Lighting up Africa: Energy for development

Victor Konde, ATDF

Abstract

Energy is vital to poverty reduction, improving the quality of life, driving economic development and creation of employment. This paper provides a glance at Africa's energy resources, energy production and consumption patterns and some of the policy trends. The paper also suggests some alternative options of improving access to commercial energy and ensuring Africa's energy security.

Introduction

The relationship between energy and poverty is one that is often ignored until fuel shortages, blackouts and price increases remind us of the link. Energy is central to reducing poverty, whether poverty is seen as material deficiency, measured in terms of income or consumption, or quality of life, measured in terms of exposure to risks.

For instance, indoor air pollution caused by open cooking fires increases the risk of pneumonia, chronic obstructive lung diseases and headaches [1]. According to the World Health Organization, "half the world's population is exposed to indoor air pollution, mainly the result of burning solid fuels for cooking and heating... [globally accounting] for 36% of all lower respiratory infections and 22% of chronic obstructive pulmonary disease" [2].

History also shows that the industrial revolutions were partly driven by increasing access to improved energy services. Countries with greater access to advanced energy resources (largely coal) grew faster [3]. Similarly, a recent survey found that rural electrification benefited even homes that were not connected, in terms of longer business hours, improved health and education services, and greater access to information (e.g. television). Electricity was cheaper, safer, cleaner and better than kerosene lighting and charcoal heating (e.g. pressing irons) [4].

Indeed, the electrification of additional rural farms in Mkushi, Zambia, is credited with driving agricultural performance by reducing the cost of irrigation and supporting [crops] farming throughout the year. Zambia's non-traditional exports have increased by over 212% in 10 years, accounting for about 34% of total exports in 2004, despite mineral production hitting a new high [5]. Other benefits of commercial energy include easy processing of food, and extension of business/service hours, among others.

Energy firms employ thousands of highly qualified and experienced individuals, contribute greatly to the revenue base of the country (e.g. corporate income tax or government tax on fuel) and to development (e.g. inbuilt rural electrification taxes). For instance, the major African oil exporters, such as Angola, Algeria, Libya and Nigeria, rely heavily on the energy sector for economic growth. Furthermore, there are also indirect benefits through backward linkages such as with firms that supply products and services to the energy sector.

Over the past few years, energy issues have received little attention in development planning, especially among development agencies. The Millennium Development Goals are unlikely to be attained without access to reliable energy. The just released Africa Commission Report acknowledges the role energy plays in development in several places. Similarly, the African leaders, through the African Energy Commission, emphasized that "Africa must harness its energy resources and make them available to meet the energy needs of its peoples in order to be able to develop and provide an alternative to deforestation and use of firewood." However, energy does not seem to receive the attention it deserves.

Poverty reduction in Asia has been associated with increase in trade, most of which was driven by increased foreign direct investment (FDI). Destinations that had the necessary infrastructure and services (including energy) and skilled labour attracted most of the FDI. As discussed later, it is not surprising that Asia's energy production and consumption grew the faster between 1980 and 2001 than that of Africa or South America, within the same period.

The provision of even diesel powered hammer mills could enable farming rural communities to process their crops in a short period of time and encourage them to store some of their harvests. Many people already struggle to provide modern lighting by using batteries to power television sets, florescent tubes and bulbs. Whether we agree or not with the assertion that commercial energy is vital in fighting poverty, industrial growth and wealth or job creation, at least we know there is demand for commercial energy services.

1. Africa's exploitable energy resources

Africa is estimated to have at least 112 billion barrels of proven oil reserves and at least 14 trillion cubic metres of proven natural gas reserves [6]. In addition, the continent has over 50 billion tones of proven coal reserves, technically exploitable hydro-energy capacity of about 1,888 TWh/y (TW = terawatt or one million megawatt) and abundant biomass [7]. The exploitable hydro energy capacity in Congo D.R. alone is thought to be higher than the installed electricity capacity in the US. In addition,

Africa is one of the major producers of uranium, an input for generation of nuclear power.

One of Africa's most abundant renewable energy resources is sunlight. With the equator dividing the continent in half, lengths of daylight vary marginally all year round. In addition, the continent has a number of hot-springs and other exploitable geothermal resources, wind and biomass.

These energy resources are unevenly distributed across the continent. Most of the petroleum reserves are concentrated in the northern and western parts of Africa while most of the exploitable hydro-energy resources are concentrated in central Africa. Similarly, most the confirmed coal reserves are found in southern Africa while economically exploitable geothermal resources are located in eastern Africa.

Technically, Africa has sufficient exploitable energy resources to meet its energy needs. The continent is a net-exporter of energy resources, especially petroleum and uranium. For instance, in 2004, Africa produced about 9.3 million barrels of oil per day but is estimated to have consumed only 2.6 million barrel a day [6].

2. Africa's energy consumption

The energy consumption pattern, on the other hand, is very worrying from a developmental perspective. About 60% of Africa's energy requirement is met by biomass alone (primarily wood) while petroleum and electricity meet only about 33%. In contrast, biomass meets only 14% of the global energy consumption while petroleum and electricity meet about 60% (see table 1).

Table 1. A comparison of Africa and world energy consumption patterns

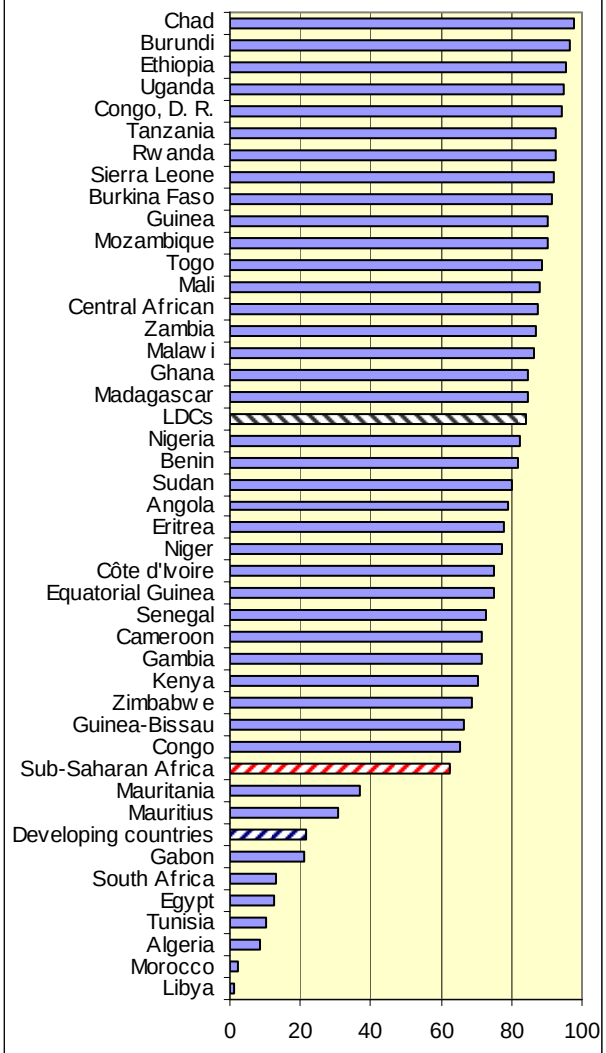
Source	Africa (%)	World (%)
Biomass	59	14
Coal	4	7
Electricity	8	16
Gas	4	16
Heat	-	3
Petroleum	25	44

Source: International Energy Agency

At a country level, biomass makes up more than 90% of the energy consumed by about 12 countries. About three 3 countries (Algeria, Libya and Morocco) derive less than 10% of their energy requirements from biomass. Most African country's dependence on traditional energy resources is above the average for SSA and developing countries (see figure 1).

It is, therefore, not surprising that only 17% of the population in sub-Saharan Africa has access to electricity. That figure drops to about 5% in rural areas [8]. In other words, Africa, with 850 million people, consumes almost the same amount of electricity as United Kingdom, with 60 million inhabitants. Africa's average electricity consumption per capita is about

Figure 1. Traditional fuel consumption (% of total energy)



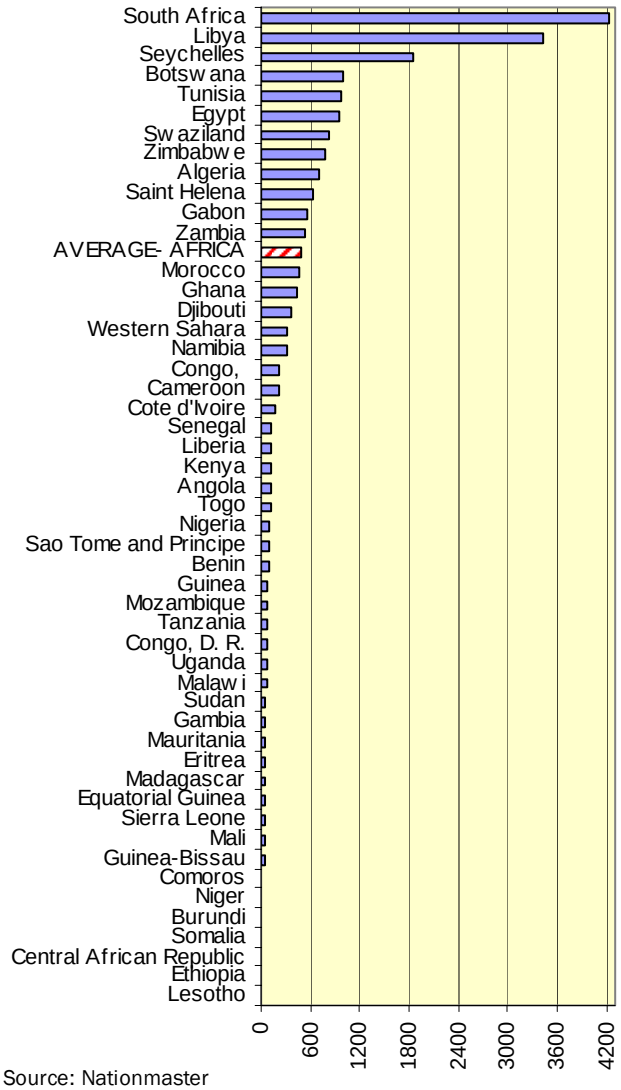
Source: UNDP, HDR 2004

15% that of the world average. About 12 countries have electricity consumption per capita above the African average (see figure 2). More importantly perhaps, four countries - South Africa, Egypt, Libya and Algeria- account for nearly 80% of the electricity consumption in Africa even though these countries have only 13% of Africa's population.

From a global perspective, Africa's share of commercial energy consumption is small. Africa consumes about 3.3% of the global oil even though its production share of global oil is 11.4%, and its consumption of natural gas is about 2.6% even though it production share is 5.4% [6]. Similarly, Africa consumes only 3.8% of global coal although its world production share is 5.4% (see a comparison of consumption by energy source of developing regions in table 2).

In terms of sectors, about 50% of commercial energy of Southern Africa is consumed by the industrial sec-

Figure 2. Electricty consumption (in KWh/capita 2001)



Source: Nationmaster

Table 2. Share of global energy consumption (as a percentage of total).

	Oil	Gas	Coal	Nuclear	Hydro
Africa	3.3	2.6	3.8	0.5	3.2
Asia	28.9	13.3	50.7	17.5	23.1
LAC	6.0	4.2	0.7	0.8	21.5

Source: BP, 2005.
Note LAC; Latin America and the Caribbean

tor and about a third goes to transportation [8]. In contrast, transportation accounts for a much greater share in Central, East and West Africa than in Southern Africa, - an indirect indicator of a small industrial base. Further, residential activities account for about a quarter of energy consumption in North Africa.

Africa's energy consumption per capita has remained almost constant between 1980 and 2001. However, Africa's energy intensity (*the amount of energy required to generate a given economic output*) remains one of the highest, almost twice the world average. Congo D.R., Ethiopia, and Nigeria are among the most energy intensive countries (see figure 3).

Over the same period, the energy intensity of the US, UK and Canada have decreased partly due to the increasing shift toward services from manufacturing and promotion of energy efficient production systems. However, energy intensity may vary widely especially when countries experience economic and political crisis, such as in the case of Congo D.R. and Mozambique, reflecting both a difficult to acquire energy resource or the limited energy is spent on economically unproductive activities.

Africa's low energy consumption per capita may be explained by the low economic growth and, to a lesser extent, high population growth. As Table 3 shows, Africa's real GDP grew on average at about 2% per annum between 1980 and 2001 while that of Asian and LAC grew at about 6.8% and 2.1% per annum, respectively. Africa was the only region where population growth outpaced economic growth and GDP per capita fail.

Table 3. Regional average annual growth rates, 1980-2001

	Energy consumption	Electricity consumption	GDP	Population
Africa	*2.5*	*3.1*	*2*	*2.5*
Asia	5	7.7	6.8	1.7
LAC	2.9	4.5	2.1	1.8

Source: US Department of Energy, 2003

3. Meeting the escalating energy demand in Africa

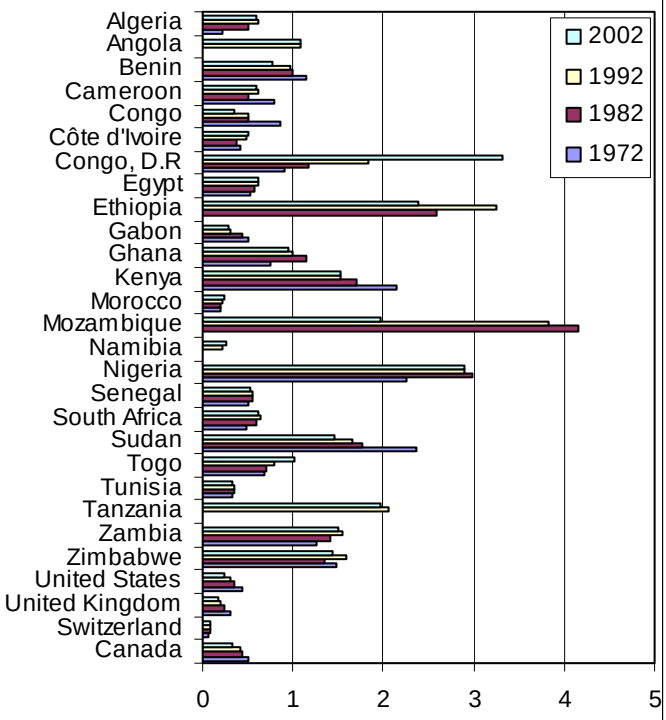
Albert Einstein is quoted saying "[w]e can not solve problems by using the same kind of thinking we used when we created them". Some of these problems include limited investment in innovation (especially energy-related R&D), infrastructure, public awareness and diversification efforts. Africa is experiencing its best growth rate in recent times (since 1995) and energy should facilitate as well as be part of the growth.

The choice of energy technology

Although there are several energy technologies, the choice may be influenced by natural energy resource endowment, comparative costs of deploying and maintenance of the various options, technological base of the country, consumer needs, political ambitions and environmental considerations, among others. For example, South Africa and Congo D.R generate most of their electricity from coal and hydro resources, respectively, due to the existence of such resources in their respective countries.

Figure 3. Energy intensity of selected countries

(Kg OE per 1 dollar of GDP)



Source: UNCTAD Database of Statistics

The need for clear and consistent energy policies

Following the oil crisis of 1973 and the fall in sugar prices, many African countries considered production of ethanol to reduce their dependence on and the import bill of oil. Zimbabwe's experience highlights the problems associated with technology transfer and the need for clear and predictable policies to allow corporate planning. Triangle Ltd, a private sugar production firm, decided in 1975 to use surplus molasses to produce ethanol. A Germany firm agreed to supply only a "turn-key" project. However, several automatic controls had to be discarded in favour of manual operation to suit the capabilities of the local workforce [9].

By the mid 1990s the plant was producing about 40 million litres per year and a blending ration of 13:87 (ethanol to gasoline) had been attained, slightly lower than the target ratio of 15:85. Ethanol production increased incomes of about 150 cane farmers, facilitated acquisition of advanced technologies and consumed molasses, formerly a waste product. This success was partly based on a ready and influential customer- National Oil Corporation of Zimbabwe - which bought the ethanol and sold it to various oil distribution firms.

In contrast, Kenya's success was short lived even though its 60,000-litres per day ethanol plant created employment for about 1,200 people. Although the failure was partly blamed on drought and pricing, the lack of government commitment and clear production, blending and marketing policies accounted for much of the failure.

Irrespective of the energy 'mix' of the country, a sound energy policy should at least:

⇒Seek to maintain stable energy supply and, indirectly prices

⇒Set predictable regulatory and fiscal incentives

⇒Set clear, quantifiable and verifiable targets

⇒Encourage diversification, investment and efficiency, and

⇒Promote innovation and technological upgrade and development.

The need for policy stability and clarity is more important especially following the current liberalization of energy markets in Africa and Africa's environmental and trade commitments enshrined in international agreements.

4. The way forward

Rural electrification; the need for sustainable and cheap energy

The challenge of increasing access to electricity for rural areas, from its current 5%, is daunting. However, African countries have unique opportunities of accessing a wide range of established and emerging energy technologies to exploits their abundant natural energy resources.

Given a choice, she would prefer a gas or electric cooker to give her lungs a break from polluted air and her back from carrying loads of firewood.

Solar energy is currently promoted as an easy to deploy, use and manage energy technology. Several countries, including Ghana, Kenya, South Africa, Zambia and Zimbabwe, have included solar energy in their programmes in an effort to provide wider access to electricity lighting. This has to be viewed as 'quick-fix'

as its economic viability and sustainability (without long-term government subsidies) remains unknown [10].

However, emerging technologies promise to cut down the cost of production of solar panels and may bring them within the reach of some communities or national programmes.

Biogas technology exploitation remains low in Africa despite its potential as a source of heating (cooking) and electricity generation. In South Africa, a school with 1000 students depends on two 20-cubic metre digesters fed by an 8-toilet block and cow dung. The biogas generated, about 16 cubic metres per day, is used for cooking in the domestic science classroom and running a modified 5 horse power diesel engine which in turn drives a 2 kW AC generator. "The unit energy costs over a 15 year lifecycle are lower than solar electrification, and can be markedly cheaper than grid power, should the grid have to be extended to this location" [11].

India and China are among the few countries that employ biogas for community electrification [12]. Communities with high cattle populations could easily use the dung to produce biogas for power generation. In addition, recent improvements in biotechnology could soon make it possible to generate biogas or capture it from landfills. In this case, the electricity or gas is a bonus as the slurry is used as a fertilizer.

A school biogas plant powers a four-plate cooker and an electric generator

Source: AGAMA

Mini-hydro power plants: There are several small hydro power plants in many African countries. However, it is not as highly promoted as solar power despite the fact that the initial investment is comparatively low, maintenance costs are minimal, economically sustainable, and the expertise and materials are locally available.

Countries could employ local knowledge and student research projects to identify potential hydro-energy resources for small electricity generation plants. This could lead to the development of reliable maps and stimulate entrepreneurs, with adequate public support, to develop commercial energy ventures.

Exploiting other energy resources: Other energy resources, such as bio-ethanol/diesel, coal, gas, geothermal, nuclear and petroleum, should be considered, depending on national resource endowment, technological expertise, public perception and national experience. The diversification of energy sources is important to ensuring energy security of countries. For instance, countries that are prone to severe droughts have seen their hydro power production drop (e.g. Ethiopia, Kenya and Uganda) during droughts or periods low rainfall.

Countries, such as Angola and Nigeria, burn valuable gas from their oil wells that could be harnessed to generate electricity for a good proportion of their population. Kenya, because of its growing demand for electricity, is encouraging the exploitation of its geothermal resources that are generally not affected by rainfall variations. Others may wish to emulate such diversification efforts.

African experience with bio-ethanol and bio-diesel, and cogeneration of electricity from agricultural raw materials is well established. Countries such as Kenya, Malawi, Mauritius and Zimbabwe have, to varying degrees of success, developed power plants or refineries. Mauritius' experience shows that with supportive legislation and government incentives, generation of electricity from bagasse is commercially viable. For example, "[t]*he gross revenue derived from sale of electrical energy represent [ed] 90% of that derived from processing of cane into sugar by the millers in Mauritius"* in 2000 [13].

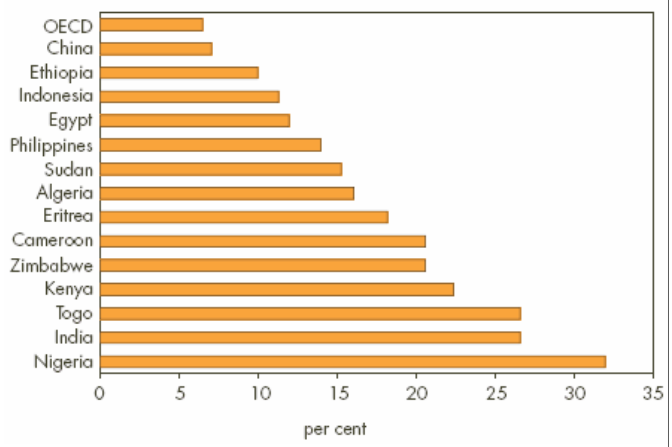
Africa, with its high dependency on agricultural commodities, could pass legislation that requires petroleum refineries to use a given percentage of bio-ethanol produced from crops, such as sorghum, sugar cane and maize. For instance, the US Senate passed a bill in June 2005 that requires refineries across the country to use about 30 billion litres of ethanol a year by 2012 [14]. The major beneficiaries of such a policy are farmers and processing plants, and those employed due to expansions and development of new facilities that will process the extra ethanol.

For Africa, the technology does not need to be fancy but practical and useful. There are many studies to determine if filtered soy oil could somehow be tweaked to run in a car [15]. For Africa, finding a way to make it safe to run hammer mills, water engines, irrigation pumps and power electricity generators could improve the lives of rural communities.

"And God said, 'Let there be light' and there was light, but the Electricity Board said He would have to wait until Thursday to be connected." (S. Milligan – Indian Humorist)

Curing Africa's chronic blackouts: The cost of electricity blackouts in African is not known. The 2003 electricity blackout that plunged part of US and Canada into darkness is estimated to have cost about $6 billion [16]. The number of blackouts in many African cities could easily accumulate into several lost labour-days or weeks. A businessman put it simply: “The worst part is not knowing when the blackouts will hit. When you least expect it, everything comes to a standstill” [17] Unreliable energy supply may account for the low levels of private investment Africa attracts and economic productivity of its limited industries, needed to reduce poverty.

Figure 4. Electricity losses of selected countries



Source: Energy Outlook 2002: Energy and Poverty, IEA

African countries have also some of the highest levels of electricity losses (see Figure 4). Such losses may be due to illegal and dangerous connections by people who live close to the electricity grids (that are denied the service) and unpaid bills. Countries with losses of over 20% are losing revenue that could be used to expand energy services.

Regional integration of grids: Although some of the measures above may help light up Africa, curing Africa's chronic blackouts is critical to industrial development. Bilateral and regional integration of electricity grids could provide a quick and reliable fix (where blackouts are due to limited electricity supply and load shedding). There are already several electricity pools or initiatives in Africa [18]. For example, Eskom's proposed 40,000 megawatts (worth $50 billion) hydro power plant on the Inga river, Democratic Republic of Congo, will feed a pan-African electricity grid to western and northern parts of Africa, and from there to southern Europe.

Blackouts due to load-shedding and overloads of the grid would be reduced by such regional projects. The rest will require investment in modern infrastructure to detect faults, improvement in public awareness to reduce or eliminate illegal connections and theft of public property (e.g. transformers), improvement in revenue collection and development of technical expertise needed to ensure reliability.

Reducing the impact of price volatility: Many African countries began searching for new energy alternatives following the 1973 oil crisis, partly credited for the decline of some African economies. That enthusiasm disappeared with fall in prices. As oil prices have continued to climb new initiatives are in the offing but very little is concrete. At risk, is Africa's overall growth potential as only a handful of oil-exporting countries are benefiting from the windfall in 'petrol dollars'.

African countries have to consider energy efficiency in the development of their transport, housing and industrial development. For instance, the lack of mass public transport into and out of African cities is a major drain on national

Energy efficiency: Mass transport options for Africa?

Top; Cuban "Camel"; **bottom:** Belgian bikes and streets

Source: http://ohbike.org and http://www.cubaheritage.com

resources (in increasing petroleum import bill) and make transportation of already under-paid workers expensive. This may include improving the efficiency and comfort of railway networks as an alternative passenger transport system, phasing out of up to 12-seater buses, development of central cooling and heating systems of larger buildings, among others.

Given the small size of African economies, they may wish to develop common or regional oil stock reserves. Since, African economies may not witness economic prosperity or crisis at the same time, such a reserve may regionally cushion those hardest hit by price increases and provide them with time to put into place national measures to cushion the impact. Such a mechanism may have the added advantage of fostering political and economic cooperation, enabling countries to tap into refining capacity of others and the development of common petroleum-related standards.

Marketing alternative energy technologies: The marketing of several energy technologies, such as briquettes (from agricultural remains) and deployment of biogas, remain a major challenge. Several African countries (e.g. Ethiopia, Ghana, Kenya, Malawi, Senegal Zambia, Zimbabwe) have produced or produce briquettes. However, production remains low and marketing is very poor in some of the countries.

It may be wise to locate demonstration units closer to the target population and/or industry and to sensitize the public of the benefits and limitations of the technology. Such awareness could attract political and industrial interest. For example, the ability of briquettes to compete with or replace charcoal may be influenced by the availability of briquettes at public market places and their costs and user benefits. Like

all other products, alternative energy technologies have to be marketed efficiently and effectively if they are to make a meaningful impact.

Conclusion

Continuous investment in energy-related research and development, and the creation of energy courses in polytechnics and universities has to be part of national energy policies. Indeed, introducing courses on the design of solar cookers and panels, electrical wiring of homes and cars, energy efficient technologies and products, and advantages and disadvantage of nuclear and hydro-electric plants, among others, in primary and secondary school programmes could help raise interest and awareness in energy technologies.

Emerging technologies in the areas of nuclear, fuel cell, solar and wind energy also open up new opportunities for business and expanding energy supply in Africa. African leaders should pay more attention to what others are doing. If other countries are scrambling to secure the limited energy resources and investing in new technologies, it may be time to join the race. Even bigger players like the US regard energy as central to their economic and social development.

It may also be easier to acquire emerging technologies, through international R&D agreements, before their commercialization. The cost of establishing a competitive production plant once the technology has matured can be prohibitive to late comers. Africa could either learn along or wait in the hope that once the technology's economic viability is demonstrated business houses will donate it. So far, the later has not worked.

For Africa, energy is a source of income (major source of tax revenue and foreign exchange), a business (a major employer) and a facilitator of development (key input in health, agriculture, transport and education). Any energy policy has to recognize and provide incentives to ensure energy effectively plays its different roles in poverty alleviation, industrial development and wealth creation. Such support may take the form of friendly legislation, fiscal incentives and political awards or recognition to encourage investment, R&D activities and involvement of different players in the energy sector.

References

1. Bruce, N., McCracken, J., Albalak, R., Schei, M., Smith, K. R., Lopez, V. and West, C. (2004) Impact of improved stoves, house construction and child location on levels of indoor air pollution exposure in young Guatemalan children, *Journal of exposure analysis and epidemiology*, S22-S33.
2. WHO (2004) *The World Health Report 2002: Reducing Risks, Promoting healthy Life*. WHO; Geneva
3. Barnett, A. (2000) Energy and the Fight against Poverty, Energy and the "Empowerment" of Livelihoods, Sussex Research Associates Ltd
4. Marge, R. M. (2003) Impacts of Rural Electrification on Poverty and Gender in Sri Lanka World Bank; Washington DC
5. 2005 Budget speech, Ministry of Finance and National Planning, Zambia
6. BP (2005) Putting energy in the spotlight, BP Statistical Review of World Energy 2005
7. WRI (1994) World Resources 1994-1995: A guide to the Global Environment. Oxford University Press, New York.
8. EIA (1999) Energy in Africa, US DOE accessible at http://www.eia.doe.gov/emeu/cabs/archives/africa/africa.html
9. See the thematic background paper for 2004 International Conference for Renewable Energies at http://www.renewables2004.de/pdf/tbp/TBP11-biomass.pdf
10. See O.S. Kalumiana- Rural Energy Access: Promoting Solar Home Systems In Rural Areas In Zambia – A CaseStudy at http://www.afrepren.org/Pubs/articles/wrec/pdfs/kalum.pdf
11. Austin, G. (2003) Biogas energy and sanitation provision in south Africa, AGAMA Energy (Pty) Ltd.http://www.agama.co.za/press_news/ae_biogas.htm
12. Goldemberg, J. and Johansson, T.B. (Eds; 1995) "Energy As An Instrument for Socio-Economic Development" UNDP, New York,
13. Deepchand, K. (2001) Commercial scale co-generation of bagasse energy in Mauritius, *Energy for Sustainable Development* Vol. 1
14. http://www.washingtonpost.com
15. http://energy.cas.psu.edu/soydiesel.html
16. For review of three estimates see ELCON (2004) The economic impacts of the August 2003 blackout (at http://www.elcon.org/)
17. Madamombe, I. (2005) Energy key to Africa's prosperity: Challenges in West Africa's quest for electricity, Africa Renewal, 18, 6-8
18. WEC (2003) The Potential for Regionally Integrated Energy Development in Africa: a Discussion Document, World Energy Council, London.