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REPORT

on the problematics of energy in the ACP countries

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INTRODUCTION

Article 32 of the Cotonou Partnership Agreement provides as follows:

"1. Cooperation on environmental protection and sustainable utilisation and management of natural resources shall aim at:

(a) mainstreaming environmental sustainability into all aspects of development cooperation and support programmes and projects implemented by the various actors;

(b) building and/or strengthening the scientific and technical human and institutional capacity for environmental management for all environmental stakeholders;

(c) supporting specific measures and schemes aimed at addressing critical sustainable management issues and also relating to current and future regional and international commitments concerning mineral and natural resources such as:

i. tropical forests, water resources, coastal, marine and fisheries resources, wildlife, soils, biodiversity;

ii. protection of fragile ecosystems (e.g. coral reef);

iii. renewable energy sources notably solar energy and energy efficiency;

Energy therefore constitutes one of the areas provided for under the Cotonou Agreement.

The theme of energy is a crucial challenge for the ACP States and its partnership with the European Union to analyse the ways of implementing the recommendations of the Johannesburg Summit of 2002, when the two organisations made commitments to strengthen their respective roles in the sustainable development of the natural resources of their Member States, especially to provide their populations with affordable, environmentally-sound energy options.

Indeed, considering energy as a fundamental aspect of the energy debate was aimed at: *"Helping to attain the Millennium Development Goal to halve the number of people living on less than a dollar a day, by 2015, as well as the other goals, by providing sufficient, affordable and sustainable energy services."*

A discussion was held on the theme of energy during the last session of the Joint ACP-EU Parliamentary Assembly held in Edinburgh, Scotland from 15 to 28 November 2005. This report was prepared in the wake of the discussions that took place on that occasion within the Committee on Economic Development, Finance and Trade. As such, the document should facilitate the identification of areas of work that would enable the energy objective of the ACP-EU cooperation to make a significant contribution to the economic support of the ACP States and create the conditions for rational and efficient production, development and distribution to the benefit of their economies. In that way, the main objectives targeted in Article 1 of the Cotonou Partnership Agreement can be attained:

> *Article 1 […] The partnership shall be centred on the objective of reducing and eventually eradicating poverty consistent with the objectives of sustainable development and the gradual integration of the ACP countries into the world economy.*

The theme of energy is dealt with extensively in the Compendium on cooperation strategies of the Cotonou Partnership Agreement which provides as follows:

2.5. Energy Development:
Co-operation shall put particular emphasis on energy programming, operations for saving and making efficient use of energy, reconnaissance of energy potential and the economically and technically appropriate promotion of new and renewable sources of energy. Co-operation shall also support policies aimed at the development of the ACP States' conventional and non-conventional energy potential and their self-sufficiency.

Broad access to suitable energy constitutes a necessary condition for economic and social development, although currently a large, and in places growing, proportion of the population do not have access to adequate energy services.

Long-term sustainable development should be the guiding principle for future development co-operation programmes involving sustainable energy, with the concept of sustainability encompassing social, economic, environmental, functional and institutional considerations.

The priorities for development co-operation are to help improve the supply, distribution and use of energy in developing countries in order to help foster economic and social sustainable development and the elimination of poverty.

The adverse local, regional and global environmental effects of current and future energy systems should be minimized. Examples of important energy related environmental issues are the balance between

A broad objective is to improve the efficiency of production, distribution and use of energy in all its forms.

The parties recognize that sustainable energy is an important tool for achieving sustainable development, with energy being regarded not as a commodity but as a provider of services to improve livelihoods. They recognize the importance of decentralized, user focused activities, and place a particular emphasis on renewable sources of energy and end-use energy efficiency techniques, with large electricity generating plant now predominantly in the hands of the international financing institutions and the private sector.

As a cross-cutting issue, sustainable energy shall be integrated into wider development co-operation policies and projects (rural development, water, health, education, communications and information technology, transport etc).

One priority shall be to develop the internal capacity in ACP states to achieve policy objectives. Institutional capacity and skills shall be enhanced through development co-operation to allow energy analysis, planning and the development of appropriate policies and framework conditions to attract investment.

A competitive energy sector shall be encouraged through development of appropriate policies, framework conditions and capacities, with the private sector having an important role in providing finance for energy developments.

The parties recognise the importance of civil society for implementation of sustainable energy objectives. Development of partnerships between the various actors (public administrations, private sector, civil society and donors) shall be important for achieving policy objectives.

The benefits of regional development shall be operationalised where appropriate. Potential benefits include the enhancement of economic stability, as well as the advantages of economies of scale.

Technical and financial assistance shall be provided to support priorities outlined in indicative programmes.

Capacities shall be developed to allow for the integration of sustainable energy into all levels of development co-operation.

Partnerships shall be encouraged between the various actors (public administrations, private sector, international financing institutions, civil society etc) in order to allow the financing and implementation of decentralized activities.

Co-ordination between donors shall be enhanced to improve the effectiveness of development co-operation in the field of energy. One possible mode of operation is for partnership agreements between EU and ACP country parties regarding institutional and policy support for the energy sector.

This report is intended, therefore, to provide specific indications of the energy potential in the ACP States, so that the strategies formulated in the framework of the ACP-EU Partnership can be directed towards optimally developing the energy potential of ACP States, thereby allowing them to secure the cost and volume of their energy supply.

I –SOURCES OF FOSSIL ENERGY

1.1 – OIL AND GAS

1.1.1 – Oil and gas in Africa

1.1.1.1 – General situation in the sector

Africa has considerable oil reserves concentrated mainly around the Gulf of Guinea. The main oil deposits are distributed as follows:

- Nigeria has the largest oil reserve in Africa with a potential of 3,000 million tonnes, and is the leading oil producer in Africa with 98 million tonnes in 2003;
- Angola, with oil reserves (730 million tonnes) considerably smaller than Nigeria's, has made giant deep-sea discoveries (Dalia, Girassol and Kuito off-shore from Cabinda province
- Congo (Brazzaville), Gabon and especially Equatorial Guinea also have significant reserves ranging between 212 and 450 million tonnes.
- Oil reserves in Chad and Cameroon, though much smaller than in the other countries already mentioned, are estimated at around 120 million tonnes and 55 million tonnes respectively. However, industry sources believe that these may be much greater with

further exploration. This also applies to other countries (e.g., Angola), so Africa's share of world oil reserves may well rise.

TABLE 2.2 Crude Oil: Recoverable reserves and production		
Million tonnes	**Reserves end 2003**	**Production 2003**
Algeria	1 235	39.9
Angola	730	36.8
Benin	1	0.1
Cameroon	55	4.8
Chad	120	10
Congo (Brazzaville)	212	14.5
Congo (DRC)	26	1.2
Côte d'Ivoire	14	0.5
Equatorial Guinea	450	4.5
Ethiopia	NA	NA
Gabon	342	17.0
Ghana	2	0.3
Nigeria	3 000	95.6
Senegal	NA	NA
South Africa	5	1.1
Sudan	36	3.2
Total Africa	**6 228**	**229.5**

Source: Survey of Energy Resources 2001, WEC

Of a total of 46 refineries in Africa, Nigeria and South Africa have 4 each while 17 countries have only a single refinery each (Table 2.3). In terms of actual refinery capacity, Egypt leads with 726,000 barrels per day while South Africa, Algeria and Nigeria have 469,000, 450,000 and 439,000 respectively.

TABLE2.3. Refining Capacity (January 2004)			
	Number of Refineries	**Crude Oil Distillation**	**% of Africa Capacity**
Angola	1	39	1.2
Cameroon	1	42	1.3
Congo (Brazzaville)	1	21	0.65
Congo (DRC)	1	15	0.46
Côte d'Ivoire	1	65	2.02
Eritrea	1	15	0.46
Gabon	1	17	0.53
Ghana	1	45	1.40
Kenya	1	90	2.80
Liberia	1	15	0.46
Madagascar	1	15	0.46
Nigeria	4	439	13.71
Senegal	1	27	0.84
Sierra Leone	1	10	0.31
Somalia	1	10	0.31
South Africa	4	469	14.64
Sudan	3	122	3.81
Tanzania	1	15	0.46
Zambia	1	24	0.74
Total	**27**	**1 495**	**100.0**

Source: USDoE

African gas reserves are similarly concentrated in the Gulf of Guinea region which has the largest reserves in Africa and is the 7th largest in the world with 4.5 trillion cubic metres. Nigeria has gas reserves of 3.5 trillion cubic metres and the other countries have smaller reserves. Only two countries south of the equator, i.e. Mozambique and Namibia, have reserves in excess of 50 billion cubic metres.

Algeria is the largest gas producer in all of Africa - by a large margin - and the 4th gas producer in the world. Net of gas re-injected into oil fields, Algeria produced 83 billion cubic metres in 1999. The second largest African producer was Egypt with 15.5 billion cubic metres, followed by Nigeria with 7 billion cubic metres. Unlike the situation in Algeria, most of sub-Saharan Africa's gas is associated with oil and is simply flared. In 1998, 58% of gross gas production in sub-Saharan Africa was flared.

TABLE 2.4 Natural Gas: Recoverable reserves and production		
Billion cubic metres	**Reserves end 2002**	**Production 2002**
Angola	46	0.6
Benin	1	
Cameroon	110	
Congo (Brazzaville)	91	NA
Congo (DRC)	1	
Côte d'Ivoire	30	1.3
Equatorial Guinea	37	NA
Ethiopia	25	
Gabon	33	0.1
Ghana	24	
Madagascar	2	
Mozambique	57	0.1
Namibia	85	
Nigeria	3 515	7.0
Rwanda	57	
Senegal	11	NA
Somalia	6	
South Africa	19	1.4
Sudan	85	
Tanzania	28	
Total Africa	**4 263**	**9.8**

Source: Survey of Energy Resources 2001, WEC

1.1.1.2 – Human resources

Oil and gas production is a high-intensity activity with regard to human and financial resources due to the highly technical aspects involved in carrying out the activity. Indeed the significant mobilisation of these resources has led producers to focus on recruiting highly qualified workers with a particularly high level of training.

In this regard, oil producing countries are generally inclined to train their nationals in the occupations of the sector, or to create sufficiently attractive working conditions for people with this type of qualification.

Therefore, Nigeria, Gabon, Cameroon, Angola and South Africa (small producer) are among the countries which are making substantial efforts to ensure that their training systems have a technical training section or that their nationals benefit from training programmes in the best establishments in the developed world.

Nonetheless, there is still a significant lack of skilled national workers, which contributes to making oil production an essentially foreign-based activity since specialised staff is very often from the developed countries (e.g., in Equatorial Guinea, Congo (Brazzaville), Congo (DRC) which had a single science faculty whereas there were hundreds more in South Africa, Uganda and Nigeria, which had their own universities. The latter were faced with different problems. In general, a similar lack of skilled workers can be seen in senior, middle and lower management sectors, as well as in the manual labour categories. Qualified engineers are usually

hampered by a lack of support staff - boilermakers, welders, drill runners - to carry out their work effectively.

The proportion of specialised scientific workers is low: Africa contributes 0.7% to the world's Research and development scientists and engineers despite having about 13.5% of the world's population, representing 75 R&D scientists per 1 million inhabitants. Consequently, highly-qualified Africans are rarely found in management-level jobs in oil companies operating on the continent.

Attempts have been made to reverse this trend but to date no strategy has proven effective. The 1980 Lagos Plan of Action initiated by the Organisation for African Unity (OAU) and the Technical Skills Development Plan proposed by the African Development Bank (ADB) in 1990 did not produce the expected results. They were short-circuited by the ineffectual political will of the States to implement the recommendations they proposed.

In addition to scarce financial resources there is the problem of human resource capacity. Even where countries have minerals or other raw materials, they may lack the skill to utilise them or develop alternative areas of comparative advantage. Consequently, although Africa is rich in raw materials these are exploited primarily by foreign companies which reap a major part of the profits.

1.1.1.3 – Financial resources, legal mechanisms and related factors

The financial capacity of the oil producing states is a fundamental element for assessing their ability to plan project development in the oil sector.

Generally, a country's credit rating is critical if it is to obtain loans for major international projects. Many African countries need to mitigate the real and perceived risks of investing in their countries. Factors contributing to risk include:

- Inadequate energy laws and regulations
- Lack of clear property rights
- Lack of capacity to enforce laws and regulations where they exist
- Currency non-convertibility (non-payment of energy import bills)
- Unstable purchasing power of energy customers
- Potential interference by governments
- Breach of contracts or concession agreements.

The main problems are the lack of trained manpower with the experience to organise proper maintenance and repair schedules, combined with a shortage of available funds. The problem is almost across board except in the far south of the continent. As a result, much of the plant and equipment is in dire need of refurbishing and upgrading.

In the petroleum industry, the poor state of roads and rail systems has sometimes caused disruptions to petroleum supplies that need to be transported to landlocked countries. Power stations in a number of countries are in serious need of attention, as are transmission systems. It has been said that the development of a maintenance culture would do much to help attract investment. NGOs and governments all have a role in capacity building, and they need to coordinate their efforts in this regard.

Growth in oil and gas production could be a powerful impetus for economic development in Africa. However, the events in 2002 and 2003 in the Niger delta during which demonstrators stormed the oil installations, causing them to close down temporarily, show that oil can also have a disruptive influence, if the country's oil revenues are not managed in a fair and transparent manner. Nigeria has learned from the Niger delta experience and taken measures aimed at managing the resources from its oil and gas production in a more transparent manner and using its oil revenues to promote economic reforms.

1.1.2 – Situation in the Caribbean

The Caribbean states are predominantly oil and gas importers since none of them boasts a significant oil production. Oil and gas imports represent over 75% of their primary energy supply. The small size and isolation of these countries make energy infrastructure costs higher than on the continent. In addition to being very costly, oil transport is dangerous for the environment. However, energy demand is increasing with population growth.

Cuba is one of the two significant producers of oil and gas in the Caribbean. Its oil and gas sector has attracted significant investment, both national and foreign, over the past ten years. In 2003, Cuba produced 4.3 million tonnes of oil equivalent (TOE), which enabled it to meet almost all the island's basic energy needs and half of total consumption. However, rocketing crude oil prices in 2004 has had a strong financial impact on the Cuban economy (in 2003, oil represented 21% of total Cuban imports). There are high hopes that the Spanish company Repsol will discover commercially-viable deposits in the Cuban part of the Gulf of Mexico within the next year. In summer 2004, Repsol discovered oil but it was not in sufficient quantity to be commercially viable.

Trinidad and Tobago is the 2nd natural gas supplier in the Caribbean region with two liquefied natural gas production units operating in the country and plans to construct two more. The oil industry is the most important element of the national economy and contributes to the GDP.

1.1.3 – Situation in the Pacific

Papua New Guinea is the only oil producing country in this region. In 2004, PNG's estimated production was 46,200 barrels a day, with proven oil reserves of 170 million barrels. Local consumption totals 17,000 barrels a day. In addition, an oil refinery has been constructed in Lae (north-centre of the main island). The US$30 million project (approx. 3.5 billion CFP) was financed by Paradise International Oil, a subsidiary of the Singapore-based Brian Chang Group.

Papua New Guinea also has significant gas reserves of 385.5 billion cubic metres. In 2001, national production was estimated at 110 million cubic metres, representing revenues of US$2,437 billion. Main export destinations are Australia 44.3%, Singapore 20.5%, New Zealand 7.7%, and China 4.9% (2003 figures).

1.2 - COAL

In contrast to oil and gas, virtually all of Africa's coal reserves are in the south. They are overwhelmingly bituminous and 90% are in South Africa, with proven recoverable reserves of 49,520 million tonnes in 1999. Most of the remaining reserves are shared between South Africa's neighbours, Botswana, Zimbabwe, Mozambique and Swaziland. South Africa is also the leading producer of coal, with 1999 production at 223,510 thousand tonnes. The second producer in 1999 was Botswana, with 945 thousand tonnes, followed by Swaziland with 426 thousand tonnes. Tanzania has produced minor quantities of coal, and no coal production was recorded in East Africa.

Coal represents 27% of South Africa's exports (after iron ore, but ahead of cereals, phosphates and bauxite). Richard's Bay Port is the main coal terminal in the world (60 million tonnes/year). South Africa's total production is 62 million tonnes.

The following industrial groups are involved in coal production and the market:

- Oil companies: Shell, Exxon, Mobil, Agip, Total which have a 50% interest in two South African mines (East Transvaal): Arthur Taylor Colliery (with the Group JCI)- 4.5 million tonnes/year; and Ermelo (with the Gencor Group) -1.25 million tonnes/ year. In 1996, the Total Group marketed 5.2 million tonnes, 3.2 million tonnes of which was its own production;

- Mining Groups: BHP (Australia), Anglo American Corporation of South Africa (Amcoal with 1996-97 production of 48.3 millions tonnes);

- Other Groups: Hanson (United Kingdom, United States, world's No. 1 of private groups, 120 million t/yr.), Consol-RWE (Germany, United States, No. 2 in the world), RTZ (United Kingdom, United States), Veba (Germany), Mitsubishi (Japan);

TABLE 1.1. Bituminous coal: recoverable reserves and production

	Reserves end 1999 (million tonnes)	**Production 1999 (thousand tonnes)**
Algeria	40	25
Botswana	4 300	945
Congo (DRC)	88	50
Egypt		200
Morocco		129
Mozambique	212	18
Niger	70	168
Nigeria	21	-
South Africa	49 520	223 510
Swaziland	208	426
Tanzania	200	5
Zambia	10	128
Zimbabwe	502	4 977
Total Africa	**55 171**	**232 581**

Source: WEC, Survey of Energy Resources 2001

1.2.1 –Situation in the Caribbean

There is no coal production in the Caribbean.

1.2.2 – Situation in the Pacific

There is no coal production in the Pacific.

1.3 - URANIUM

1.3.1 – Situation in Africa

Africa is relatively rich in uranium with a long history of producing it as a by-product of gold production in South Africa (the uranium was simply left in the tailings in the early years). The largest quantity of reserves recoverable at less than $130/kg lies in South Africa (mainly in association with gold), followed by Namibia and Niger.

These three African countries currently rank among the 10 leading global uranium producers. Within Africa, Niger leads with 2,918 tonnes annual production U3O8 (in 1999), followed by Namibia with 2,689 tonnes and South Africa with 1093 tonnes. South Africa's production is geared to its rate of production of gold. The Democratic Republic of Congo and Gabon were both previously producers of uranium.

TABLE 1.1 Uranium: reserves and annual production
(Conventional resources recoverable at US$130/kg)

thousand tonnes	**Reserves recoverable at US$130/kg end 2003**	**Annual production 2003**
Algeria	26.0	
Central African Republic	16.0	
Congo (DRC)	1.8	
Gabon	4.8	0.3
Malawi	11.7	
Namibia	180.5	2.7
Niger	71.1	2.9
Somalia	6.6	NA
South Africa	292.8	1.1
Zimbabwe	1.8	
Total Africa	**613.1**	**7.0**

Source: WEC Survey of Energy Resources 2001

Niger, with a production of some 3,000 tonnes a year, is the 3rd largest producer in the world. Its vast resources are estimated at approximately 210,000 tonnes and located close to the border with Algeria. However, the world market is declining. COGEMA plans to launch new uranium exploration projects in the Arlit region, 1,200 km north of Niamey. Explorations will be re-launched in addition to the concessions held by the group in the region. In 2002, a feasibility study was launched with a view to using the ISL method to mine the Inamouren deposit with reserves of some 80,000 tonnes of uranium.

Namibia has announced the start-up of the Langer Heinrich Uranium Project. The 6th largest uranium-producing country in the world in 2003, Namibia should now be able to maintain its position despite the steady decrease in production over the past years. First of all, the project life of the Rössing mine has been extended to 2009, and a 3rd development phase to 2016 or 2017 may

also be considered, given the evolution of metal prices. But more importantly, Paladin Resources, in charge of developing the Langer Heinrich deposit has given approval for production to commence. The reserves are estimated at 22.24 Mt at an average of 0.071% U_3O_8 (in the form of carnotite. With total investment estimated at $92 M, the project has an expected lifespan of 11 years for the mine and 15 years for the processing plant.

In Gabon, COMUF (Compagnie des Mines d'uranium de Franceville) began extracting uranium at the Mounana open pit mine in 1961, then the underground mine in 1968. To date, COMUF has produced approximately 25,000 tonnes of uranium from various deposits in the Mounana district, where it has extracted some 6.6 million tonnes of mineral at an average grade of 0.38% U. With a mill capacity of 1,500 tonnes/year of uranium metal, in 1996, 623 tonnes were produced. At the end of December, uranium reserves were estimated at 514 tonnes. Uranium production stopped in 1999.

South Africa has one nuclear plant with two 920 MW reactors. The plant is located in Koerberg, Cape province, and has been in operation since 1985, producing 11.3 TWh of electricity, that is, 6.5% of the country's production. No new power plant is foreseen. The country is the only producer of nuclear-generated electricity among the Member States of the ACP Group.

1.3.2 – Situation in the Caribbean

The Caribbean does not produce uranium.

1.3.3 –Situation in the Pacific

The Pacific does not produce uranium.

More specifically, nuclear energy is out of reach for most ACP countries. Currently, only one African country has access to nuclear energy: the Republic of South Africa, which has little hydro-electric sources to develop and which has the necessary technological know-how to utilise this energy source.

II – NON-FOSSIL ENERGY SOURCES

2.1 – HYDRO-ELECTRICITY

Note: The countries cited are the only ones where significant hydro-electricity production has been noted.

2.1.1 – Situation in Africa

2.1.1.1 – Southern Africa

Hydro-electric installations in South Africa total 667 MW, representing only 0.68% of total energy production in the country, while coal accounts for 92.68% of the total energy supply.

There are 10 large hydro-electric power stations in Angola with installed power of 287 MW. An additional 520 MW (Capanda projects) are being developed. In 1996, the hydro-electric plants in the country produced 846 GWh (latest data) out of a total 1,047 GWh of electricity produced. Angola's hydroelectric potential is 150 TWh per year but only 65 TWh is actually developed. The largest project currently under way in the country is the Capanda hydroelectric power plant (520 MW) in Malange province, at an estimated cost of CAN$2.8 billion. Once completed, the plant will enable Angola to double its installed power capacity by producing 2.4 TWh/year, which far exceeds the national demand for electricity. Machinery and equipment intended for electricity production were sabotaged during the war, and the government plans to renovate the Gove dam on the Cunene River. The Matala hydroelectric plant in Huila province will also be renovated. Angola and Namibia have signed bilateral agreements to develop the Cunene River and are considering the construction of a 300 MW hydroelectric facility at Calueque.

Lesotho has an installed power capacity of 75.2 MW. The country has only one power plant of over 10 MW.

Malawi's hydroelectric potential is estimated at 6 TWh/year, and the country has 282.5 MW of installed hydroelectric power. In 1996, Malawi's hydroelectric installations produced 858 GWh of electricity (last known data). The Kapichira hydroelectric plant has been in operation since 2003. Constructed at a cost of US$130 M, this facility should have the capacity to meet the needs of 4% of the population.

Mozambique has installed hydroelectric power capacity of 2,108 MW. In 2002, its installations produced 1,468 GWh of electricity. The country's hydroelectric potential is estimated at 50 TWh/year; just over half (32 TWh) of this potential could be developed. In summer 1996, Mozambique and South Africa signed a protocol agreement to continue the Mepanda Uncua project. In March 1997, Eskom (South Africa) and Electricidade de Mozambique launched feasibility studies. The 2,000-2,500 MW project is currently being developed downstream of Cahora Bassa (2,400 MW) on the Zambezi River. The Mozambican government commissioned feasibility studies concerning hydroelectricity development on the Zambezi River. Two projects were examined: Mepanda Uncua (1,400-1,600 MW) and the addition of 500 MW to the Cahora Bassa plant (2,040 MW). The cost of these projects is estimated at US$3 billion. The energy produced would be exported to South Africa.

Namibia's hydroelectric potential is estimated at 9 TWh/year. Almost all this potential (8.6 TWh) could be developed. The Ruacana hydroelectric plant (240 MW) in Angola supplies 97.8% of Namibia's electricity. NamPower, Namibia's national power utility, is currently examining the feasibility studies for two hydroelectric projects on the Cunene River, the natural boundary between Angola and Namibia: Epupa project (450 MW) located at the Epupa Falls, and the Baynes project (200 MW) located 40 km downstream of the Epupa falls in the mountains. The selected project will be developed by state-owned corporations from the two countries, consolidated into a bi-national organisation, "Permanent Joint Technical Commission for the Cunene River." Whichever project is selected, construction is expected to begin within the next two years at the latest. The Cunene River project would enable Namibia to be self-sufficient in energy, and the country could even export energy to its neighbours. Namibia currently purchases energy from South Africa.

The hydroelectric installations in Swaziland have a total installed power capacity of 44 MW.
They produce 40 GWh of electricity annually. Unfortunately, although the country's potential is estimated at 3.8 TWh/year, barely 10% of this potential can be developed.

Zambia has an installed hydroelectric capacity of 1,670 MW. These installations produce 7.6 TWh of electricity annually. Zambia's hydroelectric potential is estimated at 5,982 MW, of which a little more than a quarter (1,520 MW) could be developed. Zambia has signed a €6M contract with the Indian company, Bharat Heavy Electrical (BHEL), to renovate the Kafue Gorge hydroelectric station located south of Lusaka. Work will consist in installing 10 135-MW turbines which should increase production power from 900 to 1,000 MW. The World Bank and other donors have granted a US$230 M loan to Zambia to rehabilitate its electricity network. Work started with the renovation of the Victoria Falls power station. Similar work will be done on the Kafue Gorge and Kariba North hydroelectric stations.

Zimbabwe has an installed power capacity of 800 MW. Its installations produce close to 3 TWh of electricity annually. The country's power potential is estimated at 18.5 TWh/year, of which almost all (17.5 TWh) could be developed. At present 27% has been developed.

2.1.1.2 –East Africa

In 1994, Burundi's power potential was estimated at 1,371 MW with an annual production of 6 TWh (latest data). In 1995, the technically- and commercially-viable potential was estimated at 300 MW for an annual production of 1.5 TWh. Electric power in Burundi is made up mainly of hydroelectricity (95%) from 24 micro-hydro stations with a total installed capacity of 32 MW. The most important stations are at Rwegura (18 MW), Mugere (8 MW) and Nyemara (1.4 MW).

Electricity production by a few micro stations in the Comoros is considered insignificant by the official statistics, which also downplay the sole hydroelectric complex at Miringoni, Moheli.

Ethiopia has enormous hydroelectric potential estimated at 650 TWh/year, of which 250 TWh could be developed. The new hydropower station at Gilgel Gibe, with an installed capacity of 180 MW, has been in operation since October 2003. Investment totalled €247M. Donors included the World Bank and the European Investment Bank (EIB). The Tekeze power plant with an installation capacity of 225 MW is under construction and is expected to be completed in 2007 [as per Web sources, JA]

In 1998, Kenya's hydroelectric installations produced 3,359 GWh. The country's hydroelectric potential is estimated at 30 TWh/year and just under one third (8,860 GWh) of this potential can be developed. A Siemens-led consortium added 80 MW of power to the Gitaru hydropower station, which now has an installed capacity of 225 MW. Kenya Power Company Ltd. (KPC) is developing a 60-MW project on the Sondu River in Nyanza province. This plant, known as the Sondu/Miriu Hydropower Project, is located 250 km north-west of Nairobi. Work began on the Sondu/Miriu, a run-of-river power plant, in 1999 with funding (US$60 M) from the Japanese government's Overseas Economic Cooperation Fund. Kenya has an installed power capacity of 624.5 MW, of which 13.6 MW is distributed among six micro stations.

Madagascar's hydroelectric installations are made up of 11 small and micro hydroelectric stations with less than 20 MW of installed power, for a total installed capacity of 106 MW. JIRAMA operates the country's two hydroelectric power plants, six mini- and micro-stations and manages its water resources. In 1981, Madagascar's theoretical hydropower production potential was estimated at 321 TWh/year, technically feasible production at 180 TWh/year and economically feasible production at 49 TWh/year. Only 0.2% of Madagascar's technically-feasible potential has been developed.

Mauritius' hydroelectric potential is utilised to its maximum, but remains modest at only 6% of total power production. Electricity is produced during the rainy season from January to March. A portion of the water resources is allocated to agricultural activities. The CEB has eight hydroelectric power plants.

Uganda has an installed hydroelectric capacity of 186 MW at the Owen Falls plant (180 MW) on the Nile. The power at this plant has been increased by 80 MW, bringing capacity to 260 MW. This increase has enabled Uganda to increase its exports to Kenya from 30 to 80 MW a month, thereby injecting nearly US$1 billion per month into the coffers of the State. Another block of 120 MW should be added to the plant which was completed in 2004. Uganda's hydropower potential is estimated at 2,000 MW. To date, barely 10% of this potential has been developed.

In Sudan, in order to address the country's energy deficit, the NEC has undertaken two infrastructure projects to improve its distribution network: an emergency plan that is currently underway and a medium- term plan. China is financing 75% (US$200 M) of the Kajbar hydroelectric project, and the Sudanese government is to provide the remaining 25%. Environmental protection groups fear that the project will disturb the Nile's fragile ecosystem. The Nubian populations also risk being displaced. Construction of a dam at Hadab would, if it is completed, add 1000 MW to Sudan's hydroelectric installations. The country's hydropower potential is approximately 2,000 MW. The Chinese group, CCMD, has signed a US$555 M contract to construct a dam on the Nile in the north of the country. CCMD commenced work in July 2002. The Merowe Dam, located approximately 300 km west of Atbara, is currently under construction at a cost of US$800 M funded by the Arab Development Fund (AFESD). Installed capacity will be 1,250 MW and will facilitate an increase in the country's potentially arable lands.

Tanzania's hydroelectric installations produce 1.7 TWh/year. The country's hydropower potential is estimated at 40 TWh/year, half of which (20 TWh) could be developed. At present, 5% of this potential has been developed. The country has an installed hydropower capacity of 377 MW, of which 10 MW is distributed among 22 small stations.

2.1.1.3 – Central Africa

Electricity production in Central Africa is more than 90% hydroelectric, except for Chad. Hydroelectricity is the source of several regional projects:

- joint development of the hydro potential in the Great Lakes region by SINELAC (Société Internationale de l'Electricité des Pays des Grands Lacs) established by Burundi, Congo (DRC) and Rwanda (Ruzizi II Dam);

- links to facilitate electricity exports from the Inga Dam on the Congo River to Rwanda, Congo (DRC) and Burundi.

Major projects currently being considered to facilitate better development of the hydroelectric resources of the Democratic Republic of Congo and the Great Lakes, on the regional or even international scale (exports to Egypt from Inga), have been compromised by the existing tension in the region. In some countries, the low price of hydroelectricity has been a factor in attracting large mining and metal processing (in Cameroon and DRC, for example).

Next to Democratic Republic of Congo, Cameroon is the country with the greatest hydroelectricity potential in Africa. Over 110 sites, with an electricity production potential of over 50,000 MW, have been identified.

The country's two largest hydroelectric plants, Edéa and Song Loulou, are located on the Sanaga

river. In 2003, China granted a € 46M loan to partly finance the construction on the Memve'Ele hydroelectric power station on the Ntem river, located along the border with Gabon and Equatorial Guinea. That station will provide 125 MW per year, a portion of which will be exported to these two (2) countries, while the rest of the energy produced will be used to partly offset the energy deficit currently facing the Cameroon.

The Republic of Congo's electricity facilities have an installed capacity of 89 MW. The Bouenza (74 MW) and Djoué (15 MW) hydroelectric plants, alone, have been providing 99 % of that country's electricity since 1980, the year in which the Bouenza power station was built. All the country's electricity is produced by SNE, the national electricity company. At present, the Congo has only two (2) hydroelectric power stations and one gas-powered thermal plant to meet its electricity needs, and must therefore import from the Democratic Republic of Congo (DRC) between 35 and 45 MW from the Inga station. The Congo and two Chinese companies signed a $US 220M-contract in November 2001 for the construction of a hydroelectric power plant of 120 MW on the River Congo. Once construction is completed in 2006, the plant is expected to double that country's installed power. The dam that is currently being constructed is located at Imboulou, on the River Léfini, some 14 km from the point where it meets with the River Congo, 215 km north of Brazzaville. The station with 120 MW will assist in providing electricity to the north of the Congo and put an end to the numerous power outages that affect Brazzaville. The work, the cost of which is estimated at $US 280M, is financed (15 %) by Congo's oil revenue while 85 % is funded by a loan from the combined entity led by China National Machinery and the Equipment Import and Export Corporation (CMEC). Work is expected to span a six-year period, i.e. until 2010.

Democratic Republic of Congo possesses approximately 37 % of Africa's potential hydroelectric resources, of which 16 % is located in Inga. DRC is currently developing a policy to export surplus energy from Inga. The Inga hydroelectric complex, located on the River Congo, some 300 km above Kinshasa, is the largest in Sub-Saharan Africa. It is made up of 2 stations - Inga I and II - boasting 1 800 MW each (a total of 3 600 MW), which were commissioned in 1972 and 1982, respectively. The stations are operating at only 20 % of their rated capacity; due to poor supplies of spare parts, 2/3 of the turbines are non-functional. Siemens hopes to renovate the Inga hydroelectric complex so as to re-launch its production operations that have slowed down since the start of the civil war. The German company also plans to install high-tension lines to Kinshasa and the Katanga region, located in the south-east of the country. This entails investment in the sum of 960 M$US, partly financed by Siemens' involvement in the diamond sector. The Inga site possesses significant hydroelectric potential. The project to build the *Centrale Grand Inga* (6 000 MW) is the condition *sine qua non* for a number of ambitious projects to export electricity from DRC to South Africa, Nigeria and even Egypt. New high-tension lines are expected to be installed over vast distances. The Grand Inga site in DRC possesses hydroelectric potential of 39 000 MW and could, by itself, meet the entire demand of all Africa. The hydroelectric sector is the origin of almost all electricity produced in DRC. That country's hydroelectric potential is estimated at 100 000 MW.

As regards hydroelectricity in Central Africa, the M'Bali dam, constructed to improve electricity supplies in Bangui, also ensures the regularity of the flow from M'Bali. There is another dam, located in Mobaye that was built by the Democratic Republic of Congo, but is not yet exploited by Central Africa. The country has two hydroelectric plants, Boali I and Boali II, with a combined installed power of 18.65 MW, located about 80 km north of Bangui, the country's capital. The country abounds in sites favourable to the production of hydroelectricity.

Hydroelectric plants produce three-quarters of Gabon's electricity. The largest ones are Tchimbele (69 MW) and Kinguele (57 MW) on the M'Bei river, and Poubara on the Ogooue river. The country's hydroelectric potential is estimated at 6 000 MW.

The hydroelectric plants in Equatorial Guinea are the Riabo station and the Musola micro-station for Bioko Island. The Bata hydroelectric plant that was built by the Chinese in 1980 supplies power to the continental region. The country's electricity production comprises oil-powered plants (80 %) and hydroelectric stations (20 %).

The water courses in Chad do not harbour a significant energy potential. They generally have inconsistent flows and lack manageable height differences. Nonetheless, the Gauthiot Falls, in the south of the country, offer the possibility of setting up hydroelectric facilities with an estimated annual production capacity ranging between 24 and 45 GWh.

2.1.1.4 – West Africa

In West Africa, with the exception of Mali and Burkina Faso, the Sahelian countries do not produce hydroelectricity.

No major hydroelectric plants exist in Benin, but 35 potential sites for hydroelectric stations were identified in 1984 in Benin by the CEB. Some of them are considered priority: Adjarala on the Mono, Kétou, Assanté and Olougbé on the Ouémé. There is also the possibility of constructing micro-stations, particularly in the north of the country. The Pouya hydroelectric micro-station on the Yéripao was built and commissioned in 1997. Consideration is being given to the idea of constructing, on the Mono river, the Adjarala hydroelectric plant with an installed capacity of 94 MW. The expected production is 0.16 TWh per year. According to a 1996 study, Benin's hydroelectric potential has been estimated at 1.67 TWh per year, all of which can be developed.

Côte d'Ivoire's energy production facilities are essentially made up of 9 stations (6 hydroelectric and 3 thermal). The state owns most of the plants, except for the two largest thermal plants which are under BOOT-type contracts (Vridi and Azito). The transport and distribution infrastructures are all state-owned. Approximately three-quarters of Côte d'Ivoire's installed capacity are hydroelectric. The main supplies come from Ayame I, Ayame II, Buyo, Grah, Kossou and Taabo. Construction and commissioning of the Soubré Dam (320 MW) will require investment estimated at 320 M$US. The Government would like the Soubré hydroelectric project to be placed under a BOOT-type contract. Construction of the complex will take between 6 and 10 years. Several projects for small hydroelectric plants of 5 MW or more are under consideration for the Aboisso region, in the south east of the country.

Ghana plans to build a hydroelectric plant on the Black Volta. This Bui project, with a budget of 700 million dollars, would have a capacity of 400 Mw. In addition to increasing the national electricity supply, the electricity produced in Bui could be exported to Burkina Faso, Mali and Côte d'Ivoire. Another facility, built on the Pra, would have a total capacity of 125 MW.

Guinea possesses significant hydroelectric potential estimated to have a total capacity of about 6.1 GW for guaranteed annual energy evaluated at 19 300 GWh. Seven stations produce 52 MW, including that of the *Grandes Chutes* (27 MW). The Garafiri dam, 160 km north of Conakry on the Konkouré River, began production in 1999. The hydroelectric plant has an installed capacity of 75 MW and an average annual production of 264 Gwh. Three other projects are under consideration: the Fomi project on the Niandan river (tributary of the Niger), the Kouroussa region, 45 km from Kankan (plant of 90 MW or 402 Gwh/per year), the TIOPO project on the Kogon river, the Boké

region (plant of 120 MW) the Kalèta-Souapiti hydroelectric Complex, designed for aluminium production (plant of 975 MW on the Konkouré river).

In 2000, Mali's hydroelectric facilities comprised two power stations: Sotuba (5.4 MW) which produces an average of 0.04 TWh per year and Selingue (44 MW) which produces 0.18 TWh per year. The Manantali hydroelectric power station was made operational in January 2002. Cost overruns and political tensions between Mauritania and Senegal had initially delayed its construction that was begun in 1997. Its capacity is made available to various networks based on contractual distributions: 15% for Mauritania, 52% for Mali, and 33% for Senegal. The power station of 200 MW (5 X 40 MW) can supply 0.81 TWh per year to three countries thanks to a high-tension network of 225 Kv over 1 300 Km. The Malian Government is considering several projects, such as the Tossaye and Kénié dams, and the Félou and Gouina plants, to develop the country's hydroelectric potential estimated at 1 050 MW.

There are few permanent water courses in Niger, but that country has several major sites that are suited to the construction of hydroelectric dams. These are located on the Niger river and its tributaries: the Kandadji site with a potential of 1 322 GWh per year, the Gambou site with 360 GWh per year and the Dyodyonga site with 75 GWh per year. The sites identified have significant capacities and their development will require considerable financial investment. The economic worth of Niger's hydroelectric potential is estimated at 230 MW.

Nigeria's hydroelectric installations have a total installed capacity of 1 938 MW, of which 20 MW is distributed among five small power stations. In 1998, these installations produced 7 TWh of electricity. Nigeria's hydroelectric potential is estimated at 43 TWh per year, and 60 % can be developed. At present, hardly 26 % of that potential is exploited.

Senegal linked its network to Manantali in July 2002 and Mauritania did the same in November that same year. In February 2004, the Energy Ministers from Togo and Benin agreed to strengthen cooperation by constructing a hydroelectric dam at Adjaralla, on the southern border between the two countries. Towards the end of the 90s, the two countries suffered disastrous power outages when Ghana, their main supplier of electricity, was forced to cut its supply by 50 %, as a result of severe drought which affected the hydroelectric powers stations in Akosombo.

Togo's total supply (520 GWh in 2000) includes production from Togo Electricity, from self-producers (50% of Togolese production capacity and 36% of production) - mainly from the Togolese Phosphates Office (OTP)-, land electricity purchased from CEB. The latter company exploits the Nangbéto dam on the Mono river (65 MW of which 30 MW goes to Togo) and provides 70% to the Volta River Authority (VRA) in Ghana. Since August 1994, CEB has also been purchasing electricity from the *Compagnie Ivoirienne d'Electricité* (30 MW for peak-hour supply). Togo's hydroelectric potential is estimated upwards of 200 MW.

The networks of the Nigerian Electric Power Authority (NEPA) and the *Compagnie électrique du Bénin* (CEB), are responsible for supplying electricity to Benin and Togo. NEPA has linked up to build a 330 kilovolts line linking Nigeria to Benin in the framework of West African integration that also includes Niger and Togo. At the start of 2003, work was begun on a project to link certain regions in Niger to the Nigerian electricity network. In the context of this project, three separate networks will be set up, at total estimated cost of 16 million dollars. The imported electricity will be much cheaper than the electricity that is currently used, which is locally produced from oil.

2.1.2 – Situation in the Caribbean

Dominica has three hydroelectric power stations that are responsible for approximately half the island's production. There, hydroelectricity accounts for 0.032 TW/h, i.e. 8 MW per day. Overall,

supplies from fossil energy sources account for 0.030 TW/h, i.e. 48..4% of the country's energy needs and a total of 11 MW/per day.

The Government of Guyana entrusted the development and construction of the Tumatumari hydroelectric power station (45 MW) to the Hydro-Energy-Qué Corporation. The project is estimated to be worth 75 M $CAN. CHE-Q is equally owned by HQI, Boralex, Hydro-Mecanic Construction and the *Fonds de Solidarité des Travailleurs du Québec*. Its role is to identify and develop hydroelectric and thermal projects of less than 50 MW in Latin America and the Caribbean. Guyana's main hydroelectric plant is Moco-Moco. It became operational in November 1999 and has an installed power capacity of 0.5 MW.

Haiti's hydroelectric potential stands at 154 MW, of which about one-third is exploited. The Péligre hydroelectric plant is Haiti's largest station with 54 MW. Its production is channelled to Port-au-Prince. The country's national hydroelectric capacity includes seven other micro-stations.

In Jamaica, total hydroelectric production stands at 0.114TW/h. This represents 1.83% of the country's energy needs, i.e. a production of 23MW per day. Fossil fuels account for 96.65 of local consumption, which corresponds to a supply of 1.269 MW per day.

The Dominican Republic's installed hydroelectric capacity stands at 402 MW, of which 2.2 MW is shared among 4 small hydroelectric power stations. In 1998, the country's hydroelectric installations produced 1.4 TWh. The Dominican Republic's hydroelectric potential has been assessed at 50 TWh per year, but only one-fifth (9 TWh) of that capacity can be developed.

2.1.3 – Situation in the Pacific

No significant hydroelectric production activity has been identified in the Pacific region.

2.2 - RENEWABLE ENERGIES

2.2.1 – Situation in Africa

The African continent is, for the most part, fully exposed to the sun, but solar energy technology is generally still too expensive to be used in Africa. Senegal and South Africa, leaders in this field, each have an installed capacity of approximately 1MW. Solar panels are now beginning to provide the solution in the most remote regions where they can serve as a less expensive option than diesel.

Geothermal resources are concentrated in the Red Sea Valley and the Rift Valley. Kenya is the main developer of geothermal energy in Africa, with 45 MW and direct use of heat. Ethiopia is the only other African country that now produces geothermal power. Algeria and Tunisia both obtain direct heat from geothermal sources.

So far, wind energy is largely underexploited in Africa. In Ghana, an initial evaluation has revealed that there exists, particularly along the border with Togo, wind energy potential of 2 000Mw. This is a considerable amount when one considers that the African continent, according to some experts, would need 40 000Mw of electricity to feed its industrialisation process.

Wood and its by-products are the sources of energy most frequently used by African households – especially in rural areas – due to availability and the absence of property rights on forestry resources, which constitute an almost free resource on an individual level. However, the availability of these fuels is now greatly reduced in certain regions due to over-exploitation. As a result, women and children are now obliged to cover increasingly larger distances to collect them.

In addition, the low volume of heat produced by this biomass greatly increases the cost of its utilisation per calorie consumed. Finally, poor combustion conditions cause not only low yields but also pose a danger to the health of the populations (this contributes to pollution inside homes and is the source of serious respiratory diseases). 89% of the population of Sub-Saharan Africa uses biomass (wood, residue…) for their lighting, cooking and heating needs.

An agricultural residue developed by many African countries is bagasse, a by-product of sugar-cane processing. It is estimated that there is a considerable potential to use energy from some 26 million tonnes of bagasse produced in Africa. The most significant example is Mauritius. In that country, the use of bagasse is part of a national plan implemented by the Government since 1992, following the first Gulf War. It offers an alternative to oil imports (savings on 20.000 tonnes per year), and facilitates better use of residue from sugar-cane processing. Its use remains a priority option in the implementation of Mauritius' energy policy in the medium- and long-term. Thanks to government support and local and foreign private investment, the Mauritius sugar industry currently meets 27 % of the island's electricity needs through the use of bagasse.

2.2.2 – Situation in the Caribbean

Traditional energies play an important role in the energy supply within the Caribbean, and particularly in Haiti (nearly 70%). This resource is threatened in Caribbean countries and has given rise to substitution policies (primarily diffusion of LPG and kerosene for cooking).

A meeting of Ministers of the Environment from Latin America and the Caribbean, organised in São Paulo in May 2002, prior to PrepCom IV, adopted, a Brazilian energy initiative as a resolution, the preamble to which provides for an increase, by 2010, in the region's use of renewable energy by 10 % of the total used (Preamble of the Final Report of the 7th meeting of the Inter-sessional Committee of the Forum of Ministers of the Environment from Latin America and the Caribbean).