (cooling system, bearings replacement etc) and the press (rebuilding of screw elements etc). The operators were invited to Bamako for intensive theoretical and practical training for more independent sustainable breakdowns and preventive maintenance. A management structure was formulated which included a secretary, book-keeper and chairperson. The Mali-Folkecenter team has remained in contact with Falan and N'Tjila, with frequent visits to follow operations. The experiences gained in Falan and N'Tjila will be exchanged with Diou, N'Gara, Niaradougou to allow analysis by the other villages of the techniques adopted. The Mali-Folkecenter team has visited these three villages to analyse the particular problems. Arrangement of inter-village visits is underway. The women in the five rural communities were equipped with the skills in basic management and accounting procedures including long term planning, budgeting for repairs and maintenance, and basic analysis of platform performance. It was anticipated that the project would also help to identify sites of interest for potential investments in new multi-functional platforms under the African Rural Energy Enterprise Development (AREED) programme, to facilitate further independent commercial diffusion of the technology by supporting small businesses and entrepreneurs. Entrepreneurs have approached Mali-Folkecenter requesting for AREED support to start business based around multi-functional platforms for energy service provision and for sale of jatropha oil to make soap. The multi-functional platform is recognised as a valuable tool that contributes to rural development whilst also being profitable, whether it is operated by women's groups or entrepreneurs.

Emerging lessons are

- A clearly defined policy on biomass development is required as a catalyst to investors because generally the private sector is reluctant to fund high initial capital as well as project risks. Well-defined government policy in terms of subsidies, price supports, and long-running research and development (R&D) programmes are central in building infrastructure for the developing modern biomass technology, and fostering the national market. Creating an enabling environment for participation by all stakeholders in all stages of the project development and monitoring, as well as transparent flow of information is crucial.
- The need for associated programmes to build capacity of local artisans on the fabrication, repairs and maintenance of equipment as these projects will not be sustained if they are not available locally. Successful projects are characterised by locally fabrication of some portions of the equipment, and local artisans adequately trained for equipment repairs and maintenance.
- Thus, the support of the government is needed when clear public benefits can be associated with the technology.

Regional cooperation and trade

Regional cooperation and trade in the energy sector has been largely limited to the electricity and the oil and gas sectors. There is limited trade in charcoal in West Africa and coal in Southern Africa. Discussion here will be limited to power, oil and gas.

Regional cooperation and trade in electricity has a long history in West, East and Southern Africa. Several appeals are now being made to increase regional cooperation operations in electricity supply, some challenges need to be overcome before this can be achieved. Apart from harmonisation of specifications of equipment which are different mainly due to their colonial legacy, few sub regions are connected, although connections within regions have made some advances. In southern Africa, nine out of 12 countries are interconnected, while in Northern Africa, five out of six are interconnected. In West Africa, 12 of the 16 countries are linked, but only two in the five countries in Central Africa, and two in the 10 countries of East Africa are connected. This has led to the development of regional power initiatives to improve the adequacy and reliability of electricity supply to urban and rural consumers. There are now initiatives operating in each of the sub-regions for a more optimum supply of power and better penetration and access.

The Southern African Power Pool (SAPP) was created in 1995 following the signing of a Memorandum of Understanding by twelve (12) countries in the Southern African Development Community (SADC). The East African Pool is the Eastern African initiative and plans to interconnect the grids of Kenya, Uganda and Tanzania. Already, Kenya imports electricity from Uganda's 180 MW Owen Falls hydroelectric facility. The West African Power Pool (WAPP) plans to interconnect the utilities of Côte d'Ivoire, Nigeria, Benin and Togo and Mali. Some external funds are now available for the installation of a 200 MW capacity hydroelectric facility at the Manantali Dam in Mali, with transmission lines to Mali, Mauritania and Senegal as part of the WAPP network.

There are several on-going trading activities in oil and gas in Africa, but the volume of trade is quite small compared to total trading that is occurring, because most of oil and gas trading is external, and at times the producer do not even have enough to satisfy the local market. A case in point is Nigeria which frequently suffers from shortages of petroleum products and has to import from Europe, while selling low-sulphur crude to USA or Asia to meet their stringent environmental conditions. Similarly, South Africa's refineries could process West African crude, which could be re-exported to Nigeria for use, but until recently South Africa imported from the Middle East, while Nigeria imported final products from Europe (Tsikata 2001). The net result is a major cash outflow from the continent.

Despite many discussions on harmonising specifications in oil and gas pro-

cessing between African countries, these specifications vary significantly, leading to refineries producing very small quantities at high cost. This reduces regional trade potential; a similar situation exists for price and tax differentials between countries, and also ends up as losses. Another problem is risk aversion in the oil and gas trade. Oil trade between neighbouring countries passes through intervention by two banks in different western countries which create many problems due to different language and systems, especially between an English-speaking country and a French-speaking country. The reason for going through a third country out of the continent is the fear of non-payment by other African countries. This system is normally referred to as 'counter-party risk' (Rutten 2001). As a result, significant cash leaves the continent.

There are, however, a few new initiatives aimed at solving some of these problems but the source of funding is crucial, as shown in the two case studies below of private-public partnerships and regional energy co-operation and integration. The internally funded South Africa-Mozambique project is progressing fast, while the West African pipeline, partly funded by the World Bank, is not.

Box 4.13: The Mozambique-South Africa natural gas pipeline project

The primary objective of this project is to construct an 865km long, 660mm diameter natural gas pipeline from the Pande and Temane gas fields in Mozambique to Secunda in South Africa, to contribute to the socio-economic development of both countries. It is a joint initiative between the governments of South Africa and Mozambique (each having 25% of equity shares) and Sasol Pty Ltd (50%). The total investment cost required is about US$1.2 billion, with the transmission pipeline accounting for about 50% of this. In line with the policies and development plans of both countries, there are specific objectives:

- *limitation of capital flight through retention for local and regional economies;*
- *development of local and regional economies and capacity building in the gas industry through the use of local personnel, materials and capital;*
- *maximum utilisation of gas resources for national and regional development; and*
- *integration of the gas project with other industrial and developmental projects.*

Earlier stages of the project have been completed, construction of the pipeline has begun and gas should be flowing by 2004 for marketing and sales. Generally, the project will provide capacity building in the region in upstream and downstream activities through the employment of local personnel who will be involved in construction and engineering activities, as well as in operation and maintenance of the pipeline, and marketing and sale of gas. Mozambique is expected to significantly benefit from royalties, and profits, with an estimated

boost of about 20% to the GDP, substantially changing the predominantly agricultural economy of Mozambique to an industrialising one. The main benefit to South Africa will be in gas-based technologies, thereby increasing its overall industrial energy-use efficiency, and promoting environmental sustainability, raising the share of natural gas in South Africa's primary energy supply from 2% to 7%. The project shows that private-public partnerships coupled with development policies can yield private sector investment capital and expertise.

Box 4.14: The West African Gas Pipeline Project

The economic community of West Africa, ECOWAS adopted a regional energy policy in 1982 which included the development of a gas pipeline. A plan was drawn up in 1991, and in 1992 conceptual studies, funded by the World Bank, concluded that a pipeline from Nigeria to Ghana, the first to cross West Africa. was feasible. The West African Gas Pipeline Project involves four countries: Nigeria, Benin, Ghana and Togo, and six companies: Nigerian National Petroleum Corporation, Ghana National Petroleum Corporation, Shell Petroleum Development Company of Nigeria, Chevron Nigeria, Societé Togolaise de Gaz, and Societé Beninoise de Gaz. The daily throughput of the pipeline should be between 2.8 and 3.4 million cubic metres of gas. In addition to enhancing regional co-operation and integration, this project will provide other benefits, such as the diversification of Nigeria's foreign exchange earnings and the enhancement of industrial development in Benin, Ghana, and Togo, as well as mitigation of greenhouse gas emissions in the region. A major lesson learnt so far is that a step-by-step approach based on economic interest offers the best prospect for regional integration. It has also been revealed that co-operation between government, private sector, and public corporations can provide a suitable vehicle for attracting much-needed financing for the energy supply infrastructure in the region.

The following lessons can be drawn from the above discussions:

- Regional cooperation and trade in the energy sector is rising and has contributed to the overall social and economic development of the countries concerned. The impact of this growth is not yet fully realised, however, because the starting base is very low.
- Cooperation among countries on several aspects in the energy sector has been increasing more than trading activities among countries. Trading has been largely confined to the power*? sector, rather than being extended to oil and gas.
- Enhancement of regional trade and cooperation can be boosted by harmonisation of standards, improved infrastructural links, and proper understanding of shared risks and benefits.

CHAPTER 5

Energy strategy: Think bigger and move faster

Transforming the energy sector of Africa to not only satisfy urgent energy needs but also to improve its overall net productivity and competitive position requires a strategic approach that fully considers its resources, constraints and opportunities. This task is particularly difficult because the starting base in the energy sector of the continent in comparison with those of other developing regions or countries is low, and there is therefore a needs a substantial increase in modern, efficient, and reliable energy supplies.

Past energy initiatives have been relatively small in size and scope as compared to the energy problems facing the continent and their impact on the overall energy economy was marginal, at best. The few larger energy initiatives were oriented towards promoting energy exports, and because of past and current terms of trade, benefits from these exports have minimal or negative effect on the overall energy sector and the national economies of African countries. Therefore, the strategy suggested here will aim at promoting relatively bigger projects and programmes so that the ultimate gains to both the energy economy and the overall economy will be significant. The time lag between conceptualisation and implementation of energy projects and programmes is extremely long, varying from 10 to 30 years. This means higher equipment, labour and equipment costs, as well as transaction costs, and since most of these are externally sourced there is a serious drain on the economy. Projects and programmes end up being scaled down as a result of the high cost, and quality and usefulness are compromised. Sources of financing are the main contributors to the problem, along with project and programme definition. Any future strategic approach must be aimed at shorter lead-times than in the past.

Expanding modern energy services to the majority of Africans – not only to satisfy their urgent and immediate needs, but also to advance Africa as an important participant in world manufacturing and trade – requires a strategic approach. This approach must reflect the central concept of this chapter: thinking bigger and moving faster, while optimising indigenous resources in a cost-effective way, with improved equitable distribution and minimum adverse environmental impacts. The discussions in previous chapters provide some guidelines to develop components for this strategy, which will not be advanced in terms of economic sectors, but will be based on some interventions that are like-

ly to produce positive effects. Strategic interventions that are likely to achieve gains in the continent's energy economy are:

- widening access to cleaner fossil fuels;
- strengthening of government and energy institutions;
- energising rural areas;
- mobilising energy investments;
- regional trade and cooperation;
- human capacity development.

Widening access to cleaner fossil fuels

To repeat – only a minority of Africans have access to modern energy services, while the continent has the resources, and is producing enough, to allow this situation to be reversed.

Wide use of petroleum fuels: Over two thirds of indigenously produced crude petroleum is exported, either raw or as petroleum products. A strategy to achieve greater use of petroleum products in the continent would include: stimulating energy demand, rationalising refinery operations and building more refineries, rehabilitating transport and storage infrastructures, and joint procurement. The magnitude of the tasks and changes involved will require the assistance of lending institutions and the active cooperation of international oil companies, as well as the firm commitment of governments to implement necessary adjustments.

Intense use of natural gas: Continuing finds of natural gas in Africa and the increasing interest in exploration gives gas a promising future in the power and industrial sectors. Africa has the third largest reserves of natural gas after the Middle East and Russia. The Mozambique-South African project and the West African Gas Pipeline Project are replicable. Some countries can also use local reserves for power supply, as is being planned in Ghana and Tanzania. Introducing technology to convert gas to liquid is receiving attention (as in the plant recently completed in Nigeria), and this will provide opportunities for transporting the fuel source across national borders. Another technological development in combined-cycle gas-powered plants is leading to cheaper electricity – 5 USc/kWh, compared to 7 USc/kWh for a modern hydro power plant (OGJ 1997). However, the need remains for the basic infrastructure for national supply and for international connections for regional projects.

Optimal production and use of electricity: Increasing the efficiency of existing power plants through rehabilitation and overhauling offers great potential. In

Nigeria, for example, the total generating capacity was increased from 1000MW to 3000MW within a year of undergoing such a process. Reduction of technical transmission and distribution losses using well-known methods can easily achieve 10% more power output, and non-technical losses can be reduced through improved management of utilities. Diversification of energy sources in power generation is important to reduce vulnerability – this was a lesson learnt from the effect of the 1997-98 drought on power generation from Akosombo dam, which led to Ghana importing power and a policy shift towards more inclusive energy sources.

Use of LPG in households: LPG for cooking, especially in urban areas, should be actively promoted, because of the positive lessons learnt from cases such as in Senegal, Mauritania, Ghana and Botswana. This measure has many advantages, such as a substantial reduction in urban use of low-grade fuels such as unpopular wood and charcoal, replacing the kerosene that has proved so dangerous in some countries, such as South Africa. The use of LPG can lead have multiplier economic effect such as the production of ancillary components, gas stoves and gas cylinders as was in the case of Ghana. Promoting LPG, however, requires investment and policies to set up a national LPG infrastructure (supply chains, ancillary equipment, adequate transportation, etc), like those in Egypt, Senegal and Ghana. Adequate government policies will lead to increased participation of international oil companies and growth of local entrepreneurs in the supply chain, as has been experienced in Botswana, Senegal and Ghana. The case of Senegal in which LPG was promoted to counter deforestation and land degradation provides some inputs to the strategy of using LPG. Policies were put in place for awareness raising; designing inexpensive stoves that accommodated traditional cooking techniques; removing of taxes on imported equipment; developing a differentiated pricing policy for different bottle sizes with subsidies only for low-income users; and micro-credit schemes for the purchase of stoves. This contrasts with the case of Botswana, where higher incomes stimulated the LPG market, though government actions and improved overall transport infrastructure contributed significantly.

Converting waste to wealth: the current 65-70% un-associated natural gas being flared in Africa, mainly in Angola and Nigeria is estimated to be worth $2.5 billion annually, and using this gas in combined cycle gas turbine system, could generate up to 200 000MW (World Bank, 2002) as compared to the present capacity of just about 120 000 MW. This presents a major opportunity that can be exploited for the African energy sector because in most developed countries, un-associated gas that is flared is around 4%, hence the technology exist to reduce the present high percentage to a substantially lower value and also

produce significant electricity for the continent. It is therefore important that African governments should create an environment through consultation and eventual regulation with the oil companies that are extracting petroleum as these are the same companies operating in developed countries that have succeeded to reduce flaring to 4%. It may be necessary to use international funding agencies to assist with facilitation as the investments required can be high.

However, steps are already being taken to halt gas-flaring in most countries in Africa. In Nigeria, the country with the highest rate of gas-flaring in the world, large-scale recovery projects are being implemented. The first of such projects is the production of liquefied natural gas (LNG) for export to European markets that was conceived three decades ago. The second project that is 4expected to start soon is using gas from Escravos to be piped to Benin, Togo, and Ghana dedicated to power generation for the West African Pipeline Project (Tsikati 2001). Nigeria plans to phase out gas flaring by 2008, and Algeria is also making efforts to reducing flaring there.

It is should be noted that foreign oil companies in Africa are mainly interested in extraction; without the regulations found in developed countries, they have no incentive to process it locally. Three factors that will the resolve this situation are: (a) changing the regulatory environment; (b) technology availability; and (c) international pressure for environmentally sound options. Cooperation between the oil companies, multilateral organisations and the national governments is needed for this to happen.

Strengthening government and energy institutions

Policy-making is an important function of governments, whose role it is to ensure that effective measures are instituted for formulating comprehensive policies based on sound information. Government therefore must set up institutions and establish linkages between them, to collect, organize and analyse information on energy sources, conversion, transportation, use, and imports and exports. Further, it should facilitate consultation with relevant stakeholders so as to ensure participation and compliance. Integration of energy policies should be considered in terms of their connections to all sub-sectors of the energy economy and to other sectors of the economy. In general, energy policy should consider technological necessity, economic optimality and variability, and social desirability so that the majority of Africans are included.

Weaknesses in the management of African energy institutions have prevented them from performing their expected tasks. As a result, countries in Africa are largely influenced by external initiatives that are not always in their regional or national interest. 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.

Policy analysis: This is a crucial activity that has long been ignored. Such analysis requires innovative thinking to reflect the different conditions of the continent. If done well, it will increase local ownership of the energy sector and provide the capacity for effectively screening external advice and assessing costs and benefits entailed. Policy analysis can also assist in providing early warning of external shocks, such as price fluctuations, and allow the development of appropriate coping measures. Activities which are not directly energy matters but which will assist such analysis include the search for trade advantages and identifying suitable partners, and tracking down technical innovation and development. For institutions to be effective in this regard, national and international links are needed, along with well-trained staff and the necessary support infrastructure.

Institutional collaboration: Energy institutions are many and tend to be formed around different fuels rather than around activity; creating effective linkage for collaboration is difficult. Attempts to form energy commissions and councils have failed to deliver expected results. However, setting up a coordinating mechanism that is chaired by a very senior official is needed – but such a mechanism would vary, depending on the country. A regional mechanism such as the proposed Energy Commission of the newly formed African Union could help to facilitate this move. Such a mechanism 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.

An important area for government policy is the establishment of rational energy pricing that reflects taxes and subsidies as dictated by government. These instruments are largely dependent on the macro-economic environment of the country, but there are valid reasons to use them to encourage energy consumption on an equitable basis, to protect local employment and local industry, driven by reasons of energy security as well as social ones. In the case of Africa, where most national energy economies are far from saturated which means that majority still do not access modern energy, the protection of the poor and disadvantaged is crucial, and governments should employ a cross-subsidy system targeting the poor , while letting those who can afford it pay for services delivered, while reducing leakages. The pricing system, including subsidies and taxes, should also stimulate equitable growth while improving economic efficiency and environmental quality in the energy sector. Experience has shown that trying to tackle leakages has led to the removal of subsidies, with consequent adverse effects on access.

Privatisation in the energy sector is very popular in Africa now, despite the difficulty of identifying and stories of success. Projecting successes from the oil

and gas sectors to the electricity sector has led to many disasters insofar as increasing access is concerned. A major factor that should govern privatisation in the electricity sector is whether the size of operation warrants a market situation: in most cases privatisation means changing government monopoly to a private sector monopoly, or a western government monopoly. In these cases it is difficult to see what is being solved. Another factor is the setting up of regulators without well-defined location, management or functions. In many countries this only increases transaction costs. Africa is in a unique position, because of the very low incomes, poor savings potentials, and weak institutions; attempting to replicate strategies and policies conceived elsewhere needs to be done with great caution. In general, any privatisation strategy should not only aim to provide efficient services but also to increase access. The example of Senegal having to terminate an 18-month contract between the government and Hydro-Quebec of Canada and Elyo of France because of inadequate supply should not be repeated.

Energising rural areas

The energy needs of rural areas are particularly great. Relative neglect since colonial times and after independence means that rural areas are yet to receive the attention required for growth. Taking access to electricity access as a dummy indicator for access to modern energy services, Table 5.1 clearly shows the disparity between urban and rural in selected countries.

Table 5.1. Urban and rural electricity access in selected African countries
Source: ESMAP (2000)

Country	*Percentage of households electrified*	
	Urban	*Rural*
Malawi	11.0	0.32
Tanzania	13.0	1.0
Lesotho	14.0	4.0
Mozambique	17.05	0.66
Zambia	17.85	1.39
Namibia	26.0	5.0
Botswana	26.48	2.09
Swaziland	42.0	2.0
Zimbabwe	64.72	0.6
South Africa	74.6	27.2
Côte d'Ivoire	73.1	12.7
Ghana	61.7	4.3
Average	**25.78**	**1.7**

Providing energy for rural areas should not only close the gap between the urban and rural areas but also to make the latter part of any national expansion programme. The rural energy problem is complex and requires a combination of diversified options; solutions go beyond resolving the situation with fuelwood. Several past initiatives have shown that strategies for these areas require community-based and integrated management programmes, which take into account local natural and technical resources, human capabilities, financial resources, and environmental constraints. Another consideration is that, at least in the foreseeable future, activities in rural areas will be largely limited to agriculture and small-scale industry. Strategies should therefore focus not only on households, but also on meeting the growing demands for modern energy to facilitate mechanised agriculture, including fishing and animal husbandry, and appropriate support infrastructure.

Renewable energy sources and their associated technologies have been widely advocated as viable options for solving energy supply in rural areas, but impacts from past initiatives have been minimal. A few initiatives that have shown some gains are given below, though it is not being advocated that renewable energy will effectively solve rural energy problems in the short or medium terms.

In general, rural areas need reliable energy systems; there is at present a low level of confidence because of past initiatives' high failure rate. System and components standards, testing centres and quality assurance, and adequate maintenance are all needed (as provided for most other technologies). It is important that renewable energy systems are linked with other energy initiatives and also with development initiatives such as health improvements and infrastructure projects of roads and water rural roads, water (Mogotsi 2001). Government should help create business opportunities for the local private sector to participate as entrepreneurs, importers, local manufacturers, craftspeople and technicians, and operators of financial institutions. Strategies and policies that can foster the use of renewable energy technologies are as follows:

Financing schemes: The intended users are poor and financial assistance is needed, but the conventional loan system is inaccessible as interest will be high due to perceived risk, so government support is needed in the form of direct or indirect subsidy. Reforming taxes and duties, supporting special financing schemes, reducing transaction costs, etc, are some measures that be considered (Davidson & Turcson 2000). A financial guarantee system can be also be employed with development banks for risk minimisation (as in the case of hoteliers using solar heating systems in Morocco).

Technical appraisal and testing: Technical policies should be instituted to ensure that renewable energy technologies (RETs) are treated as engineering

devices, and are subjected to appraisal and testing for suitability and safety. Testing will assist in setting performance standards of equipment and a code of practice for operators. Some past projects have resulted in formulation of standards (Mzezewa 2001; Mogotsi 2001) and quality assurance (Sarr & Thomas 2002) but enforcement is crucial. The efforts of Zimbabwe, South Africa and Kenya are examples that should be replicated.

Technology transfer and job creation: The development, dissemination and use of RETs involves significant amount of technical skills and human resource. With suitable policies, skills can be transferred to the locals through adequate training at different levels, as in the case of ethanol production in Zimbabwe (Davidson, 1998). Existing training institutions can be useful here. The areas that require attention are product design and modification, product downsizing, after-sales service, and maintenance. It is strategic for renewable energy industry to provide job opportunities for locals to importers, manufacturers, contractors, after-sales service technicians and financiers and this can be significant if well planned.

Product manufacturing: The technical capacity and competence of most African countries will prevent them from undertaking manufacturing of advanced RETs or their components, but they can manufacture ancillary components such as batteries for solar home systems (as in Zimbabwe and Kenya), and controllers (as in Botswana). The manufacturing technique should reflect flexibility and adequacy; limitation can be very expensive as solar home systems show, where adding extra modules to cope with demand would increase cost substantially, as the system cannot easily be upgraded.

A few programmes have started to address these problems, such as African Rural Energy Enterprise Development (AREED) that is targeting the poor as well as manufacturers and installers. Use of a hire-purchase scheme based on local financing is being done in Kenya. Mobilising capital from communities, as in the case of Mali, should be encouraged, as this increases a sense of ownership and involvement, especially when done from the start of the project.

Renewable energy has a promising future for African countries in specific circumstances and location, because of the limited access to high quality energy by the vast majority and the availability of renewable energy resources. Because of current economic constraints and the limited technical capacity of the people that need energy the most, however, RETs will contribute only a limited share in Africa's immediate future.

Promote modern biomass

Notwithstanding the barriers to modern biomass use in Africa, such as uncompetitive costs of energy, low energy content and seasonality and competition for land use, there are some opportunities for the dissemination and wide-scale adoption of modern biomass technologies because if well planned they provide useful inputs to the energy economy. Three key factors successful development and implementation of modern biomass are technological development and demonstration of conversion technologies, creating markets for biomass production and use and supportive Government policy and fiscal arrangements;

Technological development and demonstration of conversion technologies: Intensified efforts on research, demonstration, and commercialisation of advanced biomass technologies for power generation with high conversion efficiencies, low emissions, and low costs. These technologies include the integrated gasifier/combined cycle (BIG/CC) technology, the production of modern bio-fuels, using hydrolysis and gasification. Combining biomass with fossil fuels can also be an excellent way to achieve economies of scale and reduce the risks of supply disruptions.

Creating markets for biomass production and use: The supply and demand for modern biomass energy should be matched over prolonged periods, and diversifying supplies will create a better market. A promising options is creation of niche markets for modern biomass. Major examples are the modernisation of power generation in the sugar, and in organic waste treatment. Niche markets can also be found for modern bio-fuels, such as high-value fuel additives, as mixes with gasoline, or for specific parts of a local transport fleet (such as buses). To compete with other commercial fuels, biomass energy may have to follow a poly-generation strategy, where there is co-production of electricity, fuels, fibres, and food from biomass. One example would be the generation of electricity by a BIG/CC plant as well as any fluid that can be produced from the syngas, e.g. methanol, dimethyl ether, other liquids using Fischer-Tropps synthesis. Another could combine biomass and fossil fuels to co-produce modern energy carriers (Hagan et al 1996).

Supportive government policy and fiscal arrangements: A coherent policy framework for the development and utilization of biomass technologies is one of the most important component for harnessing the biomass resource on a sustainable basis. Such a framework should have targets, investment plan or financing mechanisms (Hagan & Brobby 1996). The facilitation of modern biomass a conducive fiscal and legal regulation should be established to enable private sector participation.

Mobilising energy investments

Africa offers a good prospect for international investments: a steadily increasing economic growth rate of over 3.5% since 1995, declining population growth rates, a high rate of return on investments (above 25% compared to 18% in other developing regions), a declining inflation rate (from 26% in 1996 to around 11% in 2001) (OGJ 1997; ADB 2002). Unfortunately, foreign financial flows have been declining, such that a growth of 25% in foreign direct investments (FDI) in 1999 represents only 1.2% of global FDI flows and 5% of such flows to developing countries (UNCTAD 2000). There are two main reasons for external assistance: firstly, investment in energy infrastructure is beyond local capacity; secondly, the financial needs of these countries are well beyond their financial capability. For example, the World Bank estimated that at least US$17 billion would be needed for new power projects in sub-Saharan Africa, excluding South Africa, by 2005. Governments can provide $5 billion, and the World Bank, the African Development Bank and other lenders can provide $2 billion; the balance of $10 billion will have to come from investments. Donor assistance is declining: by 2001 is only 0.25% of gross national product was given as official development aid (ABD, 2002), far below the agreed UN target of 0.7% announced during the Earth Summit in 1992. Aid can be very useful for the least developed African countries that will not normally attract FDI, as it can be used as leverage funds to investments and also assist with social infrastructure development.

A substantial challenge for African countries is to create an enabling environment for attracting FDI and to become part of the multinational networks. In recent years most African countries adopting the stringent measures of the World Bank/IMF-sponsored 'structural adjustment' programmes have had mixed results in their capacities to create such an environment; as a result, external investments have been slow. Policies and strategies that should be considered to promote enabling environment include the following:

- African countries must embark on measures that will deliver the 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, banking and business sectors. In some countries, new institutions may needed such as setting up business intermediaries in new areas. One of such is information brokers to cope with new electronic communicating initiatives Developing pro-active investment agencies can help to 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.

African countries should put mechanisms in place to ensure the attraction of investors with long-term perspectives, however, rather than the short-term natural resource prospectors that now pervade the continent.

Another area which can assist is more and effective management of donor assistance, as gains from such exercises have hitherto been limited. Appropriate measures include:

- effective interaction between projects and programmes and national development priorities;
- establishing a co-coordinating mechanism among donors and creating linkages with local NGOs;
- providing a mechanism of documenting good practices and lessons 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.

Regional cooperation and trade

Due to the fragmented nature of African countries, cooperation, especially in planning, presents significant opportunities for growth and cooperative planning activities. This would lead to minimising existing wastage, optimal efficiency, and to increasing the chances of effective competition with other developing regions. This is true for the energy sector, whose deficiencies can be either substantially reduced or eliminated by strengthening regional cooperation – including 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, 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. This type of planning should aim at complementing national planning, and focus on rationalising the supply and use of electricity so that optimal results will be achieved. Both supply and demand initiatives and their related costs should be used. 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 the Southern African Development Community (SADC) shows a surplus capacity of over 11 000 MW within the sub-region (African Energy, 2001), because the uncoordinated national planning currently practised in the continent results in significant stranded assets. The Southern African Power Pool hopes to balance the surplus/deficit situation and transform power planning from national self-sufficiency to regional self- sufficiency, and there are plans for

setting up the West African Power Pool (WAPP).

The petroleum consumption of most African countries is relatively small by world standards and each country, presently operating in isolation, pays the same overheads. It has been shown that if optimal choice is made among countries in the sub-region, up to 30% savings can be made (Davidson 1992). Further, trends in world trade demand that Africa should operate collectively to participate, which supports the case for regional cooperation using the trade blocs which already exist. Though there is already energy trade between some countries, especially in electricity from hydro resources, there is potential for more such practice. There are some inter-connection facilities that can be strengthened for such trading activities. However, for such a level of cooperation, efficient and well-staffed coordinating centres must be established. Energy standards in many countries, which date from the colonial past, need to be upgraded and improved to ensure harmonisation and compatibility, which will help to improve the design quality of equipment and operating conditions. There will also be a need to ensure that suitable mechanisms are put in place to ensure compliance.

Strengthening of information among countries is important for future development in the energy sector, and the advances in information technology should be fully exploited for this purpose. This will require competent and adequately staffed regional and sub-regional institutions for energy and related matters.

Human capacity development

Africa has an insufficient number of well-trained people to cope with the demands of the different strategic components discussed above, so suitable cooperative mechanisms should be instituted. The benefits of resource-pooling include competence maximisation and an improved work environment. Most regions in the world are developing and strengthening their regional and sub-regional centres, and Africa will be able to compete with these centres by forming such networks. Possibilities of effectively participating in joint research and development (R&D) projects will also be enhanced.

Energy research needs serious attention, because the problems of the energy sector call for innovative solutions. Such activity started in earnest in the mid 1970s, largely driven by the responses to the oil crises. As a low priority in government expenditure, it was mostly externally funded, so the agenda was significantly influenced, and not clearly linked to the government priorities of the time – import restrictions, grid expansion, and economic constraints. More recently, though, while energy research funding has not changed, its agenda has been broadening to reflect some government interests, which has led to some funding by government and local agencies.

Energy R&D in the world is becoming more complex, specialised and expensive, and African countries will find it difficult to participate unless substantial investments are made in collective R&D in regional and sub-regional centres. A strategy to cope with the growing complexity is for firstly, African centres to set up tracking mechanisms for advanced energy technologies to enable them to undertake product testing and product/process modifications. Secondly, these centres should be fully involved in policy development, development of less advanced technologies, associated equipment for advanced technology, training schemes and data collection and analysis. An opportunity that is yet to be fully exploited in African countries is the use of specialised local energy institutions for routine data collection, a quite common practice in developed countries, especially for the household sector. A suitable and well-funded programme should be instituted to ensure that baseline energy and energy-related data collection becomes a regular and continuing exercise.

The role of regional agencies to fund research done by national institutions is crucial for two reasons. Firstly, they can afford to fund the large long-term R&D projects, which are now done by institutions outside Africa; and, secondly, they are likely to get more appropriate solutions. It would also will assist in reversing the 'brain drain', which is a major problem for Africa. Improving the working environment and increasing the number of trained staff, along with supporting local and regional training programmes, will help to deal with the African skills shortage.

CHAPTER 6

The way forward

Despite African countries having the least access in the world to modern energy services, there are several promising energy initiatives which deserve some comments before looking at the way forward in implementing the strategy being advocated here. These initiatives are at different stages of development and they largely depend on funds availability, as most of them are expected to be externally financed. Among these are the following:

- Egypt is preparing to increase its existing 16 620 MW as of 1997 by 10 000 MW in 2010. Also, extensive oil drilling is progressing presently.
- Nigeria at presents flares unassociated gas that is equivalent to 460 000 barrels of oil a day but has decided to eliminate this by 2008. The start of the Nigeria Liquefied Natural Gas project is an indication of progress here. Nigeria has also raised electricity production from 3 000 MW in 2000 to 5 000 MW in 2001 through overhauling and rehabilitating existing facilities, and plans a rise to 10 000 MW by 2010.
- The South Africa–Mozambique oil pipeline project will be finished in 2004.
- Uganda now has two more new dams with a capacity of 80 MW added to the 180 MW from Nalubale, and plans three other 40 MW units by 2004. Further, a Norwegian Consortium is planning another 150 MW by 2006. Rural electrification programmes mean that 100 MW from mini hydro plants will be also be added soon.
- Zimbabwe intends to construct a 1 400 MW thermal station by using an independent power producers scheme.
- PV solar home systems for 16 000 households in rural Morocco will be undertaken by Total Energie, Total FinaELF and Electricité de France, at a cost of 13 million euros.
- A solar module plant in Namibia costing $6.4 million opened in March 2002; another in Sudan will produce 40 000 per year, equivalent to 2 MW.

African Union future energy plans

The future of Africa will substantially depend on further development of the African Union, which was formed in July 2002. The economic and social development aspects of the Union were discussed in the New African Initiative, which is merger of Senegal's Omega Plan and the Millennium Partnership for African Recovery that was proposed by Algeria, Nigeria and South Africa. This

New African Initiative was later renamed as the New Partnership for Africa's Development (NEPAD). Among the priority areas for NEPAD is investing in information and communications technologies and other basic infrastructure (transportation, energy, water, and sanitation). Apart from this, all the priority areas have indirect links with the provision of adequate modern energy production and use. According to NEPAD, the objective is to increase access to reliable and affordable modern energy supply from 10% to 35% in 20 years (2020), provide energy at a low cost to support annual economic growth of 6%, reverse environmental degradation due to energy supply and use, exploit hydropower, develop regional networks in electricity and oil and gas, and reform petroleum regulations to facilitate cooperation.

Some of these proposed actions are in line with the strategy proposed in this book, and we are satisfied that the strategy will assist with meeting some of the desires expressed by the political leaders of the continent.

The future path

The future of energy in Africa will depend on the continent's capacity to fulfil the different components of this strategy and that of the African union. Africa's energy starting base requires substantial modern energy input to the energy system. Contributions from commonly advocated practices such as energy efficiency and renewable energy technology can have only a limited impact, given the low starting base, and the comparatively high cost of the latter.

In advocating the present strategy, however, the following points are brought forward:

- Most of the technologies advocated in the strategy are available but not accessible because of their cost.
- Suitable and appropriate technology acquisition mechanisms need to be employed.
- Existing financial mechanisms with concessionary terms are limited, and commercial loans are difficult because of high interest rate.
- African countries need to take full responsibility for the future of their energy sector.
- Well-known strategies for stimulating energy demand by building on the productive sector should be employed.
- Building of capacity, both institutional and human, is crucial.

If these considerations are satisfied, then there can be an African energy system capable of not only producing modern reliable and affordable energy services for meeting urgent needs, but one which can also provide the inputs to improve the overall net productivity of the continent and ensure prosperity.

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