Technical Paper on Environmental Implications of Energy Developments in Africa

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1. INTRODUCTION

Energy utilization is indispensable for all human activities of survival and development and for improvement of quality of life. Improving energy access and energy security have therefore been high priorities in national development policies and programmes.

Energy supplies are obtained directly or by extraction and conversion from primary energy resource endowments found at specific environments. The utilization of energy also takes place in the environmental locations where specific energy services are needed. Above tolerable limits, concentration of the solid, liquid or gaseous products and the residual waste heat of energy conversion, supply and utilization processes, can adversely impact life and health as well as the carrying capacity of the environment. The intricate links between energy, environment and development have recently attracted increasing policy attention due to mounting international concern over adverse environmental impacts of energy supplies and uses at the local, regional and global levels.

The role of environmental conditions determining the availability and utilization of renewable and fossil energy endowment has also recently become a matter of growing policy concern. Changes in climate due to global warming induced by increasing concentrations of greenhouse gases in the atmosphere, and severe environmental degradation due to deforestation will

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decisively influence future energy systems and availability of energy and especially biomass energy in Africa.

2. CURRENT ENERGY SITUATION IN AFRICA

2.1 Traditional and commercial energy patterns

Energy used in Africa in 1988 totalled 288 million tons of oil equivalent (Mtoe). Africa's population of 610 millions (12 percent of world population) thus accounted for only 3.5 percent of world total energy of 8.2 billion toe in 1988. By comparison South America and Europe with 5.5 and 9.7 percent of world population accounted for 4 and 22 percent respectively of world energy use.

At 0.48 toe, the yearly average energy use per capita in 1988 in Africa as a whole, was only 29 percent of the world average, 40 percent of South America's, and 74 percent of Asia's. Low per capita production and service levels as well as low quality of life of the vast majority of African populations are largely a consequence of low average per capita energy use.

Traditional energy (i.e. woodfuel, charcoal, crop residues and other biomass etc)in the majority of African countries contributes over 70 percent of total energy use. Its share is lowest in the southern-most and northern-most parts of the region. It contributed only about 4 percent in the group of African countries Botswana, Lesotho, Namibia, South Africa and Swaziland which are members of the South African Customs Union (SACU); and about 8 percent in the North African group Morocco, Algeria, Tunisia, Libya and Egypt.

In the 27 least developed countries (LDC) among the 42 African countries sandwiched between the two groups , traditional energy accounted for 85 percent of total energy. These 27 African LDCs holding one third of the continent's population accounted for only 18 percent of its total energy use.

The share of commercial energy (i.e. coal, electricity, petroleum fuels, natural gas etc.) in African per capita average energy access is very low , except in the ten countries at the northern and southern extremities of the continent. The commercial energy percentage of average per capita energy in the 27 LDCs is 15 percent and considerably lower in many individual countries. Overwhelming dependence on traditional energy utilized at very low efficiency adds to the high rates of depletion of the standing stock of biomass in local environments which is drawn down for other important purposes. The environmental degradation that follows can be severe especially where biomass survival and growth rates are inherently low as in the drought-prone arid and semi-arid environments which are wide spread many in African countries.

2.2 Energy resource endowments and their use

The African continent's endowments of primary energy resources are considerable although unevenly distributed; 55 billion barrels of petroleum and some 6 000 billion cubic meters of natural gas identified in Africa's 17.5 percent share of world sedimentary basin area (which however has received less than 4 percent of world petroleum exploration/production expenditure); 88.5 billion tons of coal, peat and lignite (despite very low exploration coverage); over 200 000 MW of hydro potential; considerable potential in geothermal energy mainly in the Rift Valley; wind energy chiefly on the continent's sea coasts; great potential in solar energy especially in the ASAL and substantial potential in biomass and animate energy etc. This wide range of fossil and renewable energy resource endowments remains largely undeveloped for the benefit of Africa's major population sectors experiencing worsening shortages of energy for survival and development.

Some of the large readily accessible known African reserves of coal, petroleum and natural gas are being exploited. But the bulk of production is being exported mainly to Europe and the

Americas. Only about 40 percent of Africa's output of these fossil energy commodities during the period 1985-88, was used in the region. By comparison, South America and Asia utilized 71 and 83 percent of their respective production of commercial energy commodities.

The ten oil producing African countries are self-sufficient in petroleum products and natural gas and could remain so for the medium term future. These countries could readily cover their transportation, electricity and other energy needs with these hydrocarbons.

All the African non-oil producing countries, import petroleum products and/or crude oil where there is an operating refinery. Petroleum products contribute up to 90 percent or more of commercial energy in most of the oil importing countries. The petroleum products are used principally in transportation, mainly in the road transport sector. The very modest annual petroleum import quantities (typically only a few hundred thousand tons per country) impose a heavy burden on meagre foreign exchange earnings of most of the countries and in particular the LDCs. These imports often absorb 30 to 50 percent of annual foreign earnings depending on export commodity quantities (subject to drought) and commodity prices and oil prices that have soared to high levels.

Oil exploration is recently spreading in prospective areas in many African countries hoping for new discoveries adequate at least to relieve the heavy oil import burden and possibly earning from exports hard currency for financing development.

Less than 4 percent of Africa's hydro-power has been harnessed so far. Its considerable geothermal energy potential has also yet be tapped except in Kenya. The high levels of year-round solar radiation, which much of the continent receives, and the substantial wind energy potential along its extensive sea-coasts have also yet to be harnessed.

2.3 Energy technologies

Most African countries import all except the simplest biomass energy supply and end-use technologies. Also imported are all conversion technologies for deriving commercial energy supplies from fossil and renewable energy resources and commodities; technologies for transporting and distributing energy supplies as well as end-use technologies for obtaining energy services such as heat, light, mechanical power etc from energy supplies. These energy technologies are commonly imported fully assembled or in sub-assembled form.

Escalating costs of technology on the one hand, and declining foreign exchange earnings from commodity exports on the other, have severely constrained capacity of most African countries to import energy technologies and spare parts for technologies already in use. The result has been a widening gap between commercial energy availability and requirements, even where ample energy resource endowments exist. Overwhelming technological dependence on imports is thus a decisive factor in the growing scarcity of commercial energy supplies available for survival and development uses in Africa.

3. LOCAL ENVIRONMENTAL IMPACTS OF ENERGY

3.1 Contribution of biomass energy to environmental degradation

Drylands of Africa constitute some 65% of its continental area and about one third of the world's drylands. About two thirds of these drylands are arid, semi-arid and sub-humid areas inhabited by some two thirds of the African population total. The remaining one third of the drylands consist of hyper-arid uninhabited deserts.

The majority by far of the African LDC are located in arid and semi-arid lands (ASAL), in the Sahel and in Eastern and Southern Africa. In the LDCs located in fragile ecologies of

ASAL, heavy dependence on biomass for energy exacerbates rapid devegetation of the environment due to cutting of trees and other biomass for a wide range of uses in addition to land-clearing for expanded agricultural production of food and export commodities. Once devegetated, the fragile ecologies erode rapidly and often desertification follows with biomass for energy becoming even more scarce than before. The high level of energy wastage in biomass energy uses aggravates the scarcity. It is estimated that some 40 percent of Africans already face energy scarcity and insecurity.

3.2 Local environmental impacts of fossil fuels

Severe environmental impacts commonly arise on land, water bodies and the atmosphere in the localities in Africa where fossil fuels such as coal, oil and natural gas are produced, processed or supplied. The gaseous emissions of fossil fuel uses also cause air pollution. The health and environmental impacts of these emissions are serious problems in urban and industrial areas where fossil fuels are used intensively. These problems are becoming of serious concern in an increasing number of locations as fossil fuel production, processing supply and utilization expands in Africa.

3.3 Energy wastage - environmental consequences

Excessive wastage of energy is common in Africa in production, transport, distribution and utilization of traditional and commercial energy. The wastage arises due to low inherent efficiency of energy technologies applied as well as due to over-aged equipment. Improper operation, inadequate maintenance and repair of most energy technologies including energy efficient technologies is also widely prevalent and aggravates energy waste in African countries.

Severe soil loss and environmental degradation that is a consequence of land devegetation, is accentuated by highly

wasteful use of biomass energy. Excessive waste in commercial energy supplies whether imported or produced from indigenous resources, increases the burden that energy and energy technology imports impose on meagre foreign exchange resources.

Environmental degradation is commonly induced in production, processing and transportation of commodities exported to earn foreign exchange. Such environmental degradation may be regarded as a consequential damage that is heightened by excessive wastage of commercial energy.

4. GLOBAL WARMING AND ENERGY IN AFRICA

4.1 Greenhouse gas emissions of energy in Africa

Because of its adverse world-wide consequences, climate change due to global warming induced by rising concentration of greenhouse gases in the global atmosphere in recent years, has raised intense concern at the international level.

The principal cause of rising greenhouse gas concentrations is rapidly increasing human use of fuels, and in particular of fossil fuels such as coal and oil. Among the products of combustion of these fuels are the emissions into the atmosphere of greenhouse gases including carbon, nitrogen and sulphur oxides. Natural gas a very potent greenhouse gas, commonly occurs in coal and oil deposits. Such associated natural gas can escape into the atmosphere in the course of production of coal and oil. Leakages of natural gas into the atmosphere, may and often do occur in the course of its production, storage, transport, distribution and use.

Africa's 2.6 percent share in the world total of fossil fuel used in 1988 means that its annual contribution towards build up of carbon dioxide in the global atmosphere was only a minor fraction of the world total.

Biomass burnt in Africa in 1988 has been estimated to have made a net contribution of 80 million tons carbon- 290 million tons of carbon dioxide- to the global atmosphere, mostly due to land-clearing and burning rather than use of biomass for energy. It is worth of note that the aggregate annual growth of woody biomass in Africa as whole is over twice as much as the consumption of biomass fuels and three times as much if crop residues and dung are taken into account.

4.2 Adverse impact of global warming on energy

Arid and semi-arid lands are expected to become drier and subject to more frequent and more severe droughts under global warming. Biomass growth and survival rates reduced much below current low levels, would worsen scarcity of biomass for energy in 37 African countries partly or wholly located in such areas.

Global warming may also be expected to reduce hydro-electric energy potential in the affected countries, as a result of reduced rainfall and run-off. Cote d'Ivoire, Egypt and Ghana experienced drastic shortfalls in their hydro-electric outputs during the 1983/84 drought in Africa. Zambia and Zimbabwe have also experienced similar shortfalls during the 1991/92 drought in Southern Africa.

Growing scarcity of biomass and hydroelectricity in Africa under global warming, would heighten the need for energy thrift and efficiency; for switching to natural gas and environmentally benign alternative energy sources.

In addition, global warming would also reduce the capacity of African countries located in ASAL to produce agricultural commodities for export earnings essential to finance energy technology imports for improving energy savings and efficiency, switching to natural gas and development of alternative energy sources.

5. TRANSITION TO SUSTAINABLE ENERGY SYSTEMS IN AFRICA

5.1 Urgency of an orderly energy transition

It is evident from the foregoing brief survey that at present the development of African energy systems is confronted by formidable environmental, economic and technological constraints. Climate changes induced by global warming may be expected to heighten these constraints. Energy patterns and trends prevailing in most African countries are thus not economically and technologically sound nor socially equitable or environmentally sustainable.

A transition to sustainable energy systems is inevitable. It could be brought about as a carefully planned and controlled transition process within an acceptable time frame by implementing country-specific transitional energy policies and strategies.

On the other hand, a chaotic transition could come about as shortages of traditional and modern energy progressively worsen while predominately "business-as-usual" energy policies and strategies are continued. Such a chaotic energy transition would unleash unprecedented socio-economic devastation. The adverse economic and social impacts of a transition would be harsh, deepening deprivation and hardship among the most vulnerable members of the vast majority of African rural and urban households. The contribution of unsustainable African energy system to the degradation of local and subregional environments and to global warming greenhouse gases would also grow as long as the unsustainable systems and trends persist.

5.2 Policy for orderly transition to sustainable energy

The major elements of policy to be implemented to effect orderly transitions to sustainable energy systems in African countries would include:

Improving energy efficiency substantially in all energy forms and particularly in biomass energy;

Switching from use of the high carbon fossils fuels of coal and oil to natural gas;

Substantially increasing the use of renewable hydro, wind geothermal and solar energy resources.

An orderly transition to sustainable energy systems would aim to:

- Check the current rise of traditional and conventional energy requirements in direct proportion to population growth;

- Optimize the benefits of investments in renewable and fossil energy development.

- Arrest and ultimately minimize the contributions of traditional and modern energy supplies and uses to degradation of local environments and to build-up of the concentration of global warming greenhouse gases in the atmosphere;

It goes without saying that these policy goals would need to be pursued without prejudice to, but rather while simultaneously enhancing the attainment of sustainable socio-economic development targets.

6. MITIGATING ENVIRONMENTAL IMPACTS OF ENERGY

6.1 Agenda 21 towards sustainable energy development and environment

One of the main goals of transition to sustainable energy development in African countries would as noted above, be

mitigation of the adverse impacts of energy supplies and utilization on local, regional and global environments.

Proposals of policies, strategies and programmes of action to mitigate and avert climate change and irreversible environmental degradation, have emanated from a multitude of national, regional and international conferences and meetings. The United Nations Conference on Environment and Development (UNCED) held in June 1992 in Brazil, perhaps the most comprehensive of initiatives in this regard, has adopted Agenda 21 as well as several international conventions towards sustainable development.

African countries actively participated in and contributed their due share to the UNCED preparatory process and the elaboration of the resolutions and conventions that emanated at UNCED. The African Common Position on the African Environment and Development Agenda published in March 1992 substantively consolidates these contributions.

In adopting Agenda 21 unanimously, all member States of the United Nations, the majority of which including African countries were represented at UNCED at the highest levels of government, undertook to implement the programmes of action set forth therein. These programmes detailed in the 40 chapters of the Agenda 21 document of some 800 pages, encompass a wide spectrum of programmes in all socio-economic spheres. The member States of the UN are committed to implement without delay, the programmes of action at the national, regional and international levels, towards the attainment of sustainable development and environment early in the twenty-first century in all countries.

The intricate links and key role of energy in both environment and development, lend implicit and explicit energy dimensions to the majority of the programmes in Agenda 21, thereby making energy one of its main areas of focus. Avoiding, mitigating and rectifying its adverse environmental, health and

economic impacts while at the same time optimizing the socio-economic benefits of energy in developing and industrial countries, are features of a large number of the programmes.

Such important energy and environment issues of major relevance in Africa, are found explicitly addressed in particular in seven chapters of the Agenda, namely:

Chapter	4	-	Changing Consumption Patterns.
"	6	-	Protection and Promotion of Human Health
"	7	-	Promotion of Sustainable Human Settlements.
"	9	-	Protection of the Atmosphere.
"	11	-	Combatting Deforestation.
"	12	-	Managing Fragile Ecosystems: Combatting Desertification and Drought.
"	14	-	Sustainable Agricultural and Rural Development.

It is worthy of note that of the four programme areas of Chapter 9, the one entitled B. "Promoting sustainable development" has an extensive sub-programme dealing only with "Energy development, efficiency and consumption". It is stressed therein that:

> "The basic and ultimate objective of this programme is to reduce adverse effects on the atmosphere by promoting increase in the contribution of environmentally safe and sound and cost-effective energy systems particularly new and renewal energy, through less polluting and more efficient energy production, transmission, distribution and uses. This objective should reflect the need for equity, adequate energy supplies and increasing energy consumption in developing countries and the need to take into consideration the situation of countries that are

highly dependent on income generated from the **production, processing and export, and/or consumption of fossil fuels** and associated energy-intensive products and or the **use of fossil fuels** for which countries have serious difficulties in switching to alternatives and of **countries highly vulnerable to adverse effects of climate change."**

This objective is to be pursued by governments at the appropriate level, with the cooperation of the relevant United Nations bodies, and as appropriate, intergovernmental and non-governmental organizations, and the private sector by implementing a wide range of appropriate activities. The following is a selection from the lengthy list of activities:

- Cooperate in identifying and developing economically viable, and environmentally sound energy sources to promote the availability of increased energy supplies in particular in developing countries;

- Promote at the national level appropriate methodologies for integrated energy, environment and economic policy decisions for sustainable development, inter alia through environmental impact assessments;

- Promote research, development, transfer and use of improved energy-efficient technologies and practices, including endogenous technologies in all relevant sectors, as well as into environmentally sound energy systems including renewable energy system with particular attention to developing countries;

- Build capacity for energy planning and programme management in energy efficiency, as well as for the development, introduction, and promotion of renewable sources of energy;

- Promote appropriate energy efficiency and emission standards of recommendations at the national level.

- Review how the contribution of environmentally sound energy could be increased in an economically efficient manner, taking into account country specific social, physical, economic and political characteristics, and examining and implementing, measures to overcome any barriers to their development and use;

- Coordinate energy plans regionally and subregionally, where applicable;

- Evaluate and, as appropriate, promote cost-effective policies or programmes, including administrative, social and economic measures, in order to improve energy efficiency;

- Build capacity for energy planning and programme management in energy efficiency, as well as for the development, introduction, and promotion of renewable sources of energy;

- Promote appropriate energy efficiency and emission standards of recommendations at the national level.

The second sub-programme area under this programme area of Chapter 9, deals with promoting sustainable development in "Transportation". The objectives of activities of this sub-programme are "to develop and promote cost-effective policies or programmes, as appropriate, to limit, reduce or control, harmful emissions into the atmosphere and other adverse environmental effects of the transport sector.....". As is well known the harmful emissions of the transport sector are the fuel vapours and the gaseous products of combustion of the fuel-energy used for propelling transport vehicles on land, water and in the air. These exhaust emissions include oxides of carbon, nitrogen,

sulphur etc. and other greenhouse gases as well as suspended particulate solids which are responsible for the growing problems of urban air pollution even in major African cities.

6.2 Financial costs of implementing sustainable energy programmes

The UNCED secretariat has estimated the average total annual cost (1993-2000) of implementing activities of the four-part programme on sustainable development to be about USD 20 billion from the international community on grant or concessional terms. A major portion of this cost estimate will be required for implementing the activities promoting sustainable energy development, efficiency and consumption which are acknowledged to be highly capital-intensive.

African countries, it is anticipated will annually require about USD 5 billion minimum out of the international funds estimate. The international funds will nevertheless amount to a modest but essential catalytic component of considerably greater resources African countries themselves will need to mobilize and commit to pursuit of sustainable energy development.

6.3 Oil market prospects with carbon taxes

Several measures are being promoted recently under Agenda 21 and the International Convention on Climate Change adopted at UNCED, with a view to mitigate the prospects of rapid global warming and climate change. One of these measures, a carbon tax on petroleum fuels may be brought into force in some major OECD countries in order to inhibit further growth of carbon dioxide emissions and ultimately to reduce atmospheric carbon dioxide levels by raising the costs of using petroleum energy. It is feared that a substantial reduction in oil demand in the major oil consuming OECD nations may follow as a result. This is likely to keep international oil prices low. At the same time, energy prices raised by the carbon tax would translate into

increased prices of exports from industrialized to developing countries.

In a scenario of OECD-wide application of carbon taxes African countries can therefore expect that low international oil prices would diminish prospective returns on the considerable investments that need to be made to exploit oil discoveries hoped for in prospective ares. Oil exploration in prospective areas had recently been vigorously promoted by African countries hoping for discoveries that could at least save on the foreign exchange burden of oil imports and possibly earn from oil exports, convertible currency essential for development. African countries can also expect higher outlays for energy efficient technologies and renewable energy technologies which they need on a massive scale for an orderly transition to sustainable energy systems.

7. CONCLUSION

African countries face the prime challenge of raising their currently low levels of per capita access to energy, to levels that are adequate for sustainable development and improvement of the quality of life of the vast majorities of their populations. The challenge is redoubled by the imperative of ensuring that the improvements to adequate per capita levels are achieved in a sustainable environment. This requires them to effectively mitigate energy's adverse environmental impacts which until recently were largely neglected with considerable financial savings in the countries that have now attained advanced development status.

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