Draft Technical Discussion Paper

"The existing and possible future role of renewable energy towards Universal Energy Access Particularly in rural and peri-urban areas of the ECOWAS region: Approaches, Opportunities and Constraints

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Executive Summary

Access to clean modern energy in rural and peri-urban areas is one of the goals of MDG to eradicate poverty and improve rural infrastructure development. Energy is the source of all life, so modern energy can be the source of a better life for all. Modern energy services are crucial to human well-being and to a country's economic development; and yet globally over 1.3 billion people are without access to electricity and 2.7 billion people are without clean cooking facilities. More than 95% of these people are either in sub-Saharan Africa or developing Asia and 84% are in rural areas.

Lately, many developing and emerging economies are trying to diversify their energy mix. In many cases, Renewable Energies (RE) are becoming a more and more important strategic component for many countries' diversification of their national energy supply, particularly in the rural and peri urban areas. RE have a competitive advantage because they provide a long-term energy supply (for electricity, heating or cooling) based on locally available RE sources and thus help to reduce dependency on energy imports. Besides, RE provide appropriate technological solutions for the electrification of rural or semi-urban areas where they can be used independently from grid-connection. RE are a key for the provision of modern energy services in these areas and contribute to the local economic and social development.

Despite the fact that the technical potential for RE resources such as wind, solar (heat from the sun), hydropower, biomass or geothermal energy (heat from the earth) is considered high in almost all the ECOWAS states, the sub-region is still faced with significant barriers for the development of commercially driven and sustainable RE markets. The inappropriate policies, targets and regulations are some of the constraints that limit the dissemination of RE in these countries. The existence of comprehensive policy frameworks for the promotion of RE and incentive instruments like tax relieves are needed in ECOWAS states for favourable market conditions and proper dissemination of renewable energy technologies in the peri-urban and rural areas of ECOWAS states.

In an attempt to alleviate the challenges of energy access, especially in the rural and peri-urban populations, the ECOWAS /EUMOA White Paper was initiated as a Regional Policy on Access to Energy Services for Rural and Peri-urban Populations in the ECOWAS Region. The objective of the policy is to ensure access to modern energy services to at least half the population living in rural and peri-urban areas by 2015.

As part of the implementation of this decision, this paper intends to contribute to the implementation of the ECOWAS White Paper by reviewing the energy access situation and various energy access options available especially utilization of renewable energy and energy efficiency technologies; and define and adopt regional intervention strategies for using renewable energy and energy efficiency for increasing access to energy in the region.

1. Introduction

Energy is an important input for meeting basic needs and for achieving socio-economic development goals that include fuel for cooking, heating and lighting in households, power for industry, and petroleum products for transportation. It is also an important factor in achieving the MDG goals (Table 1). The supply of and the demand for virtually every type of energy generates varying degrees of environmental externalities that affect human health, ecological stability and economic development. These effects can occur at the household, local, regional, national or transnational level.

Table 1 Role of energy in meeting MDG goals

MDG	Role energy can play
Reducing Extreme Poverty and Hunger	Improving ability to cook staple foods. Reducing post-harvest losses through better preservation. Enabling irrigation to increase food production and access to nutrition. Enabling enterprise development, utilizing locally available resources, and creating jobs. Generating light to permit income generation beyond daylight. Powering machinery to increase productivity Reducing share of household income spent on cooking, lighting, and space heating.
Universal Primary Education	Providing light for reading or studying beyond daylight. Creating a more child-friendly environment (access to clean water, sanitation, lighting, and space heating/cooling), less time needed for firewood collection, school feeding) which can improve attendance in school and reduce dropout rates. Providing lighting in schools, which can help retain teachers? Enabling access to media and communications that increase educational opportunities.
Gender Equality and Women's Empowerment	More free time from survival activities, allowing opportunities for income generation. Improving health status by reducing exposure to indoor air pollution Lighting streets to improve women's safety.& reducing rape victimization Providing lighting for home study and the possibility of holding evening classes
Health	Reducing exposure to indoor air pollution thus reducing respiratory and eye diseases, less burns, and improving health. Providing access to better medical facilities for maternal care. Allowing for medicine refrigeration, equipment sterilization, and safe disposal by incineration. Facilitating development, manufacture, and distribution of drugs. Providing access to health education media. Enabling access to the latest medicines/expertise through renewable-energy based telemedicine systems.
Environmental Sustainability	Boosting agricultural productivity, increasing quality instead of quantity of cultivated land. Reducing deforestation for traditional fuels, reducing erosion and desertification. Reducing greenhouse gas emissions. Restoring ecosystem integrity through land management. Alleviate environmental poverty

There are approximately two billion people, who lack access to electricity, and a further two billion depend on traditional fuels, such as wood and animal and crop waste, for cooking and heating. In Africa, two thirds of the population does not have access to electricity. Over a billion of these reside in informal settlements within

developing country cities. For one-third of the world's population, dependence on traditional fuels results in a significant number of hours being spent each day gathering wood, primarily by girl children and women, even in urban areas**.** In part due to poor infrastructure and prohibitively high up-front costs, the poor often face much higher energy costs than the non-poor. This is compounded by the limited access to appropriate financing schemes that can allow the poor to overcome the high-up front costs of cleaner energy devices and appliances. Other important energy challenges facing the poor, include low incomes that are not sufficient for the procurement of energy services to meet basic needs such as sufficient energy to cook food, provide affordable transport, power pumps for potable water; sterilize medical equipment; and, provide space heating.

West Africa has a population of 100 million poor, which means 44% of the region' s population live below the monetary poverty line of $1 per person per day. This is the highest percentage of any region in the world. Worse still, the figure is rising steadily and all signs indicate that the poverty reduction goal will not be met in this region by 2015.

Energy has a profound bearing on people's well-being. It supplies water and fuels agricultural output, health, education, job creation and environmental sustainability. Despite this, still in 2002, 1.6 billion people in developing countries were deprived of access to reliable and affordable energy services (such as electricity), and 89% of the population of sub-Saharan Africa use traditional biomass for cooking and heating. With more than one-third of a household's budget being set aside for fuel costs in many countries, the region's population pays an heavy price for a substitution fuel (mainly biomass) that is of poor quality and not very effective, whereas energy in some countries is as high as one third of a household budget.

Some progress have been made of recent in the ECOWAS region in electricity sectors. As the success of the reforms must in the end be measured by satisfying the needs of the masses, there must inevitably be a component devoted to rural populations. However, despite the modest progress made in reforming the electricity sectors, this has not matched the anticipated the improvements and expansion of service in the urban areas. The situation in the rural areas and peri-urban areas for electricity services remain basically the same or with little improvement for most countries of the region.

As a result of this the ECOWAS community has joined efforts with the help of many organizations, one of which is UNDP to undertake the challenges of energy access, especially in the rural and peri-urban populations. One of the outcomes of this is a Regional Policy on Access to Energy Services for Rural and Peri-urban Populations in the ECOWAS Region called the ECOWAS /EUMOA White Paper. The Regional Policy was developed jointly by ECOWAS and UEMOA with the technical and financial support of UNDP PREP, the Government of France and the Austrian Development Cooperation (ADC). The Policy has as global objective, by 2015, to ensure access to modern energy services to at least half the population living in rural and peri-urban areas.

The purpose of this study therefore is to review the energy access situation and various energy access options available especially utilization of renewable energy and energy efficiency technologies; and define and adopt regional intervention strategies for using renewable energy and energy efficiency for increasing access to energy in the region and thereby contributing to the White Paper implementation.

2 Regional status of energy production and consumption

In 2007 the conventional oil production in the ten largest hydrocarbon-producing countries in sub-Saharan Africa (Table1) was recorded at 5.6 mb/d, of which 5.1 mb/d was exported (i.e. 91%). The projected cumulative government revenues from oil and gas revenues in these ten countries is $4.1 trillion over 2006-2030[1]. With the high hydrocarbon wealth of these countries, most of their citizens remain poor and there is limited household access to modern energy services. About two-thirds of households do not have access to electricity and three-quarters do not have access to clean fuels for cooking, relying instead on fuelwood and charcoal. If there are no major government initiatives to address this problem, the number of electricity-deprived people is projected to increase. More than half of the total population of these countries still relies on fuelwood and charcoal for cooking in 2030[5].

The capital cost of providing minimal energy services (electricity and liquefied petroleum/gas stoves and cylinders) to these households is estimated to be about$18 billion by 2030[2]. This is roughly equivalent to only 0.4% of the governments' take from oil and gas exports by that time. To alleviate poverty generally and energy poverty specifically using oil and gas revenues, this can be done by improving the efficiency of revenue allocation and the accountability of governments in the use of public funds.

Of the total energy consumed (453 Mtoe, or 5.6% of global) by Africa in 2006, traditional biomass accounted for 59%, electricity 8%, petroleum 25%, coal 4% and gas 4%. About 75% of the total population in Sub-Saharan Africa currently have no access to electricity or any kind of modern energy services[3].

Table 2 Production and reserves in sub-Saharan African countries (ranked by oil reserves)[4].

	Reserves [billion barrels]	Oil Production [mb/d]	Exports [mb/d]	Reserves [bcm]	Gas Production [bcm/yr]	Exports [bcm/yr]
Nigeria	36.2	2.35	2.03	5207	29.3	18.9
Angola	9.0	1.70	1.64	270	0.8	-
Sudan	5.0	0.47	0.39	85	-	-
Gabon	2.0	0.23	0.22	28	0.1	-
Congo Brazaville	1.6	0.21	0.21	91	-	-
Chad	1.5	0.14	0.14	-	-	-
Equatorial Guinea	1.1	0.36	0.36	37	1.3	-
Cameroon	0.2	0.09	0.06	135	-	-
Cote d'Ivoire	0.1	0.06	0.03	28	1.7	-
Mozambique	-	-	-	127	2.7	2.7
Total	56.8	5.61	5.09	6008	35.9	21.6
% in world	**4.3%**	**7.0%**	**12.1%**	**3.4%**	**1.2%**	**5.2%**

[1] **World Energy Outlook. 2008.** "Prospects in oil- and gas-exporting Sub-Saharan African countries". http://www.worldenergyoutlook.org/docs/weo2008/WEO_2008_Chapter_15.pdf.

[2] World Energy Outlook, 2008

[3] http://www.iea.org/Textbase/subjectqueries/keyresult.asp?KEYWORD_ID=4139

[4] **World Energy Outlook. 2008.** "Prospects in oil- and gas-exporting Sub-Saharan African countries". http://www.worldenergyoutlook.org/docs/weo2008/WEO_2008_Chapter_15.pdf.

A number of countries (Cameroon, Ghana and Nigeria in ECOWAS sub-region, Angola, Zambia, South Africa, Lesotho, Mozambique in Southern Africa, Congo DR in Central Africa and Rwanda in east Africa have invested in hydro-electric power generation. These investments include new projects as well as upgrades/maintenance of existing ones. Figure 1 shows regional power pools in Africa where it can be seen that there are still vast areas that are still uncovered by electricity. Most of the sub-Saharan nations face electricity shortages and unprecedented power crisis (Figure 2). In recent years more than 30 of the 48 countries in the region have suffered acute energy crisis[5]. Much of the limited energy supplied goes to energy-intensive industries like mining and smelters. Sub-Saharan nations have been adding about a thousand MW of generation each year, but plants and grids are poorly maintained such that about 40% of generated power is lost or stolen[6].

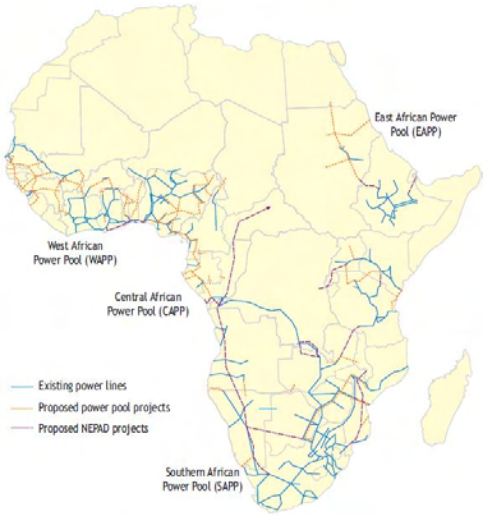

Figure 1: Regional power pools in Africa[7].

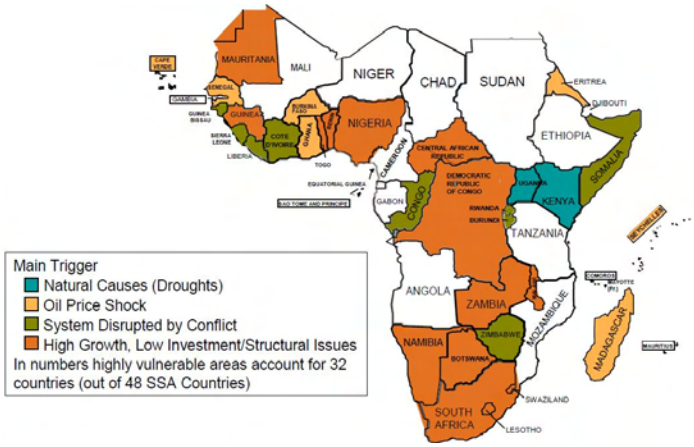

Figure 2: Areas of ongoing or imminent power shortfalls in Sub-Saharan Africa [IMF, 2008].

As solutions to the power problems, the Sub-Saharan countries are implementing temporal and long-term measures. A handful of global operators are providing short-term leases for emergency power generation.

3. ECOWAS energy context

The Economic Community of West African States (ECOWAS/CEDEAO) consists of an alliance of fifteen countries established in 1975 with an estimated population of 220 million (approximately 40 % of the total population of Sub-Saharan Africa).

Presently, there is a huge demand and supply gap (more than 40 %) in modern energy services. About 64 % of the total energy supply are covered by thermal power plants, 31 % are generated with Hydro Power, 5 % come from

[5]**IMF. 2008.** "World Economic and Financial Surveys: Regional economic outlook - *Sub-Saharan Africa*". April.
[6]http://energypriorities.com/entries/2007/07/africa_power_crisis_ny_times.php.
[7]**World Energy Outlook. 2008.** "Prospects in oil- and gas-exporting Sub-Saharan African countries".

imports and other energy resources such as RE. Traditional biomass constitutes a vital part of the primary energy consumption within ECOWAS (especially in the rural areas), with a total contribution of 80 %[8].

The region is strongly dependent on fossil fuels (for transportation purposes mainly). Less than 10 % of the rural population have access to electricity and modern energy services. Therefore RE could be instrumental in enhancing the energy situation within the ECOWAS region since there is huge potential for renewable energy. For example, **Hydro electric** potential is mainly concentrated in five of the 16 Member States and estimated at a total of 25,000 MW, of which only 16% is currently exploited[9]. At regional level very large hydro-electricity works require heavy investments and can supply several countries, and at the national level particularly in rural areas smaller hydroelectricity facilities (mini- and even micro), potential can be exploited. **Fossil fuels** – Nigeria alone is endowed with 98% of the proven reserves of crude oil, natural gas and coal (Table 2), that is 30% of Africa's total proven crude oil reserves (3,017 million tons), and 31% of Africa's proven natural gas reserves (3,581 billion m3)[15]. **Biomass (mainly in form of firewood)** one of the main energy resources of Member States. These resources are mainly concentrated in the humid southern tropical part of the region, and the available quantities vary from one country to another according to the climate.

In 2000, ECOWAS total forest area was estimated at some 69 822 000 ha[10]. IUCN reveal that the forest potential in many ECOWAS countries is considerable enough to cater for the overall fuel demand (although there are significant disparities among countries). **Wind power -** high wind speeds along coastal lines or in desert zones could represent an attractive solution, since investment costs dropped significantly these last years reaching levels almost equal to those of big main thermal power plants (i.e. around $1000/kW, depending on local conditions). **Solar -** the average **sunshine** potential in West Africa is around 5 to 6 kWh/m2 per day, as against only 3 kWh/m_ per day in temperate Europe. Because of the importance of sunshine and the real although slow prospects of cost reductions of the photovoltaic technology, it is now clear that solar energy can contribute significantly to improve the population's access to basic electric services.

Table 3 Conventional Energy Supply and Demand in member states

	Crude Oil Reserves (Millions Tons)	Natural Gas Reserves (millions m^3)	Coal Reserves (millions Tons)	Available Hydro-potential (MW)
Benin	21	2800	0	300
Burkina Faso	0	0	0	900
Cameroon	56	110.	0	500,000
Cape Verde	0	0	0	0
Cote d'Ivoire	13	20,000	0	1,650
Gambia	0	0	0	0
Ghana	1	24,000	0	2,000
Guinea	0	0	0	6,000
Liberia	0	0	0	2000
Mali	nd	0	nd	2000

[8]

[9] Kouo, 2005

[10] FAO, 2001

Niger	0	0	70	400
Nigeria	3,300	3,400,000	495	10,000
Senegal				
Sierra Leone	0	0	0	1000
Togo	0	0	nd	250
Total ECOWAS	3,324	3,444,500	580	25,760

Africa has substantial new and renewable energy resources, most of which are under-exploited. Only about 7% of Africa's enormous hydro potential has been harnessed. Existing estimates of hydro potential do not include small, mini and micro hydro opportunities, which are also significant. Geothermal energy potential stands at 9000MW, but only about 60MW has been exploited in Kenya. Based on the limited initiatives that have been undertaken to date, renewable energy technologies (RETs) could contribute significantly to the development of the energy sector Africa

At Africa level, IEA estimates show that 587 million (63%) people out of the continent's population of 937 million lacking access to electricity. Of these, 657 million (70%) people rely on traditional use of biomass for cooling. For Sub-Sahara Africa, 585 million (69%) people out of the population of 848 million people are estimated to lack access to electricity while 653 million (77%) people rely on traditional use of biomass for cooking.

Table 4 Number of people without access to electricity and relying on the traditional use of biomass, 2009[11].

	Number of people lacking access to electricity	**Number of people relying on the traditional use of biomass for cooking**
Africa	587	657
Sub-Sahara Africa	*585*	*653*
Developing Asia	799	1937
China	*8*	*423*
India	*404*	*855*
Other Asia	*387*	*659*
Latin America	31	85
Developing Countries*	1438	2679
World	**1441**	**2679**

4. Renewable energy Potential

Access to reliable electricity is important for many services, such as lighting and communications. This reliability is crucial for refrigeration, which avoids food waste and allows local clinics to keep medicines on hand. Clinics lacking electricity cannot perform such routine functions as sterilizing instruments or safely storing vaccines.

[11] **OECD/IEA. 2010.** Energy Poverty: how to make modern energy access universal. September.

Cooking and heating with solid fuels leads to high levels of indoor smoke, a complex mix of health-damaging pollutants including small particles, carbon monoxide, and nitrogen oxides. The World Health Organisation estimates that more than 1.45 million people die prematurely each year from household air pollution due to inefficient biomass combustion. A significant proportion of these are young children who spend many hours each day breathing smoke pollution from the cook stove. At present, the number of premature deaths from household air pollution exceeds that from malaria or tuberculosis

Throughout Africa there is considerable experience of fuelwood as renewable energy, there is large and well-established hydropower capacity across the sub-continent. There is considerable expectation of relatively large scale generation of electricity from solar photovoltaic. Nevertheless, to date in Africa, most experience of the new renewables relates to small-scale installations, especially for stand-alone rural electricity. The potential is very large for renewable energy (see summary of renewable energy potential in **Table 4**) but there are few African countries with comprehensive legislation to link liberalization of national utilities with increase of renewable energy from local and national resources. In many countries, there are no national targets specifically to increase renewable energy.

Table 5 RE Energy potential in ECOWAS states

	Large Hydro (MW)	Small Hydro	Fuel wood, animal waste and crop residue (million tons)	Solar radiation kWh/m2/ day	Wind m/s	Crop Residue million tons/year	Animal Waste million tons/year	Biofuel
Benin[12]	760		6	3.9 - 6.2	3 - 6	5		46.5 million liters
Burkina Faso		1		5.5	1 - 3			35000 units
Cameroon				4-5.8				2.7 million m3
Cape Verde	No (economically feasible) potential.		No (economically feasible) potential	6	>6			
Cote d'Ivoire	5–288 MW	0.5–5.0 MW	369,612 toe and 1,000,000 tons	4-5	1-2			
Gambia	No national Hydro Power potential			4.5–5.3	3			
Ghana			16 million metric tons of wood		3-5			
Guinea	6,000 MW			4.8	2-4			8.5 million to 14 million m3

[12] Renewable Energies in West Africa Regional Report on Potentials and Marktes Energy-policy Framework Papers, gtz

Guinea-Bissau	184 MW		67,000 m³ per year	4.5-5.5	2.5 to 7			10,000 m³ from cashew and about 20 hectares of jatropha plantations.
Liberia			15,248 (GWh/yr)[13]	4-6	no data available	6077 (GWh/yr)[18]	219(GWh/yr)[18]	26,869 (GWh/yr)
Mali	5,000	1,050		6	4.7 - 5.3	320,000		
Mauritania			21 million/ha	4 - 6	5–8	556,000		
Niger[14]	125.0	26.0	9.9 million ha	5-7	2.5-5	4	55	
N igeria[18]	14,750	734	144 million tons	3.5–7.0	2–4	83	61	
Sierra Leone	1,513 MW		2,706 GWh	1,460 to 1,800 kWh/ m2/y	3-5	2,706 GWh.		
T ogo	224 MW		2.6 million toe	4.4-4.5				

5 Available renewable technology options for ECOWAS

Renewable energy sources (including biomass, solar, wind, and hydropower) that use indigenous resources have the potential to provide energy services with zero or almost zero emissions of both air pollutants and greenhouse gases. Currently, renewable energy sources supply 14 percent of the total world energy demand. The supply is dominated by traditional biomass used for cooking and heating, especially in rural areas of developing countries.

Altogether, new renewable energy sources contributed 2 percent of the world's energy consumption in 1998, including 7 exajoules from modern biomass and 2 exajoules for all other renewables (geothermal, wind, solar, and marine energy, and small-scale hydropower). Solar photovoltaics and grid-connected wind installed capacities are growing at a rate of 30 percent a year. Even so, it will likely be decades before these new renewables add up to a major fraction of total energy consumption, because they currently represent such a small percentage.

Intermittently, renewables can reliably provide 10–30 percent of total electricity supplies if operated in conjunction with hydropower- or fuel-based power generation. Emerging storage possibilities and new strategies for operating grids offer promise that the role of intermittent technologies could be considerably larger.

[13] Assessment of Biomass Resources in Liberia, as of 2008

[14] CNES Inventory, as of 2006

Substantial price reductions in the past few decades have made some renewables competitive with fossil fuels in certain applications in growing markets. Modern, distributed forms of biomass seem particularly promising for their potential to provide rural areas with clean forms of energy based on the use of biomass resources that have traditionally been used in inefficient, polluting ways.

Renewable energy technologies (RETs) provide attractive environmentally sound technology options for Africa's electricity industry. RETs could offset a significant proportion of foreign exchange that is used for importing oil for electricity generation in most countries. In addition, renewables are modular and are well suited for meeting decentralized rural energy demand. The modular nature (i.e. can be developed in an incremental fashion) of most renewable energy technologies and the low investment levels makes them particularly suitable for capital-constrained African countries. Most renewable energy technologies utilize locally available resources and expertise, and would therefore provide employment opportunities for the locals. Some of the renewable energy options are summarized in the table below

Table 6 Some near, medium and long-time technological options for rural energy

Energy Source				
Energy Source	Present	Near term	Medium term	Long term
Electricity	Grid or no grid	Biomass-based generation using gasifies coupled to internal combustion engines, photovoltaic, small wind, small hydroelectric for applications remote from grids	Biomass-based generation using gasifiers coupled to micro-turbines and integrated gasifier combined cycles, minigrids involving various combinations of photovoltaic, wind, small hydro electric, batteries	Grid connected photovoltaic and solar thermal, biomass-based generation using gasifiers coupled to fuel cells and fuel cell/turbine hybrids
Fuel	Wood, charcoal, dung, crop residue	NG, LPG, producer gas, biogas	Syngas, DME	Biomass derived DME[15] with electricity co-product
Cogeneration (combined heat and power)		Internal combustion engines, turbines	Microturbines and integrated gasifier combined cycles	Fuel cells, fuel cell/turbine hybrid
Task				
Cooking	Woodstove	Improved woodstoves[16] (like	DME stoves, natural gas and producer	Electric stoves, catalytic burners

[15] Di-Methyl-Ether) is chemical substance, which can be produced from different resources like natural gas, coal, biomass, and other hydrocarbon sources. Since 1963, DME has been used only as a chemical mainly as a propellant in aerosols with small capacities worldwide. After 1995, due to its special characteristics, DME was introduced as a potential multipurpose fuel and subjected to a global intention for R & D as new fuel of the next century. The physical properties of DME are very similar to LPG. Its molecular structure, physical properties and fuel performance as well as ability of its conversion to other chemicals such as olefins has made a unique position for this newly born fuel. On the other hand, DME is a non-toxic fuel with short half-life in troposphere and has very low reactivity. After combustion, DME does not produce any soot and reduces emission of NOx, hydrocarbons and carbon monoxide.

[16] Stoves can be designed to burn wood much more efficiently than an open fire, typically reducing fuel consumption by 25 to 60%. A stove also significantly reduces the smoke produced, and if a chimney is used then all of the flue gases are directed out of the building. The

		the ones used in India), LPG stoves, biogas	gas	
Lighting	Oil and kerosene lamps	Electric lights	Florescent and compact florescent lamps	Improved florescent and compact florescent lamps
Motive power	Human & animal powered devices	Internal combustion engines, electric motors	Biofueled prime movers, improved motors	Fuel cells
Process heat	Wood, biomass	Electric furnaces, cogeneration, producer gas, NG/solar thermal furnaces	Induction furnaces, biomass/solar thermal furnaces	Solar thermal furnaces with heat storage

6. Existing renewable energy policies, strategies and legal frameworks at country and regional levels

ECOWAS states are already faced with significant deficiencies in the energy supply sector. To combat this, the member states have adopted ambitious regional policies, committing themselves to harmonize national energy legislation, to increase the autonomy of energy supply and to significantly raise the level of access to modern energy services. In order to achieve these goals, various policy initiatives and programs have been developed in the ECOWAS region. The regional ones are highlighted below:

(a) The Common Energy Policy: This covers the introduction of an integrated energy planning system, the promotion of RE and the speeding up of the connection of interlinked systems for electricity grids in cooperation within the ECOWAS states.

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(b) The ECOWAS Energy Protocol is a legal text formalizing the juridical framework of enterprises in the energy sector. It was designed as a guarantee for foreign direct investments in the energy sector. The adoption and ratification of this convention is an eligibility criterion for access to the World Bank Facility for the West African Power Pool (WAPP).

(c) The White Paper aims to provide energy access to at least half of the population living in rural and peri-urban areas by 2015. It has formulated three major specific objectives:

(i) the reinforcement of regional integration
(ii) the promotion of coherent, institutional and political frameworks for improved access to energy services in the ECOWAS region and
(iii) the development of coherent energy programs with focus on poverty reduction.

key benefits to the user of an improved stove are: improved health due to reduction of smoke, saved time collecting firewood and reduced risk of burns. The benefits to the environment include reduced contribution to deforestation and reduced air pollution

Within its specific objectives, the White Paper focuses on capacity building of private and public actors, the enhanced availability of soft loans, grants and private sector funds for energy services in rural or peri-urban areas, the improved exchange, promotion and dissemination of sub-regional experiences in view of energy services and the promotion of local energy production and energy services.

(d) The West African Power Pool (WAPP) aims at the integration of national electricity grids in a number of West African countries (i.e. e. Nigeria, Benin, Togo, Ghana, Cote d'Ivoire, Niger, Burkina Faso and Mali) by building up more than 5,600 km of interconnection lines. The medium- to long term goal is to guarantee the citizens of ECOWAS member states a stable and reliable electricity supply at affordable costs. In order to reach this goal, the framework conditions of national energy markets within the ECOWAS region need to be harmonized.

(e) Energy Program for West Africa issued by the United Nations Industrial Development Organization (UNIDO) and the Global Environmental Facility (GEF) which comprises – besides the 15 ECOWAS countries – also Mauritania, Chad and Burundi. The program with an overall project budget of 46 million USD focuses on three main objectives:

(i) taking a programmatic approach in promoting RE and EE projects at the national level in the countries of the region,
(ii) scaling up access based on RE and promoting EE measures in the industry, households and the public sector and
(iii) creating markets to catalyze private sector investments.

Among the main program components are demonstration projects, support for policy or regulatory framework, capacity building and RE based mini-grids for productive uses in rural areas.

(f) The Programme Régional de Promotion des Énergies Domestiques et Alternatives au Sahel (PREDAS) is implemented by the CILSS and the state members with financial support of the EU and the German Development Cooperation. It aims at helping the country members to organize sustainable supply and rational use of domestic energies by the inhabitants of Sahelian zone avoiding harmful impact on the environment.

(g) The Programme Régional Biomasse Énergie (PRBE) is implemented by the ECOWAS/ UEMOA with the financial support of the Netherlands. This program joins the framework of the implemented PEC (Politique Energetique Commune – Common Energy Policy) of the UEMOA and contributes to the long-term management of biomass energy in a policy to fight poverty and promote environmental protection.

(h) ALG (Autorité du Liptako Gourma – Authority for Integrated Development of Liptako Gourma Region) has elaborated a plan for developing the energy sector in this region (located between Burkina Faso, Mali and Niger) from 2007 to 2025. This plan aims to fight poverty and contribute to a harmonious and integrated development of the region through the introduction of modern forms of energy (electricity, mobility) and the reduction of harmful environmental influences.

(i) The Multi-Functional Platforms Project (MFP) aims at bringing motive power to rural areas. The project was initiated in Mali in 1996 with the backing of UNDP and UNIDO and has since then been extended to Senegal, Burkina Faso, Ghana, Nigeria and Guinea. Its goal is poverty reduction in general, but specifically poverty of rural women, by enabling them to create income generating opportunities through the supply of energy services.

At the country level, renewable energy policies, strategies and legal frameworks are summarized in the table below:

Table 7 Existing renewable energy policies, strategies and legal frameworks at country regional levels

Country	Policy/Program	Description	Source
Benin	PV electrification.	Electrification of 38 villages	Beninese Agency of Rural Electrification with funds from the Islamic Development Bank and the national budget of Benin.
	Energy Services Supply Project (PFSE)	To increase the access to modern and affordable energy services in urban and rural areas. To reduce the defores-tation, promote renewable fuels and to diversify the overall energy mix	Financed by (IDA), the West African Development Bank (BOAD), the Nordic Development Fund (NDF), the Benin National Power Company (SBEE), the Benin Electric Community (CEB) and the Government of Benin
Burkina Faso	National White Paper (LBN)	Focusing on the provision of modern energy services to the entire population of Burkina Faso by the year 2020. Renewable energy is considered to be a major contributor to this goal.	
Cameroon	National Rural Electrification Plan Energy Plan for Poverty Reduction.		
Cape Verde	Cape Verde's energy policy	To reinforce the rural electrification (2005-2008).	500 Million CVE invested by the Government
Cote d'Ivoire	Presently, there are no specific regulations, incentives or legislative framework conditions available for the implementation and promotion of RE. But the new regulations drafted at the Ministry of Mines and Energy provides the necessary environment to develop the RE sub-sector in Cote d'Ivoire.		
Gambia	There is no legislation for the RE sector at the moment. With regards to incentives for RE and energy efficient devices, the Government of The Gambia has adopted a policy in March 2008 to encourage the use of RE and energy efficiency (EE) by granting a zero-import tax status to all solar PV panels, solar water heaters, wind energy equipment and energy efficient light bulbs (compact fluorescent lamps). In addition, there is no license fee for operators in the electricity sub-sector using RE. Additional incentives are provided by the Gambia Investment Promotion and Free Zone Agency (GIPFZA) for investments especially in energy and RE.		
Ghana	National Electrification Scheme – Energy Plan 2006-2020	Electricity access for all by 2020.	Funded through grants and loans by donors and $9 million per year in domestic government budgetary support.
	Incentives include: 1. Total exemption from import duty on RE generators including solar generators, wind turbines and municipal waste 2. Exemption from VAT in importing RE products only if the components are brought in whole (i.e. e. not in separate pieces) into the country 3. Exemption from the payment of customs import duties on plant, machinery, equipment and accessories imported specifically and exclusively to establish the enterprise		

Guinea	There is no institutional framework for Renewable Energies (RE). In general, however, the RE sector is subject to the same regulations as the other energy sectors. Thus, the energy sector policy document of 1992 (LPDSE 92) can be considered as the so far appropriate RE development policy framework in force in Guinea		
Guinea-Bissau	No explicit Renewable Energies (RE) policies. Even though a draft was developed by the Government as early as 2004, the document has not been adopted yet. Furthermore, a strategic plan for RE was elaborated during 2004–2008. Due to a lack of funds, it has not been implemented yet.		
Liberia	Renewable Energy Policy to produce a national policy instrument to build and increase the application of renewable energy and energy efficiency technologies in Liberia by promoting investment, technology transfer, market development and local capacity building		
Mali	Energy policy of Mali in March	To contribute to the sustain able development of the country, through the supply of energy services accessible to the highest possible number of the population at low cost, and supporting the promotion of socio-economic activities	National Government
	Rural electrification framework of Mauritania	Regulated by the MEP, the Regulatory Authority. Prepares related laws and regulations. Furthermore, it provides licenses and amends proposals on the regulatory authority.	
	National energy policy	Formulation of a national energy policy	World Bank
	Poverty Reduction Strategy Paper (PRSP) for the period of 2005–2007	Its objective is to strengthen the energy sector and to expand the access to modern energy services while improving the overall supply reliability. The draft energy policy document of Mauritania aims to provide an electricity access rate of 35 % for the country's entire population by 2015	
Niger	Energy policy	For the promotion of RE	National Government
	SNER (Stratégie Nationale sur les Énergies Renouvelables – National Renewable Energies Strategy)	Aims at the increased contribution of RE to the national energy balance from less than 0.1 % in 2003 to 10 % by 2020 by:	

	SNASEM	Aims to improve the supply of a higher percentage of the population with modern energies by 2015 through granting: • Access to modern fuels for cooking • Access to motive power for villages with 1,000–2,000 inhabitants • Access to electricity for rural and peri-urban populations to reach a cover rate of 66 %	
	"Initiative Bio-Carbon of the PAC" (Programme d'Actions Communautaires – Community Actions Program).	To reduce poverty by focusing on the access to energy facilities for social and productive activities (cooking, motive power and electricity) for the entire population of Niger in order to achieve the MDG	World Bank/ GEF
Nigeria	Importation of Renewable Energy Equipment" bill	For tax exemptions for the import duty of PV equipment	
	National Energy Policy	The key objectives and targets for the power sector are: To expand electricity access to 7 • 5 % of the population by 2020	
	Rural Electrification Agency	The Federal Government has set a target for increasing electricity access in rural areas from 40 % to 75 % by 2015.	
Senegal			
Sierra Leone	National energy policy	Aims are to promote RE	United Nations Economic Commission for Africa (UNECA)
Togo	There are currently no dedicated policies for Renewable Energies. According to the Togo Poverty Reduction Strategy Paper Interim (PRSP-I) for 2006–2008, however, the Government pursues several objectives in the energy sector. This includes the implementation of policies for the promotion of RE, the increase of electricity supply of rural areas and the implementation of regulatory institutions		

7. Assessment of main constraints and barriers for deployment and use of renewable energy technologies in peri-urban and rural areas

The development of existing RE sources is restricted by a number of obstacles and deficiencies in the ECOWAS region. Some of which are - lack of financing facilities (higher costs of RE as compared to fossil fuels), lack of local experts and skilled personnel (financial, technical and administrative area), limited production capacity for technical

installations & equipment (expensive imports), appropriate frameworks and policies, inefficient institutional structures (energy services in rural areas and peri-urban areas), Bureaucratic and legal barriers (lack of tax incentives and feed-in-tariffs), little interest to diversify the existing energy mix and the energy supply structure and lack of strategic planning and coordination in the energy sector and energy markets. Other barriers are limited availability of products, information and technology gaps, and lack of investment. The greatest challenge is financial, even though costs have come down significantly over the past several decades. Others are: technical, economic, legal, capacities and awareness.

8. Conclusions

There is potential for the development of renewable technology in the ECOWS states. From the assessment done in this study, most of the states are highly endowed with renewable energy sources. The study revealed that access to modern energy in the region is still very low. Although some progress have been made in introducing the technology in many of the rural areas but the penetration is still very low.

Renewable energy technologies have an important role to play in ECOWAS states energy sector. With the right approach, the renewable energy industry in this sub-region can become a major player in the energy sector, and meet the energy needs of a significant proportion of the rural population in particular. Renewable energy technologies can play a major role in national development in terms of job creation and income generation as well as providing an environmentally sound energy service. Aggressive campaign for renewables at national, regional and sub-regional levels is required.

To ensure that the sub-region's energy community is able to exploit the unique opportunity of available technology, this paper suggests the following:

- A short term program of 1-5 years that would plan to implement low-risk and low-cost near term initiatives. Examples are:
  - Biomass-based co-generation
  - Small-scale renewables (improved cookstoves and kilns, solar dyers, solar water heaters)
  - Small scale windpumps and small hydro (where applicable)
  - PVs

In this program, implementation of projects that have proven track records and that maximise the use of indigenous resources, expertise and available grant would be considered. Some of the barriers to RETs development mentioned in this paper could be addressed in this program.

- A long-term program of 5-10 years that is built around major renewable energy sector initiatives that are already in existence. Examples would be
  - Skill development and capacity building
  - Long term Policy and financing programs
  - large scale hydro
  - large scale bioenergy
  - Big wind power
  - Large urban waste to energy projects

The long-term track program would build on the experience of the short term projects and suggest programs to develop medium and long-term initiatives. It would rely largely on ongoing and planned energy sector reform to establish an enabling environment that would attract both bilateral/multilateral as well as private finance for major investments in both national and regional RETs projects.

9.Way Forward

1. Renewable energy is obviously the most dependable source of energy in ECOWAS countries rural areas. This is because there are huge potentials for almost all renewable energy sources. Therefore there is need for more innovative research in the region to be able to identify appropriate technology that will suit different communities. As highlighted in the document, different countries are endowed with different resources and have different energy issues. There is need for the collection of comprehensive data to capture any challenge and monitor progress towards its elimination.
2. There is need for individual country to adopt a specific energy access target, allocate funds to its achievement and define their strategy for delivering it.
3. Additional investment in rural energy access is obviously needed. More funds at national and international levels should be diverted to more investment in sustainable energy in the rural areas
4. Private sector investment needs to grow the most, but significant barriers must first be overcome. National governments need to adopt strong governance and regulatory frameworks and invest in internal capacity building. The public sector, including multilateral and bilateral institutions, needs to use its tools to leverage greater private sector investment where the commercial case is marginal and encourage the development of replicable business models. When used, public subsidies must be well targeted to reach the poorest.
5. Concentrate an important part of multilateral and bilateral direct funding on those difficult areas of access, which do not initially offer an adequate commercial return. Provision of end-user finance is required to overcome the barrier of the initial capital cost of gaining access to modern energy services. Operating through local banks and micro-finance arrangements can support the creation of local networks and the necessary capacity in energy sector activity.
6. Skills development in the area of renewable energy, energy efficiency and management, energy engineering are very scarce in Africa and particularly in the ECOWAS states. The few skills that could have been available for use prefer developed countries where their skills are more appreciated and valued. Therefore it has become eminent for governments in this region to train and find incentives to retain the skills in their countries.
7. Beyond ensuring that there's more investment in rural energy access, there's the question of how the money should be spent. The tendency has been toward big projects — major fossil-fuel plants and electrical transmission lines. That sort of infrastructure can serve cities well, but it's not going to reach the rural villagers that are the most energy-starved — not to mention the fact that it's not the best idea to lock in carbon-heavy power sources in a warming world. That's where renewables might have a practical advantage, as well as an environmental one. Solar power can be installed quickly and cheaply far off the grid, providing enough power for light and basic services and potential for solar power is very high.
8. More need to be done to promote communication and awareness of RE and RETs.
9. A reduction in the initial cost (or form of subsidy) of RE technologies is critical in order to make it more competitive to conventional technologies.

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The Workshop is a contribution of ECOWAS to the 2012 International Year of Sustainable Energy For All . The results and deliverables will be presented in a side event at the RIO+20 United Nations Conference on Sustainable Development.