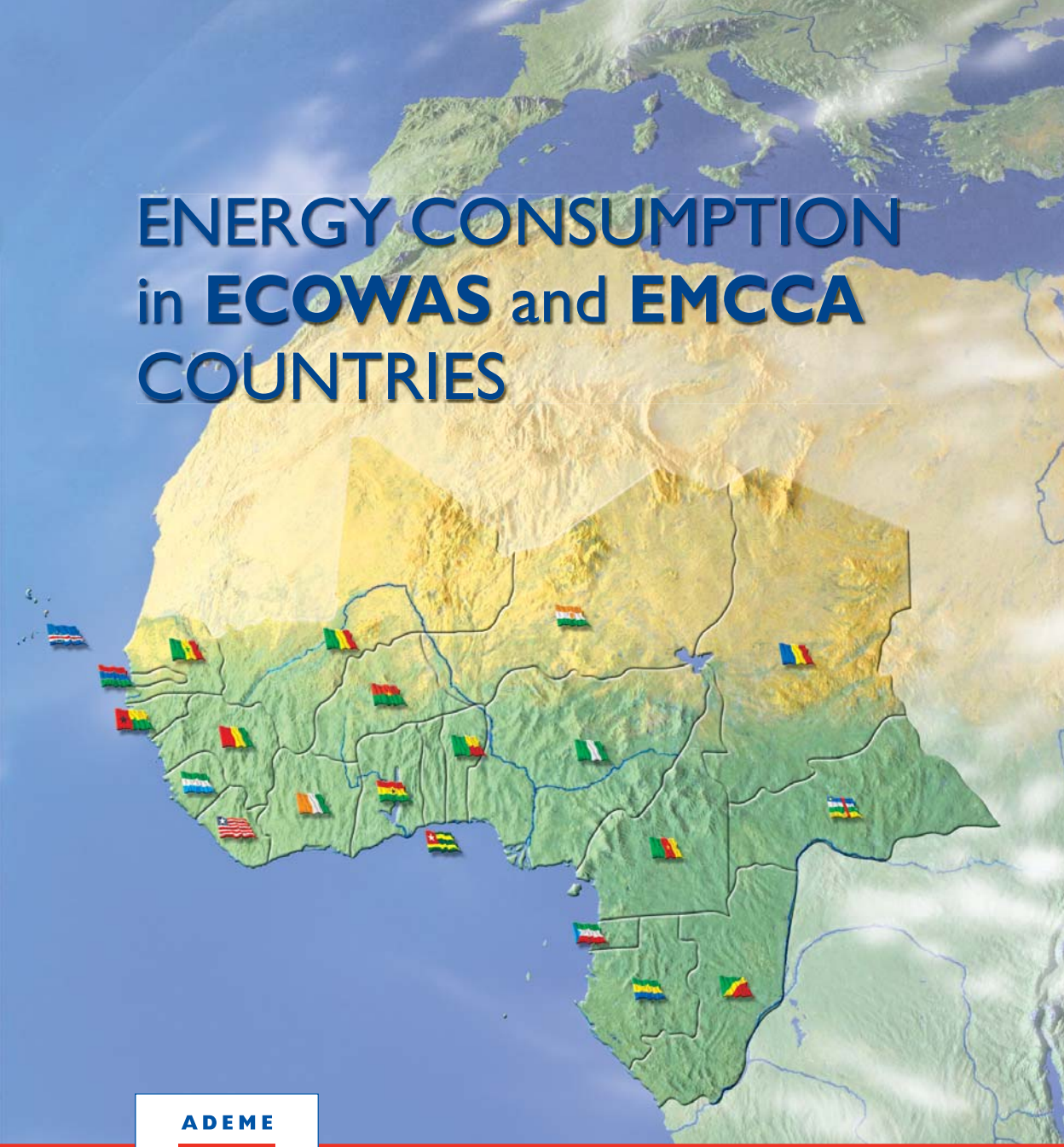
ENERGY CONSUMPTION in ECOWAS and EMCCA COUNTRIES



ADEME

French Environment & Energy Management Agency

STUDY REPORT

This document was produced under the responsibility of the ADEME by M. Jourdain KENGNE OUABO, an energy and environmental economist-engineer, and M. Bernard LAPONCHE, an international expert in energy policy and management.

Unless otherwise specified, the data used in this document has been taken from the ENERDATA online database proceeding from the publications of the International Energy Agency (IEA) and from various public national sources (values from May 2008).

FOREWORD

At the 2002 Earth Summit held in Johannesburg, the International Community agreed that energy had an essential role to play in bringing about sustainable development. Since then, the countries that make up the Economic Community of West African States (ECOWAS) and the Economic and Monetary Community of Central Africa (EMCCA) have all made considerable progress, striving to provide universal access to energy services, in conditions that are economically and socially acceptable, as well as environmentally sustainable.

This progress has involved major infrastructures in particular - such as the West African Gas Pipeline Project, and the development of regional electricity trading schemes[1] - as well as the provision of access to energy, with a number of regional strategies being adopted in the form of White Papers - ECOWAS-WAEMU and EMCCA. The French Environment and Energy Management Agency (ADEME) has lent its support to these various initiatives, helping to draft the ECOWAS and WAEMU White Papers in particular.

Developing energy systems in Africa is still a long and complicated process which requires technologies and financing, as well as the involvement of civil society, supported by appropriate policies. These policies are founded on a sound analysis of the situation, and on reliable data. This is why ADEME supported work on this document: "Energy consumption in ECOWAS and EMCCA countries".

It has been designed as a tool to help national and regional authorities - particularly those in ECOWAS and EMCCA countries – in making decisions and in managing policy in the energy sectors.

It also serves as a means of helping to develop national and regional expertise, such as the Regional Centre for Renewable Energies and Energy Efficiency (ECREEE) that was set up by countries in the ECOWAS zone in 2010.

More widely, we hope that it will be of use to anyone who is involved in developing and implementing energy policies in Africa that are designed to promote access to energy and economic development, while protecting the environment.

Dominique CAMPANA
Director of International Affairs of ADEME

1 - The West African Power Pool (WAPP) and the Central African Energy Pool (PEAC).

CONTENTS

INTRODUCTION

The ECOWAS zone (the Economic Community of West African States) was created in 1975 and is a regional group of 15 West African countries: Benin, Burkina Faso, Cape Verde, the Ivory Coast, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Nigeria, Niger, Senegal, Sierra Leone and Togo. Its mission is to promote economic integration across all areas of business.

The Economic and Monetary Community of Central Africa (or CEMAC from its name in French, Communauté Économique et Monétaire de l'Afrique Centrale) is an organisation of six countries: Cameroon, the Central African Republic, Chad, the Republic of Congo, Equatorial Guinea and Gabon. It was created in 1994 to breathe new life into the process of economic and social integration within the former Customs and Economic Union of Central Africa (itself created in 1964).

This document is made up of eight chapters, each of which deals with different aspects of energy consumption in ECOWAS and EMCCA countries using data from the ENERDATA database for 2008 (as well as information about main figures have increased from previous years).

Once the general structure of the energy systems has been explained and the fundamental elements for energy accounting provided, the document goes on to present and discuss - for each country in both these zones, as well as for both zones taken as a whole - data about final and primary energy consumption and electricity generation and consumption. It will also look at global indicators for energy and electricity consumption, energy audits and bills, as well as CO_2 emissions. Finally, it will examine the main aspects of the energy policies in force in both these zones.

Within this document's commented presentation on energy consumption, two specific issues are highlighted: Nigeria's unique position, and the issue of biomass.

Nigeria is a major state within the ECOWAS zone - in terms of population, GDP, production and energy consumption. Nigeria's values for these categories account for nearly 50% of all the countries in the ECOWAS zone taken together. To make it easier to compare energy consumption among other member countries, this document will present ECOWAS data in two forms: the zone without Nigeria (which we will represent as ECOWAS*), and the whole ECOWAS zone (with Nigeria).

Biomass is the basic source of energy for people right across sub-Saharan Africa. Throughout these zones, the vast majority of households use it for cooking and heating.

Two types of biomass energy are used in these zones: so-called commercial biomass (that is traded in the zone[1] in exchange for payment) and non-commercial biomass (biomass that is not traded: it is simply gathered[2] and used directly by households).

The data on biomass which has been used within the framework of this study is official data[3] on commercial biomass.

1 - There is trade between the various countries within the zone, but there are no details in the database.

2 - Very often within the vicinity of people's homes.

3 - From Enerdata, since it is taken from the International Energy Agency (IEA) and the Food and Agriculture Organisation (FAO).

However, the terms used to refer to the data can vary from country to country. For example, in some countries, people refer to "sold biomass", and in others, "used biomass"[4].

These differences in terminology make it difficult to define biomass in sub-Saharan African countries. There appears to be a significant difference (ratio of 1 to 3) between the national data on biomass for these countries and the data that international organisations (IEA, FAO, etc.) have on it. National data often includes both commercial and non-commercial biomass.

With regard to the importance of the role that biomass plays in energy consumption, it was considered useful to present consumption both with biomass and without biomass, the aim being to better emphasise the increasingly widespread use of other energy sources.

4 - Which can lead to confusion, since households use both commercial and non-commercial biomass for cooking.

I - ENERGY PATHS AND ENERGY ACCOUNTING

1. Energy paths: from need to primary resource

As a society develops, an ever-growing number of its needs have to be satisfied: food, housing, health and clothing need to be provided; transport infrastructure for people and goods needs to be developed; goods need to be produced and services provided; its people need to be able to access education and information, they need to be able to enjoy culture and exercise their civil rights, and they need to be able to take part in sport and leisure activities. Furthermore, the quality of their natural environment needs to be maintained.

Most of these involve - to varying degrees - energy consumption. Some use energy directly, others require energy in order to produce the goods and provide the services that are associated with them. Energy is necessary for: agriculture, animal farming and fishing; preparing, storing and cooking foodstuffs; lighting, heating and cooling people's homes, workshops, offices, shops, healthcare and education centres; producing and transforming raw materials, producing and transforming energy; constructing buildings and infrastructure; manufacturing equipment and machinery; providing transport systems; providing means for communicating and sharing information, etc.

Several "energy value chains" can be associated with each socio-economic need. Each value chain consists of the specific steps that leads from meeting a specific socio-economic development need (which involves the consumption of a certain amount of energy in order to be met) back to the basic energy resource involved in meeting this need.

Energy products are referred to differently depending on the stage at which they figure in the energy paths. The two main stages involved, which are found in statistics about energy production and consumption, are primary energy and final energy.

The "primary energy" stage refers to the forms in which nature delivers energy: chemical energy contained in fossil resources (coal, oil, natural gas) or in biomass (wood, plants, waste); the mechanical energy of water or wind (hydraulic, wind power); the thermal energy of hot water found underground (geothermal energy) or of solar radiation; solar photovoltaic energy; the nuclear energy of the nucleus of a uranium atom, etc.

The "final energy" stage refers to the energy products delivered to consumers. In some cases, the final product can be identical or very similar to the primary product, as is the case with natural gas. But in most cases, the final product is the result of the primary product having undergone a transformation: this is the case with electricity generated by fossil fuel power plants and fuels derived from oil in refineries.

The "energy sector's" manufacturing and commercial activities involve producing, transforming, transporting and distributing the energy products that are supplied to users: it is these activities that result in primary energy being converted into final energy.

STEPS INVOLVED IN ENERGY VALUE CHAINS

1. Socio-economic needs of development

Comfortable housing and work places - Food, clothing, education, healthcare, sociocultural activities - Communications, safe and reliable transport, goods transport - Production of goods and provision of services.

2. Services which require energy

Heating or cooling, hot water, cooking food - Lighting, household appliances, office equipment, audio-visual and telecommunications equipment - Transporting people and goods - Industry, mines, agriculture.

3. Forms of energy that are used directly

Heat, cold - fixed or mobile mechanical power - Light - Electromagnetic energy - Chemical energy.

4. Users' energy equipment and machinery

Boilers, ovens, stoves - Lamps, household and audio-visual equipment, electronic equipment, PCs - Engines - Industrial processes.

5. Energy products used by users (final energy)

Solid, liquid or gas fuels - District heating - Electricity.

6. Consumption sector

Manufacturing, Residential, Tertiary, Transport, Agriculture, Non-energy uses.

7. Energy transformation, transport and distribution

Heat production plants, electricity power plants (or combined heat and electricity: cogeneration) - Oil refineries, natural gas liquefaction factories, wood coal production installations - Oil and gas pipelines, oil ships and LNG carriers, barges, trains, lorries - Electricity lines.

8. Energy sources available in nature (primary energy)

Fossil sources: coal and lignite, oil, natural gas - Renewable sources: hydraulic, wind power, solar (thermal or photovoltaic), geothermal, biomass - Fissile sources (nuclear energy): uranium.

2. Units of measurement for energy and energy products

Energy is used in different forms, such as heat, cold, mechanical energy (fixed or mobile), light, electromagnetic energy, chemical energy, etc. Each of these different forms of energy, like the energy products which can supply them, has its own specific unit of measurement, which has either been adopted for reasons of convenience, or through tradition. Not all of these units of measurement are well known. Similarly, their equivalence with the units which appear on electricity or municipal heating bills (kWh) or the physical quantities that they represent are not always obvious (tonnes of coal, litres of petrol, steres of wood, etc.).

The official unit of measurement for energy is the joule. The kWh (1 million joules - or 1 MJ - is the equivalent of 0.2778 kWh) is also used - and not just for electricity.

For convenience (because it's more "meaningful" and because oil is the dominant form of energy), a common unit is used to express "primary" energy production and consumption - the tonne of oil equivalent (the toe, and its multiple Mtoe, one million toe): 1 toe = 41.8 Giga Joules (Giga: 10 to the power of 9).

The unit of power used to measure the rate of energy conversion is the Watt (and its multiples: kW and mW - kiloWatt and megaWatt, respectively).

Using the toe for the purposes of energy accounting with respect to fossil fuels and biomass is relatively unproblematic: equivalents in toe are calculated on the basis of the calorific values of these energy products. However, oil production is often expressed as "barrels per day" and the price of crude oil in "dollars per barrel": 7.3 barrels is the equivalent of 1 t of oil, and so producing 1 barrel per day is the equivalent of producing 50 t per year.

Electricity generation and consumption are measured in kWh or TWh (a TeraWh is a billion kWh). In order to convert kWh into toe, international statistics systems - for final electricity consumption - have adopted a system of conversion into physical units: 1000 kWh = 0.086 toe or 1TWh = 0.086 Mtoe.

A specific feature of international energy accounting relates to the accounting of so-called "primary" electricity which is generated by means other than fossil fuels or biomass (hydraulic, nuclear, geothermal, wind or photovoltaic solar power). For electricity that is generated by hydraulic, wind or solar power and produced without a thermodynamic cycle, the thermal equipment by joule effect of electricity generated is counted - i.e. 0.086 Mtoe per TWh generated - as primary energy. For electricity that is generated by nuclear means, the heat produced by the nuclear reactors and used to generate electricity is counted as primary energy - 0.26 Mtoe per TWh generated. For electricity generated from geothermal power, the equivalence coefficient is 0.86 Mtoe per TWh - 10 times more than for hydraulic or solar.

For electricity generated from nuclear power and a theoretical conversion efficiency of 33%, 3 MWh of heat is required in order to generate 1 MWh of electricity - 3 x 0.086 = 0.26 toe. For electricity from geothermal power, with a theoretical efficiency of 10%, 10 MWh of heat is required to obtain 1 MWh of electricity - 0.86 toe.

It is immediately apparent that these conventions can lead to misunderstandings, situations being interpreted incorrectly and flawed arguments. They can even be intentionally manipulated in a number of different ways. Because of these potential difficulties, the kWh should be used when talking about electricity generation and not the toe.

Table 1 Main units of energy

	Abbreviation	Joule(1)	British	Thermie(2)	kilowatt.heure
1 joule	J	1	9.479×10^{-4}	2.389×10^{-7}	2.778×10^{-7}
1 British Thermal Unit	BTU	1.055×10^{3}	1	2.520×10^{-4}	2.930×10^{-4}
1 Thermie	th	4.186×10^{6}	3.968×10^{3}	1	1.163
1 kilowatt.hour	KWh	3.600×10^{6}	3.413×10^{3}	8.600×10^{-1}	1

(1) 1 exajoule (EJ) = 10^{18} J
(2) 1 calorie (cal) = 10^{-6} th

Table 2: Main units of power

	Watt	MW	BTU/hour	Horse power
Watt	1	10^{-6}	3.414	1.3595×10^{-3}
MW	10^{6}	1	3.414×10^{6}	1.3595×10^{3}
BTU/hour	0.2929	292.9×10^{-9}	1	0.3982×10^{-3}
Horse power	735.5	735.5×10^{-6}	2511	1

3. Energy equivalences

Table 3 shows a summary of the conversion information needed to transform physical quantities into energy equivalents for all energy resources. It has been used by the French Energy Monitoring body since 2002, and is in compliance with international regulations.

The table should be read in the following way: for example, for the line "Engine petrol": 1 tonne of petrol is the equivalent of 44 GJ of energy and 1048 toe.

Table 3: Converting units of energy measurement

Energy or Vector	Physical unit	Gigajoules (GJ) NCV*, Billions of joule	Tonne of oil equivalent (toe) NCV*
Coal			
Hard coal	Tonne	26	26/42 ≈ 0.619
Coke	Tonne	28	28/42 ≈ 0.667
Briquettes of lignite	Tonne	32	32/42 ≈ 0.762
Lignite	Tonne	17	17/42 ≈ 0.405
Oil products			
Crude oil, diesel, heating oil	Tonne	42	1
Liquefied petroleum gas	Tonne	46	46/42 ≈ 1.095
Engine fuels	Tonne	44	44/42 ≈ 1.048
Heavy fuel oils	Tonne	40	40/42 ≈ 0.952
Petroleum coke	Tonne	32	32/42 ≈ 0.762
Electricity			
Fossil production	MWh	3.6	3.6/42 ≈ 0,086
Renewable production	MWh	3.6	3.6/42 ≈ 0.086
Natural and industrial	MWh GCV**	3.24	3.24/42 ≈ 0.077
Wood	Stere	6.17	6.17/42 ≈ 0.147

** NCV: Net Calorific Value*
*** GCV: Gross Calorific Value*
The net calorific value is the gross calorific value less the latent heat of water evaporation, that cannot be used in practice.
Source: Energy monitoring body.

II - DEMOGRAPHY AND ECONOMIC INDICATORS IN ECOWAS AND EMCCA COUNTRIES

1. Overview of the ECOWAS and EMCCA

1.1 The Economic Community of West African States (ECOWAS)[1]

The ECOWAS is a regional group of fifteen countries (Benin, Burkina Faso, Cape Verde, the Ivory Coast, the Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo) founded in 1975.

Its mission is to promote economic integration in all fields of economic activity (industry, transport, telecommunications, energy, agriculture, natural resources, trade, monetary and financial issues, social and cultural matters, etc.) and its overall objective is to promote co-operation and integration with a view to establishing an economic and monetary union as a means of stimulating growth and development in West Africa.

Source: CEDEAO

Meeting this overall objective involves the following specific aims: eliminating customs duties and taxes having an equivalent effect, establishing a common external tariff, harmonising economic and financial policies and creating a single monetary zone.

1.2 The Economic and Monetary Community of Central Africa (EMCCA)[2]

The Economic and Monetary Community of Central Africa (EMCCA) was created on 16 March 1994 in N'Djamena, Chad by the signing of the treaty. Its aim is to breathe new life into the process of economic and social integration within the former Customs and Economic Union of Central Africa, itself created on 8 December 1964.

The EMCCA is made up of six Member states: Cameroon, Central African Republic, the Republic of Congo, Gabon, Equatorial Guinea and Chad. Its main mission is to promote the harmonious development of its member states within the framework of instituting a genuine common market.

The organisation has the following aims:

- implement a multilateral system to monitor the economic policies of Member states;
- maintain stable management of the common currency;

1 - ECOWAS official website: http://www.comm.ecowas.int/sec/index.php?id=about_a&lang=en
2 - Official EMCCA website: http://www.CEMAC.int/

- ensure that economic activity and business in general can be carried out in a secure environment;
- harmonise the regulations laid out by sectoral policies in a number of essential areas stipulated by laws (agriculture, livestock farming, fishing, industry, trade, transport and communications, energy and the environment, research, teaching and professional training);
- create a common market based on people, goods, capital and services being able to move around freely.

Source: http://www.CEMAC.int/

2. Facts and figures about the zones in 2008

2.1 Surface area and population

Table 1 below gives the surface area for each country and for each of the zones under investigation, together with their populations, annual growth rates and population densities.

Table 1: Surface area and population per country and per zone

2008	Surface[3]	Population			
		Total	Growth	Urban	Density
	1 000 km²	Million	% per annum	%	People/km²
Benin	112.6	9.33	3.2	40.5	85
Burkina-Faso	274.2	15.27	3.1	18.7	56
Cape Verde	4	0.54	2.3	58.0	135
Ivory Coast	322.5	19.57	1.7	45.4	62
Gambia	11.3	1.76	2.9	54.7	177
Ghana	238.5	.01	2.1	48.5	106
Guinea	245.8	9.54	1.9	33.5	39
Guinea-Bissau	36.1	1.75	3.1	29.7	63
Liberia	111	3.8	3.2	58.8	40
Mali	1240	12.7	3.1	31.1	11
Niger	1267	14.73	3.6	17	12
Nigeria	923.7	151.82	2.4	49	167
Senegal	196.7	12.71	2.6	41.9	66
Sierra Leone	71.7	6.15	3.3	41.4	86
Togo	56.8	6.77	2.8	40.8	125
ECOWAS*	4188	138.6	2.8	40	76
ECOWAS	5112	290.4	2.8	41	82

2008	Surface[3]	Population			
		Total	Growth	Urban	Density
	1 000 km²	Million	% per annum	%	People/km²
Cameroon	475.4	18.98	2.2	55.5	41
Central African Republic	623	4.41	1.7	38.2	8
Congo	342	3.86	2.2	60.6	12
Gabon	267.6	1.35	1.6	84.1	6
Equatorial Guinea	28.1	0.52	2.4	39.1	19
Chad	1284	11.19	3.3	25.8	9
EMCCA	3020.1	40.31	2.2	50.5	16
ECOWAS+EMCCA	8132	330.7	2.6	43.4	63

ECOWAS: ECOWAS less Nigeria*

2.2 Gross Domestic Product

Gross Domestic Product is a measurement of a given country's economic activity. It is usually calculated using current prices (nominal GDP). Nominal GDP is the sum of the value (measurement of net production of a particular branch or sector in monetary units) added to the cost of factors, plus tax on products, customs duties and specific taxes. To correct for the effects of inflation, monetary values can be measured at the constant prices of a base year: this gives real GDP (here, the base year used is 2005).

The "purchasing power parity" (PPP) rate measures the currency conversion rate which equalises the purchasing power of different currencies. When a given sum of money is converted into different currencies at the purchasing power parity rate, it can buy the same quantity of goods and services in all countries. In other words, the PPP corrects for differences in price levels between several countries. Furthermore, PPP rates do not fluctuate in the same way as exchange rates, which means that more stable comparisons can be drawn between energy intensities.

The purchasing power parity exchange rates used to calculate purchasing power parity GDPs (PPP GDP) in the ENERDATA database are those published by the World Bank (these values are universally used, by the International Monetary Fund in particular). The World Bank, which had not revised its data for a long time, did so in 2007. This resulted in significant changes to PPP GDP values, particularly for countries currently enjoying strong economic development. Obviously these differences vary from country to country. Such changes have major implications when it comes to drawing comparisons between these countries (particularly with regard to the values of energy intensities[4])

• *By zone*

Table 2: Gross Domestic Product (GDP)

2008	GDP				
	Nominal GDP Current US$	at constant prices 2005 US$	at 2005 PPP (2005 US$)	% growth rate per annum	at PPP per capita
	US$ billion	US$ billion	US$ billion		2005 US$1000
ECOWAS*	94.9	71.3	160.2	4.9	1.2
ECOWAS	247.5	187.5	413.6	4.9	1.4
EMCCA	71.3	51.8	107.4	4	2.7
ECOWAS+EMCCA	318.8	239.3	521	4.4	1.6

3 - Patrick Merienne, Atlas mondial (World Atlas), published by Ouest-France.
4 - The new values are given in the table below.

Table 3: Structure of GDP (added values)[5]

2008	Manufacturing	Services[6]	Agriculture
	%	%	%
ECOWAS*	19.4	48.9	29.6
ECOWAS	24.4	40.8	33.5
EMCCA	45.8	33.6	14.5
ECOWAS + EMCCA	28.4	39.5	29.9

Table 4: Structure of GDP per country

2008	Population	PPP GDP		PPP value added per sector			2008
		Total	/capita	Manufacturing	Services	Agriculture	
Unit	Million	2005 billion US$	2005 1000 US$	2005 billion US$	2005 billion US$	2005 billion US$	Unit
Benin	9.33	11.8	1.3	1.7	4.8	4.9	Benin
Burkina Faso	15.27	17.1	1.1	4.1	6.8	4.9	Burkina Faso
Cape Verde	0.54	1.5	2.9	0.3	0.8	0.2	Cape Verde
Ivory Coast	19.57	31.4	1.6	7.2	21.2	10.2	Ivory Coast
Gambia	1.76	2.05	1.2	0.2	1.1	0.6	Gambia
Ghana	24.01	31.6	1.3	4.4	14.5	10.6	Ghana
Guinea	9.54	10.8	1.1	3.4	4.7	2.1	Guinea
Guinea-Bissau	1.75	0.8	0.5	0.1	0.2	0.5	Guinea-Bissau
Liberia	3.80	1.4	0.4				Liberia
Mali	12.71	13.4	1.1	2.5	4.7	5.2	Mali
Niger	14.73	9.5	0.6	1.5	4.1	3.7	Niger
Nigeria	151.82	253.4	1.7	69.6	89.6	90.4	Nigeria
Senegal	12.71	19.9	1.6	3.8	10.9	2.6	Senegal
Sierra Leone	6.15	3.9	0.6	0.4	3.1	0.3	Sierra Leone
Togo	6.77	5	0.7	1.4	1.7	2	Togo
ECOWAS*	138.64	160.2	1.2	31.2	74.5	47.7	ECOWAS*
ECOWAS	290.46	413.6	1.4	100.7	164.1	138.1	ECOWAS
Cameroon	19	39.4	2.1	11	18	7.5	Cameroon
Central African Republic	4.41	3	0.7	0.5	0.8	1.6	Central African Republic
Congo	3.86	13	3.4				Congo
Gabon	1.35	19.4	14.4	8.6	7.2	1.2	Gabon
Equatorial Guinea	0.52	17.6	33.9	16.1	0.6	0.7	Equatorial Guinea
Chad	11.19	15	1.3	7.1	5.1	2.6	Chad
EMCCA	40.33	107.4	2.7	43.3	31.7	13.7	EMCCA
ECOWAS + EMCCA	330.79	521	1.6	144	195.8	151.7	ECOWAS + EMCCA

An analysis of table 4 shows significant differences in GDP per capita among the various countries of both zones. Indeed, in the countries which make up the EMCCA zone, GDP per capita is approximately double that of the countries in the ECOWAS zone. Equatorial Guinea has the highest GDP per capita of both zones - 50 times higher than for Central Africa and 20 times higher than for Cape Verde, a country which has a population of more or less the same size.

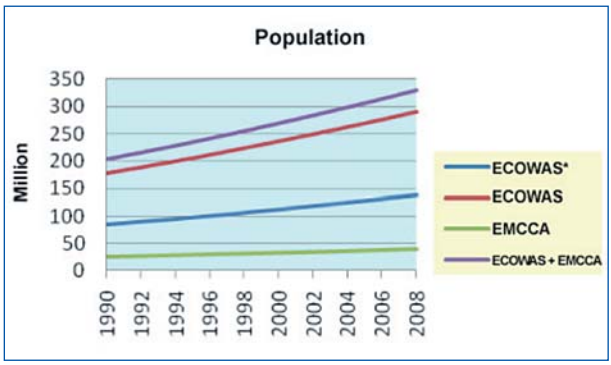
5 - Calculated without Liberia and the Congo as sectoral data not available.
6 - The service sector is made up of transport, tertiary activities, domestic, etc.

The added values show that the service sector is larger than manufacturing in ECOWAS countries - 40% of GDP, while manufacturing is stronger in EMCCA countries - also 40% of GDP[7]. Agriculture contributes to 33% of GDP in ECOWAS countries, but only around 14% in EMCCA countries.

2. Population and GDP growth per zone

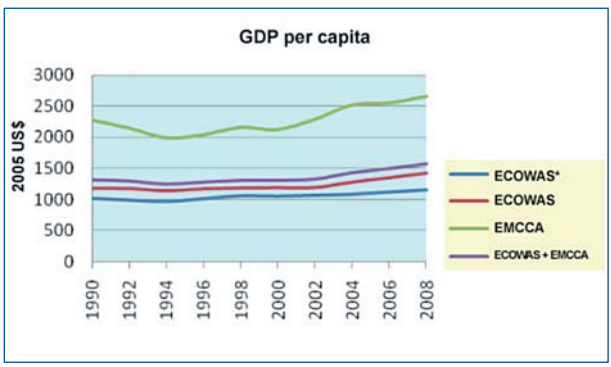
2.1 Population growth of the zones

Diagram 1: Population growth per zone



2.2 Growth in GDP per capita

Diagram 2: Growth in PPP GDP per capita in each zone



7 - Boosted by Equatorial Guinea, where the added value of the oil and natural gas industries accounts for most of GDP (new Liquefied Natural Gas installations were set up in 2006).

III - FINAL ENERGY CONSUMPTION

Final energy consumption is the consumption of the energy products that energy distributors supply to consumers in final activity sectors, including for non-energy uses (raw materials for the chemicals sector).

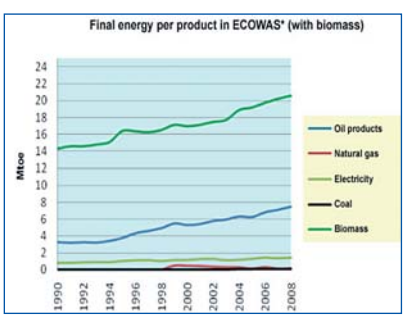
1. Per energy product

Final energy products are oil products (petrol, diesel, kerosene, etc.), gas, coal, electricity, biomass and heat (hot water or steam for use in heating networks in northern countries, heat produced by solar water heaters or low-temperature geothermal energy).

1.1 Growth in final energy consumption per product

Given that biomass accounts for more than 70% of final energy consumption in sub-Saharan Africa, we have created two types of diagram: one shows growth in energy consumption with biomass, and the other without biomass. This is so as to better demonstrate the increase in the roles played by other products in final energy consumption.

Diagram 1: Growth in final energy consumption per product in ECOWAS* countries (with and without biomass)



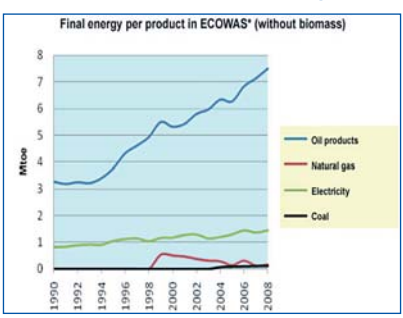
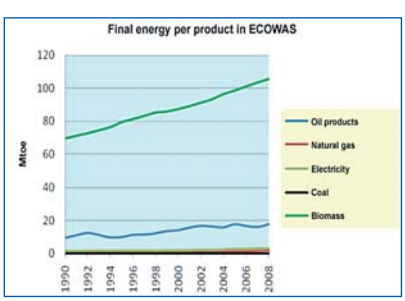


Diagram 2: Growth in final energy consumption per product in ECOWAS countries (with and without biomass)



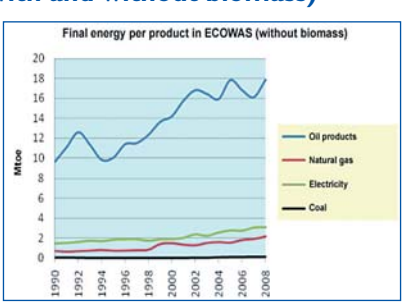
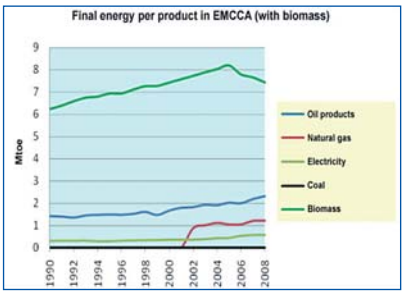
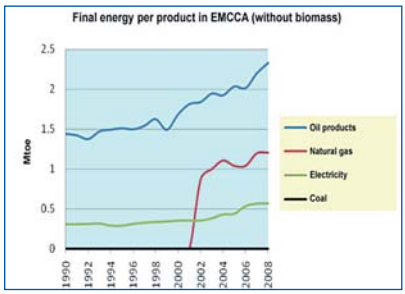


Diagram 3: Growth in final energy consumption per product in EMCCA* countries (with and without biomass)



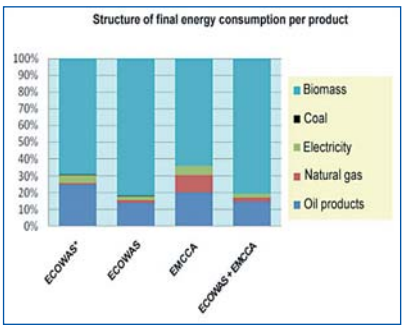


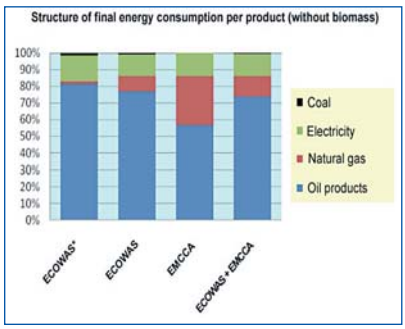
After biomass, oil (products derived from petroleum) is the main source of energy used in the countries that make up the ECOWAS and EMCCA zones. Natural gas has been growing in popularity since 2000 in EMCCA countries, particularly in Equatorial Guinea (which now has a natural gas liquefaction plant) and, to a lesser extent, Gabon. Of all the countries in the ECOWAS zone, Nigeria and the Ivory Coast have the highest levels of natural gas consumption. Biomass consumption started to fall in 2004 in EMCCA countries as natural gas consumption started to rise. Biomass consumption has continued to grow in ECOWAS countries.

Since 2000, electricity has been the fourth source of final energy in EMCCA countries, and the third source in ECOWAS countries. Among the countries that make up the ECOWAS zone, coal is mainly consumed in Senegal and Nigeria.

1.2 Structure per zone of final energy consumption per product in 2008

Diagram 4: Structure of final energy consumption per product in each zone (with and without biomass)





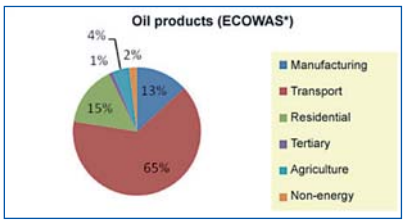
Biomass accounts for more than 80% of final energy consumption in ECOWAS countries[1], as opposed to approximately 60% in EMCCA countries. Oil accounts for 14%, 20% and 25% of final energy consumption in ECOWAS, EMCCA and ECOWAS* (without Nigeria) countries, respectively. Relatively little electricity, however, is used in both these zones: 2%, 5% and 5% in ECOWAS, EMCCA and ECOWAS* countries, respectively.

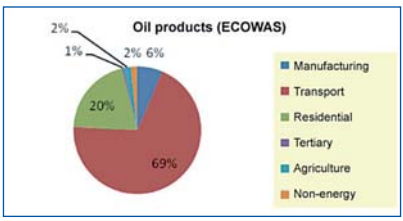
1 - Whereas in ECOWAS countries (not including Nigeria), biomass accounts for 70% of final energy consumption.*

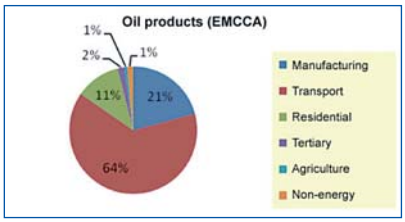
1.3 Distribution of energy products per final consumption sector (2008)

Diagram 5: Distribution of energy products per final consumption sector

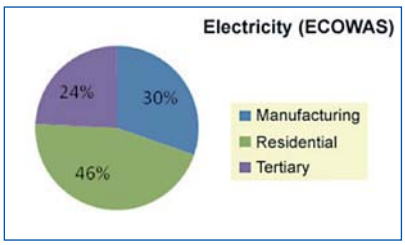
• ***Oil products***

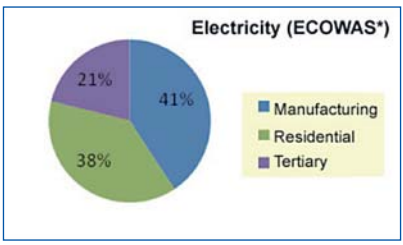


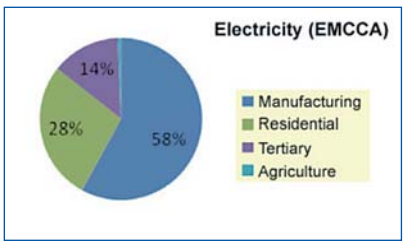




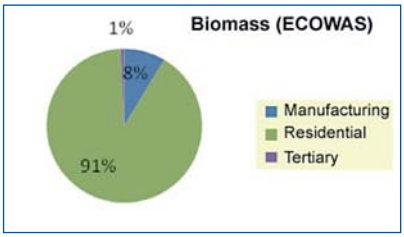
• ***Electricity***

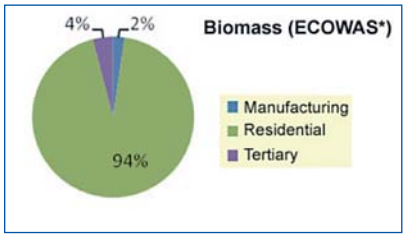


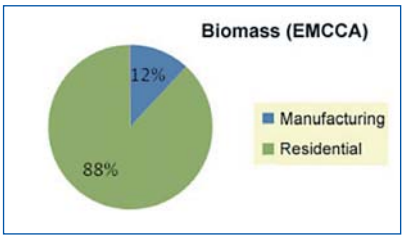




• ***Biomass***







• ***Natural gas***

Natural gas is only used in manufacturing in ECOWAS and EMCCA countries.

• ***Coal***

Coal is only consumed in ECOWAS countries, and only in manufacturing.

1.4 Final energy consumption per product and per country

Table 1 shows final energy consumption per capita, broken down for each country per energy product.

Table 1: Final energy consumption for ECOWAS and EMCCA countries per

2008	Population	Total Final Energy Consumption	Final Energy Consumption/ capita	Oil products		Gas	
Unit	Million	Mtoe	toe	Mtoe	%	Mtoe	%
Benin	9.33	2.6	0.3	1.1	42		
Burkina Faso	15.27	2.3	0.1	0.5	21		
Cape Verde	0.54	0.1	0.1	0.04	49		
Ivory Coast	19.57	5.5	0.3	0.8	15	0.2	3
Gambia	1.76	0.1	0.1	0.06	54		
Ghana	24.01	7.5	0.3	2.24	30		
Guinea	9.54	2.6	0.3	0.4	16		
Guinea-Bissau	1.75	0.2	0.1	0.1	50		
Liberia	3.8	1.2	0.3	0.2	13		
Mali	12.72	2.1	0.2	0.5	24.5		
Niger	14.73	1.4	0.1	0.2	13		
Nigeria	151.82	99.2	0.65	10.4	10.5	2	2
Senegal	12.71	1.7	0.14	0.8	44		
Sierra Leone	6.15	0.8	0.14	0.3	36		
Togo	6.77	1.5	0.2	0.3	20		
ECOWAS*	138.65	29.8	0.2	7.5	25	0.16	0.5
ECOWAS	290.47	129	0.44	17.9	14	2.2	1.7
Cameroon	18.98	5.9	0.3	1	17		
Central African Republic	4.41	0.5	0.1	0.1	21		
Congo	3.86	0.9	0.24	0.4	46.5		
Gabon	1.35	1.8	1.3	0.6	35	0.002	0.1
Equatorial Guinea	0.52	1.4	2.8	0.1	8.5	1.2	84
Chad	11.19	1	0.1	0.06	6		
EMCCA	40.31	11.5	0.3	2.3	20	1.2	10.5
ECOWAS+EMCCA	330.78	140.5	0.4	20.2	14	3.4	2.4

energy product

Coal		Biomass		Electricity		2008
Mtoe	%	Mtoe	%	Mtoe	%	
		1.5	56	0.06	2.2	Benin
		1.7	77	0.06	2.5	Burkina Faso
		0.025	30	0.02	20.8	Cape Verde
		4.2	76	0.3	5.5	Ivory Coast
		0.05	41.5	0.006	4.8	Gambia
		4.7	63	0.5	6.9	Ghana
		2.1	80.5	0.1	3.8	Guinea
		0.1	47	0.006	2.8	Guinea-Bissau
		1.1	85	0.02	2	Liberia
		1.5	70	0.1	5.1	Mali
		1.2	84	0.05	3.4	Niger
0.005	0.01	85.1	86	1.6	1.7	Nigeria
0.12	7	0.7	41	0.13	7.7	Senegal
		0.5	62	0.02	2	Sierra Leone
		1.2	77	0.05	3.5	Togo
0.12	0.4	20.6	69	1.4	4.9	ECOWAS*
0.13	0.1	105.7	82	3.1	2.4	ECOWAS
		4.5	76.5	0.4	6.9	Cameroon
		0.4	77	0.01	2	Central African Republic
		0.5	49	0.04	4.3	Congo
		1.1	60	0.1	5.4	Gabon
		0.1	7	0.007	0.5	Equatorial Guinea
		0.9	92.6	0.01	1.4	Chad
0	0	7.4	64.44	0.57	4.9	EMCCA
0.13	0.1	113.1	80.51	3.67	2.6	ECOWAS+EMCCA

The way in which the share of each energy product is distributed in final energy consumption is different for each zone. For some products - electricity and biomass - there is a slight difference between EMCCA and ECOWAS* (without Nigeria) countries. The distribution of different energy products in Nigeria has a major effect on how consumption is structured throughout the ECOWAS zone.

Natural gas accounts for a significant proportion of final energy products consumed in EMCCA countries (10.5%), but only accounts for 0.5% and 1.7% in ECOWAS and ECOWAS* respectively. This low consumption is offset by biomass which accounts for 69% of final energy consumption in ECOWAS* countries and 82% in ECOWAS countries, as opposed to 64% in EMCCA countries.

Two countries together are largely responsible for the high levels of natural gas consumption in EMCCA: Gabon and Equatorial Guinea, where natural gas is the main energy used.

In all regions, oil is the second energy source, accounting for 25.1%, 13.9% and 20.1% for ECOWAS*, ECOWAS and EMCCA countries, respectively.

With the exception of Cape Verde and Equatorial Guinea, biomass is the main energy source for countries in the ECOWAS and EMCCA zones, accounting for more than 60% of final consumption. For a number of countries, such as Guinea, Liberia, Niger, Nigeria and Chad, biomass accounts for more than 80% of final energy consumption.

The share of electricity in these zones is still very low, at around 5% of final energy consumption. The highest percentages are in Ghana (7%), Senegal (8%), Cameroon (7%) and Cape Verde (21%).

Very little coal is used in these zones. No coal at all is consumed in EMCCA countries. As far as countries in the ECOWAS zone are concerned, it is consumed in Senegal (approximately 7% of final energy consumption) and in very low quantities in Nigeria.

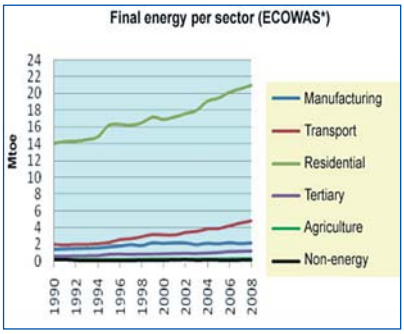
Nigeria is the only country in these zones in which all types of energy source are used, but in very varied proportions (see the energy account for Nigeria in Chapter VI).

2. Per final activity sector

Final activity sectors include manufacturing, transport, the residential sector (housing), the tertiary sector (offices, shops, healthcare centres, schools and universities, hotels, etc.) and agriculture. The use of energy products for non-energy related purposes (mainly oil products) is also included in final energy consumption. This includes the production of plastic bottles, lubricants, etc.

2.1 Growth in final consumption per sector in ECOWAS and EMCCA countries

Diagram 6: Growth in final consumption per sector in ECOWAS* countries



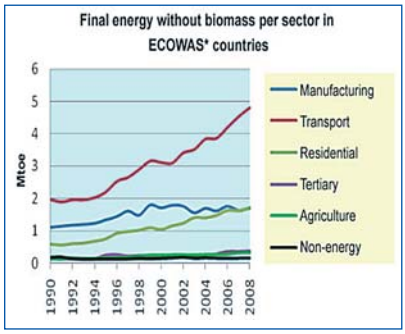
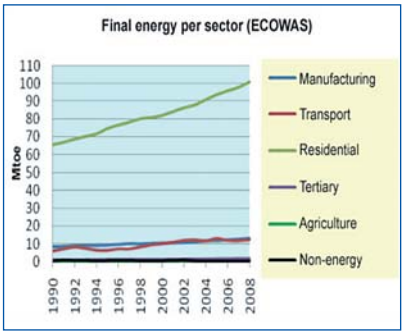


Diagram 7: Growth in final consumption per sector in ECOWAS countries



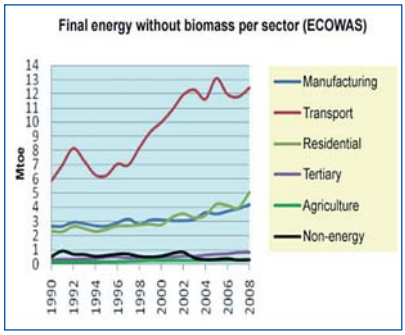
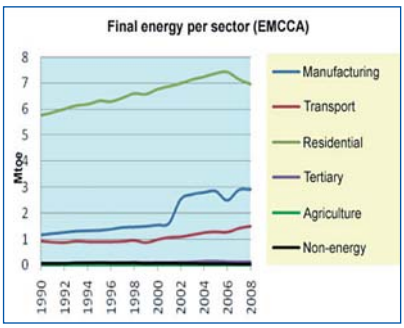
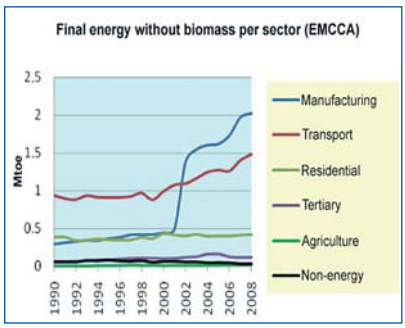


Diagram 8: Growth in final energy consumption per sector in EMCCA countries



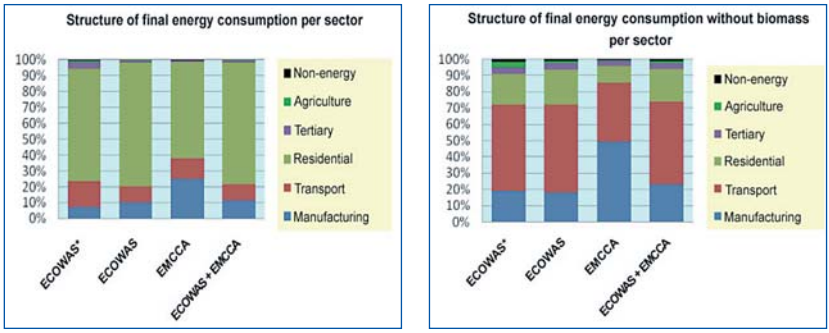


Comparing these diagrams shows that removing biomass from final consumption moves transport up to the top of final energy consumer sectors in ECOWAS countries as of 1990. In EMCCA countries, from 2000 onwards, manufacturing is the main consumer of final energy[1]. Manufacturing was the second largest consumer sector in ECOWAS countries from 1990 until the start of the 2000s, before being taken over by the residential sector, while transport found itself in second position in EMCCA countries, pushing the residential sector down into third place.

From this analysis, it becomes apparent that oil is the main source of energy - not including biomass - in ECOWAS countries, whereas in EMCCA countries, natural gas has been the main alternative to oil since 2000.[2]

2.2 Structure per zone of final energy consumption per sector (2008)

Diagram 9: Structure of final energy consumption per sector for each zone (with and without biomass)



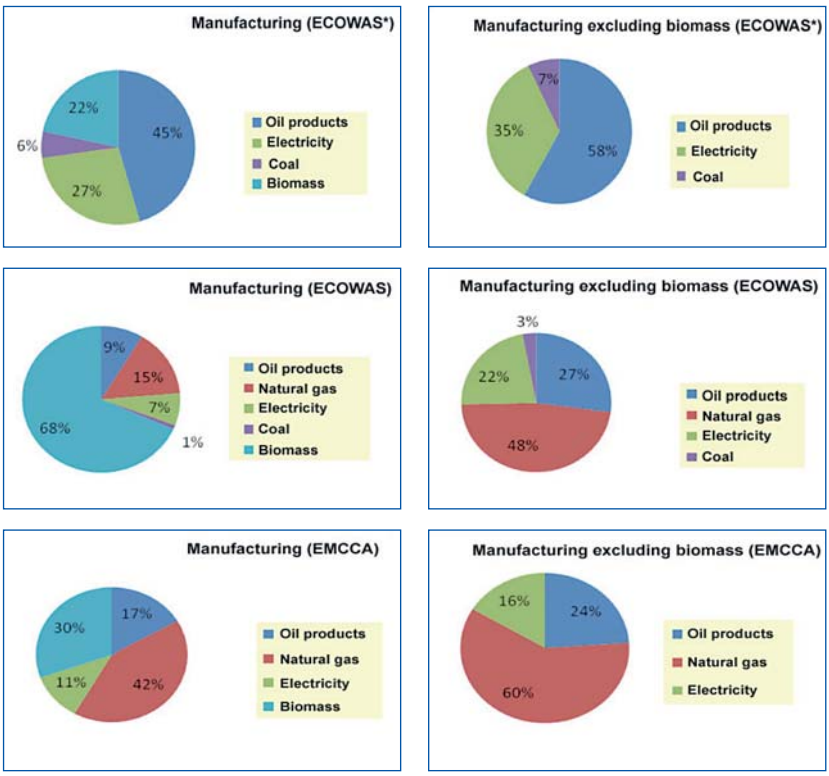
1 - Installation of a Natural Gas Liquefaction plant in Equatorial Guinea.

2 - Natural gas is mainly consumed in Gabon and Equatorial Guinea. However, Cameroon will start exploiting its own natural gas reserves in 2011 for electricity generation. This will further strengthen the position of this energy source in the EMCCA sub region.

2.3 Consumption per product for final consumer sectors (2008)

Diagram 10: Consumption per energy product for each final consumption sector

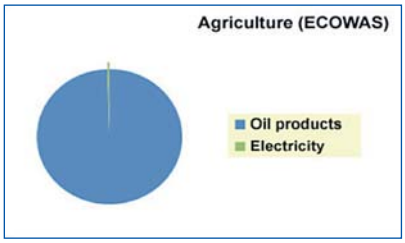
• ***Industry***

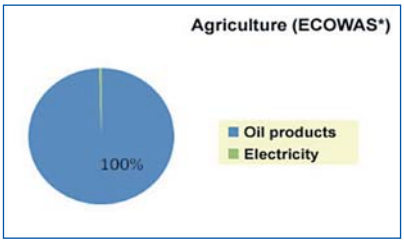


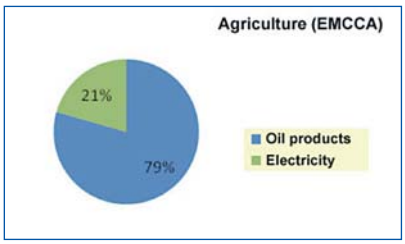
• ***Transport***

In both ECOWAS and EMCCA countries, the energy consumed by the transport sector is generated exclusively by oil products.

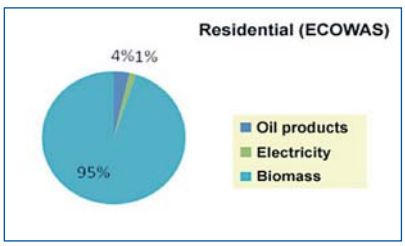
• ***Agriculture (with or without biomass)***

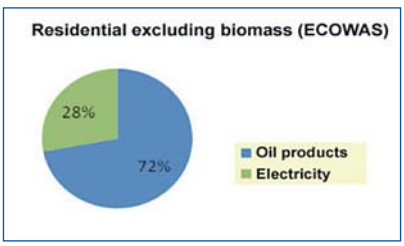


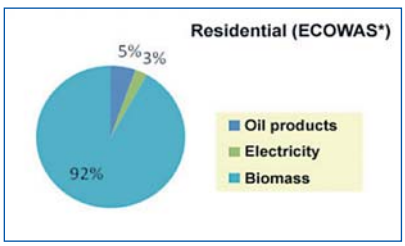


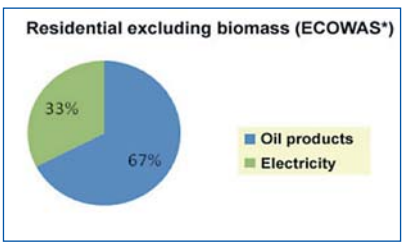


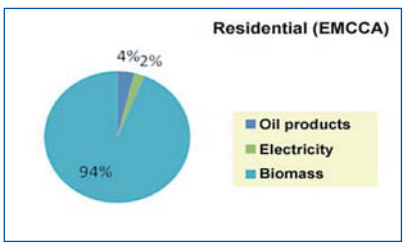
• ***Residential***

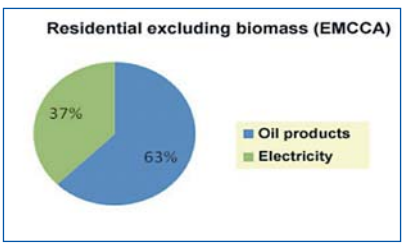




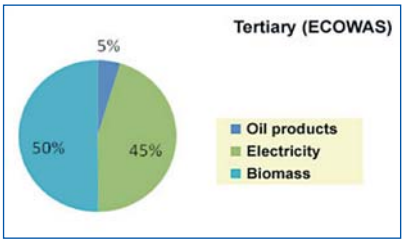


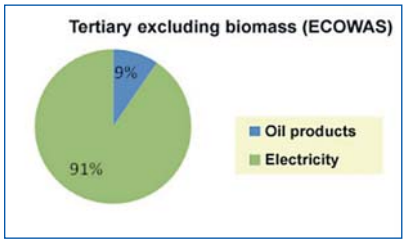


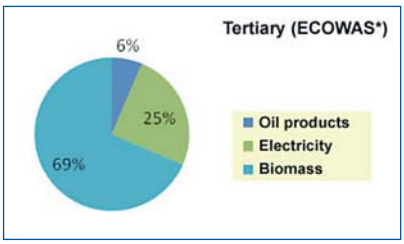


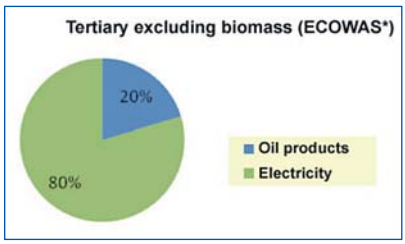


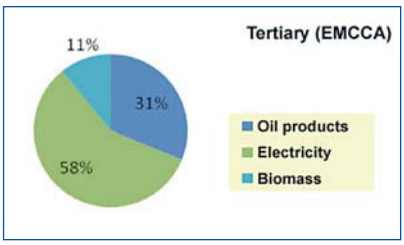
• ***Tertiary***

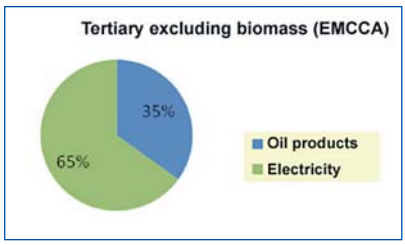












• ***Non-energy uses***

In both ECOWAS and EMCCA countries, the only primary energy resources consumed for non-energy-related uses are oil products (in the chemical industry).

2.4 Final energy consumption per sector and per country

Table 2 shows that the residential sector is easily the highest consumer of final energy in both zones, the main energy source or product being biomass. But if we remove biomass from final consumption (table 3), the transport and manufacturing sectors become the leading consumers in both ECOWAS and EMCCA countries.

Table 2: Final energy consumption for ECOWAS and EMCCA countries

2008	Population	Final Energy Consumption		Manufacturing		Transport	
		Total	Per capita				
Unit	Million	Mtep	tep	Mtoe	%	Mtoe	%
Benin	9.33	2.62	0.28	0.064	2.4	0.69	26.2
Burkina Faso	15.27	2.27	0.15	0.09	4	0.35	15.4
Cape Verde	0.54	0.083	0.15	0.005	6	0.022	26.5
Ivory Coast	19.57	5.49	0.28	0.216	4	0.40	7.3
Gambia	1.76	0.121	0.07	0.005	4	0.05	40.5
Ghana	24.01	7.49	0.31	0.977	13	1.33	17.7
Guinea	9.54	2.60	0.27	0.18	7	0.25	9.6
Guinea-Bissau	1.75	0.208	0.12	0.026	12,5	0.05	24.5
Liberia	3.8	1.254	0.33	0.018	1.4	0.16	12.8
Mali	12.72	2.10	0.17	0.206	10	0.37	17.8
Niger	14.73	1.44	0.1	0.038	2.6	0.15	10.6
Nigeria	151.82	99.18	0.65	11.12	11.2	7.6	7.7
Senegal	12.71	1.75	0.14	0.217	12.4	0.57	32.6
Sierra Leone	6.15	0.855	0.14	0.094	11	0.18	21.3
Togo	6.77	1.52	0.22	0.03	2	0.23	15.5
ECOWAS*	138.65	29.82	0.21	2.17	7.3	4.81	16.1
ECOWAS	290.47	129	0.44	13.3	10.3	12.41	9.6
Cameroon	18.98	5.86	0.31	0.923	15.7	0.73	12.5
Central African Republic	4.41	0.55	0.12	0.01	1.8	0.084	15.3
Congo	3.86	0.94	0.24	0.03	3.2	0.4	42.5
Gabon	1.35	1.77	1.31	0.55	31.1	0.18	10.3
Equatorial Guinea	0.52	1.44	2.77	1.262	87.6	0.06	4
Chad	11.19	0.98	0.09	0.13	13.2	0.034	3.5
EMCCA	40.31	11.54	0.29	2.91	25.2	1.48	12.9
ECOWAS+EMCCA	330.78	140.54	0.42	16.2	11.5	13.9	9.9

Note: consumption for the residential/tertiary/agricultural sectors is not the same as the sum of the three sectors for the Ivory Coast (statistical uncertainty).

per sector

Residential Tertiary Agriculture		Residential		Tertiary		Agriculture		Non-energy		2008
Mtoe	%	Mtoe	%	Mtoe	%	Mtoe	%	Mtoe	%	Unit
1.87	71.2	1.6	61.1	0.264	10.1			0.004	0.2	Benin
1.83	80.5	1.8	79.3	0.027	1.2	0.000	0.05			Burkina Faso
0.06	67.5	0.05	62.6	0.004	4.8					Cape Verde
4.84	88.2	3.99	72.9	0.624	11.4	0.07	2	0.026	0.5	Ivory Coast
0.07	55.4	0.064	52.9	0.003	2.5					Gambia
5.104	68.1	4.77	63.6	0.09	1.2	0.25	3.3	0.08	1	Ghana
2.17	83.5	2.17	83.4	0.004	0.1					Guinea
0.11	53.4	0.11	53.4					0.02	9.1	Guinea-Bissau
1.08	85.8	1.07	85.6	0.003	0.2			0		Liberia
1.52	72.4	1.52	72.4							Mali
1.24	86.5	1.24	86.3	0.001	0.1					Niger
80.3	81	79.9	80.5	0.445	0.4	0		0.15	0.1	Nigeria
0.94	53.8	0.89	51	0.047	2.7	0		0.02	1.1	Senegal
0.58	67.7	0.58	67.6	0.001	0.1					Sierra Leone
1.25	82.2	1.1	72.4	0.15	9.9			0.004	0.3	Togo
22.7	76	21	70.4	1.22	4.1	0.32	1.1	0.15	0.5	ECOWAS*
103	79.8	101	78.3	1.7	1.3	0.32	0.2	0.303	0.2	ECOWAS
4.19	71.4	4.11	70.1	0.075	1.3	0.004	0.1	0.015	0.3	Cameroon
0.45	82.4	0.45	82.4	0.000				0.000	0.1	Central African Republic
0.51	54.2	0.51						0.004	0.4	Congo
1.02	57.8	0.95	53.7	0.058	3.3	0.015	0.8	0.015	0.8	Gabon
0.12	8.3	0.12	8.3							Equatorial Guinea
0.82	83.7	0.82	83.7							Chad
7.11	61.6	6.96	60.3	0.134	1.2	0.02	0.1	0.04	0.3	EMCCA
110.1	78.3	107.8	76.7	1.8	1.3	0.33	0.3	0.34	0.2	ECOWAS+EMCCA

Table 3: Final energy consumption not including biomass for ECOWAS

2008	Population	Final Energy Consumption not including biomass		Manufacturing		Transport	
		Totale	Per capita				
Unit	Million	Mtoe	toe	Mtoe	%	Mtoe	%
Benin	9.33	1.15	0.12	0.064	5.5	0.686	59.4
Burkina Faso	15.27	0.53	0.03	0.091	17.2	0.35	66.5
Cape Verde	0.54	0.06	0.11	0.005	8.6	0.022	38.4
Ivory Coast	19.57	1.3	0.07	0.216	16.6	0.403	31.1
Gambia	1.76	0.07	0.04	0.005	6.8	0.049	69.3
Ghana	24.01	2.75	0.11	0.546	19.8	1.33	48.2
Guinea	9.54	0.51	0.05	0.166	32.8	0.25	49.5
Guinea-Bissau	1.75	0.11	0.06	0.026	24.2	0.051	46.7
Liberia	3.8	0.19	0.05	0.018	9.8	0.16	85.1
Mali	12.72	0.62	0.05	0.186	30	0.375	60.4
Niger	14.73	0.23	0.02	0.038	16.4	0.153	65.5
Nigeria	151.82	14.05	0.09	2.512	17.9	7.6	54.1
Senegal	12.71	1.03	0.08	0.217	21.1	0.57	55.3
Sierra Leone	6.15	0.32	0.05	0.091	28	0.182	56.2
Togo	6.77	0.35	0.05	0.03	8.4	0.235	66.3
ECOWAS*	138.65	9.23	0.07	1.7	18.4	4.814	52.2
ECOWAS	290.47	23.28	0.08	4.212	18.1	12.41	53.3
Cameroon	18.98	1.38	0.07	0.36	26	0.73	53
Central African Republic	4.41	0.12	0.03	0.01	8	0.084	66.9
Congo	3.86	0.48	0.12	0.03	6.1	0.4	83.2
Gabon	1.35	0.71	0.53	0.344	48.1	0.183	25.6
Equatorial Guinea	0.52	1.33	2.57	1.262	94.5	0.057	4.3
Chad	11.19	0.07	0.06	0.018	24.1	0.034	46.2
EMCCA	40.31	4.10	0.10	2.024	49.3	1.485	36.2
ECOWAS+EMCCA	330.78	27.38	0.08	6.236	22.8	13.9	50.7

Note: consumption for the residential/tertiary/agricultural sectors is not the same as the sum of the three sectors for the Ivory Coast.

and EMCCA countries per sector

Residential/, Tertiary, Agri		Residential		Tertiary		Agriculture		Non-energy		2008
Mtoe	%	Mtoe	%	Mtoe	%	Mtoe	%	Mtoe	%	Unit
0.4	34.6	0.38	32.9	0.02	1.7			0.004	0.36	Benin
0.086	16.3	0.058	11.1	0.027	5.1	0.000	0.1			Burkina Faso
0.031	52.9	0.027	45.6	0.004	7.3			0		Cape Verde
0.653	50.3	0.245	18.8	0.176	13.5	0.068	5.3	0.026	2	Ivory Coast
0.017	23.9	0.014	19.7	0.003	4.2					Gambia
0.803	29.1	0.465	16.9	0.091	3.3	0.247	9	0.077	2.8	Ghana
0.089	17.7	0.086	16.9	0.004	0.8					Guinea
0.013	11.6	0.013	11.6					0.019	17.57	Guinea-Bissau
0.009	5.05	0.007	3.6	0.003	1.4			0	0	Liberia
0.06	9.6	0.06	9.6							Mali
0.042	18	0.041	17.4	0.001	0.6					Niger
3.788	27	3.343	23.8	0.445	3.2	0	0	0.153	1.09	Nigeria
0.223	21.7	0.176	17.1	0.047	4.6	0	0	0.019	1.86	Senegal
0.051	15.8	0.05	15.4	0.001	0.4					Sierra Leone
0.086	24.2	0.079	22.3	0.007	2			0.004	1.08	Togo
2.563	27.8	1.7	18.4	0.384	4.2	0.316	3.4	0.15	1.62	ECOWAS*
6.352	27.3	5.042	21.7	0.829	3.6	0.316	1.3	0.303	1.3	ECOWAS
0.273	19.9	0.208	15.1	0.061	4.5	0.004	0.3	0.015	1.11	Cameroon
0.031	24.8	0.031	24.6	0.000	0.2			0.000	0.23	Central African Republic
0.046	9.6	0.046	9.6					0.004	1.07	Congo
0.173	24.2	0.1	13.9	0.06	8.1	0.015	2.05	0.015	2.15	Gabon
0.015	1.1	0.015	1.1							Equatorial Guinea
0.022	29.6	0.022	29.6							Chad
0.560	13.6	0.422	10.3	0.121	2.9	0.019		0.036	0.88	EMCCA
6.912	25.2	5.463	19.9	0.95	3.5	0.335		0.339	1.24	ECOWAS+EMCCA

3. Final energy intensities

Another indicator - "energy intensity" - is used to draw comparisons between different countries in addition to consumption per capita. Energy intensity is calculated as energy consumed (primary or final) per net GDP, with GDP being calculated on the basis of "purchasing power parity" (PPP) in order to take differences in standards of living into account[3].

This indicator (which is usually expressed in toe/US$100 or in ktoe/US$100) gives the level of "energy efficiency" or "energy voracity" for a country or a development mode. It is a measurement of the quantity of energy consumed for a given production level to produce goods and provide services.

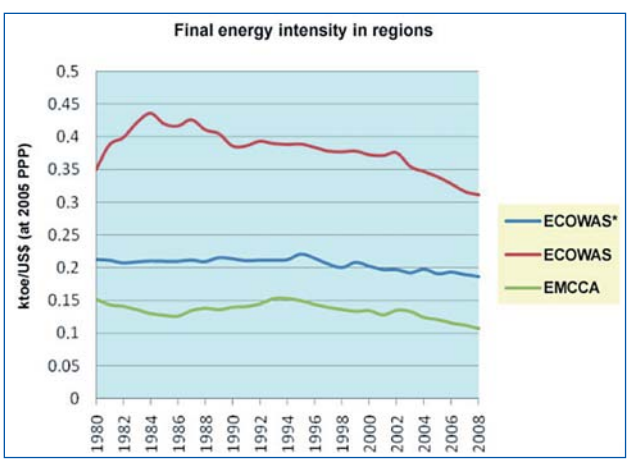
A number of factors, needless to say, influence a country's overall energy intensity, such as climate (in hot countries, energy is not required for heating), and the structure of the economy: a country with well-developed manufacturing industries (which consume a great deal of energy) will have a higher level of energy intensity.

But when countries whose economies are structured in similar ways are compared, the essential factor is the efficiency with which energy is produced and consumed: in very simple terms, the lower the energy intensity, the greater the energy efficiency[4].

3.1 Change in final energy intensity

Final energy intensity is calculated as units of final energy consumption per unit of PPP GDP, and is expressed in constant $2005.

Diagram 11: Change in final energy intensity for both zones



It is seen that at the start of 1980, final energy consumption for the EMCCA zone was growing at a slower rate than GDP. This continued until 1986: energy intensity fell from 0.152 in 1980 to 0.126 in 1986. After 1986, the trend was reversed until 1994, after

3 - See 2.2, Chapter II.

4 - A recent study - an "Assessment of energy efficiency in the European Union (15 member states)" - published by the European commission and the ADEME, and produced by 14 national teams (the ODYSSEE-MURE network), gives a detailed analysis of energy efficiency in 15 member states of the European Union. The study identifies a number of different factors which influence a country's energy intensity. It separates out the effects and then defines and assesses an actual energy efficiency indicator (www.odyssee-indicators.org).

which the rate of growth in energy consumption once again fell below that of GDP. But for countries in the ECOWAS* zone (not including Nigeria), however, the trend remained more or less constant until the start of the 2000s. An analysis of the situation in the countries in the ECOWAS zone clearly shows that Nigeria has a high level of energy dependency, despite the efforts it went to between 1984 and 2008 to reduce its energy intensity from 0.43 to 0.31.

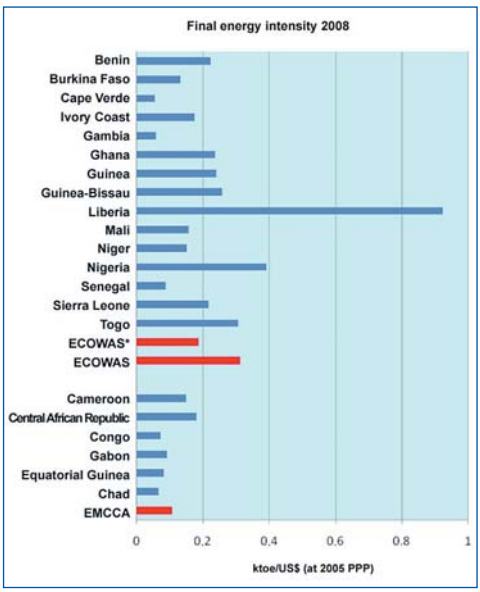
One could reasonably believe that the fall in energy intensity in these regions is closely linked to the increase in the share of fossil fuels in final energy consumption[5], more than improvements in energy efficiency as a result of other factors.

3.2 Final energy intensity per country

The diagram below shows that ECOWAS countries have very high energy intensity levels compared with countries in the EMCCA zone: analysing the structure of final energy consumption shows that biomass accounts for approximately 75% of final energy consumption in ECOWAS countries, as opposed to 60% for EMCCA countries. The fact that the energy yield of biomass across all of these countries is very low explains the low energy intensity values for these countries.

Liberia is an exception - it is recovering from a long period of war (around 10 years) which paralysed economic activity throughout the country.

Diagram 12: Final energy intensity per country in 2008



5 - *The situation seems somewhat paradoxical, but it is real insofar as the conditions in which biomass is used are archaic with very low yield.*

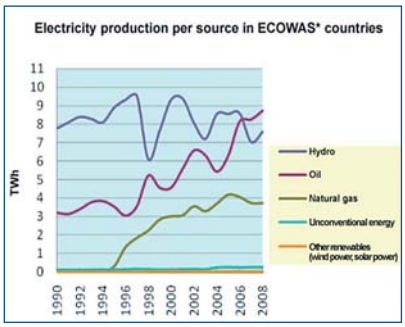
IV - ELECTRICITY GENERATION AND CONSUMPTION

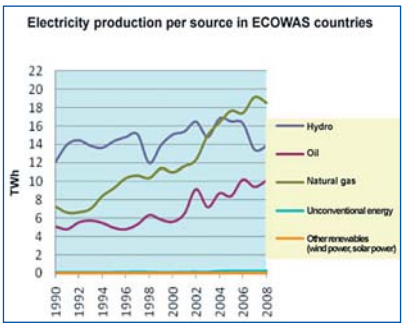
1. Electricity generation

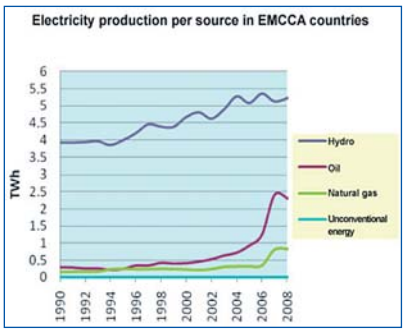
1.1 Growth in electricity generation in ECOWAS and EMCCA countries

• ***Growth per generation source***

Diagram 1: Growth per electricity generation source for each zone







Total electricity generation in 2008 was 42.78 TWh for ECOWAS countries (including more than 50% of the Nigeria) and 8.43 TWh for EMMCA countries.

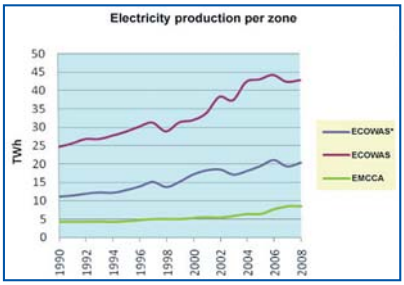
Electricity generation in both these zones is mainly centred around hydraulic power.

In ECOWAS countries, hydraulic electricity generation has remained stable at around 12 TWh since 1990, whereas electricity generation from oil and natural gas has continued to rise at an average annual rate of approximately 6% for oil and 7% for natural gas.

In EMCCA countries, however, hydraulic power is still the main source of electricity generation and has been increasing at a rate of 2% per annum since 1990. The use of natural gas and oil has also been on the increase in EMCCA countries.

• ***Growth per zone***

Diagram 2: Growth in electricity generation per zone

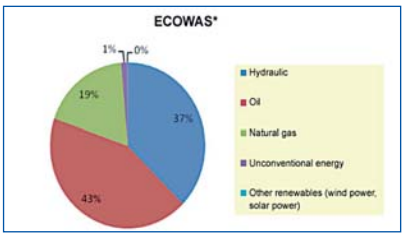


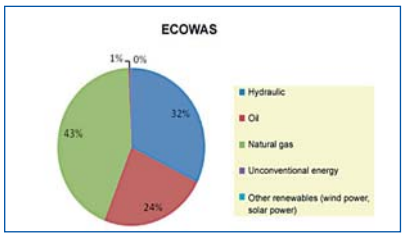
Electricity generation increased significantly in both zones between 1990 and 2008. This growth was more accentuated in ECOWAS countries.

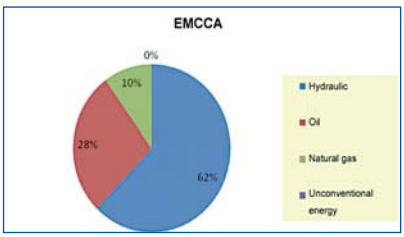
1.2 Electricity generation per country and per source

• ***Per zone and per source***

Diagram 3: Structure per source of electricity generation for each zone







In ECOWAS* countries (not including Nigeria), oil is the main source of electricity generation (43%), followed by natural gas (19%). In ECOWAS countries, electricity generation from natural gas accounts for 43% of the total, considerably more than from oil (24%). This variation in structure is mainly due to how electricity is generated in Nigeria.

In the EMCCA zone, however, natural gas is only used to generate electricity in three countries: Cameroon, Gabon and the Congo. The way in which generation is structured in EMCCA countries is strongly influenced by the situation in Cameroon, which accounts for approximately 70% of the zone's electricity production.

In most of the ECOWAS zone's countries, most of the electricity is generated by thermal fossil fuel plants, with the exception of Ghana (46% in thermal fossil fuel plants and 54% by hydraulic means) and Mali. In this zone, the Ivory Coast and Nigeria use natural gas to generate 66% of their electricity.

But all countries in the EMCCA zone - except for Chad (which uses oil to generate 100% of its electricity) are heavily reliant on hydraulic means for generating electricity.

In both zones, other means of generating electricity from renewable sources are only in their very early stages (apart from hydraulic).

Table 1: Electricity generation per energy source and per country in the

2008	Gross total production	Generation by thermal power plants					
		Oil		Natural gas		Total for fossil fuels	
Unit	TWh	TWh	%	TWh	%	TWh	%
Benin	0.14	0.14	99.3	0	0	0.14	99.3
Burkina Faso	0.65	0.41	64	0	0	0.41	64
Cape Verde	0.29	0.28	97.9	0	0	0.28	97.9
Ivory Coast	5.57	0.02	0.3	3.7	66.3	3.71	66.6
Gambia	0.11	0.11	100	0	0	0.11	100
Ghana	7.65	3.56	46.6	0	0	3.56	46.6
Guinea	1.23	0.79	64.3	0	0	0.79	64.3
Guinea-Bissau	0.07	0.07	100	0	0	0.07	100
Liberia	0.35	0.35	100	0	0	0.35	100
Mali	1.49	0.7	46.6	0	0	0.7	46.6
Niger	0.19	0.19	100	0	0	0.19	100
Nigeria	22.42	1.34	6	14.82	66.1	16.17	72.1
Senegal	2.18	1.77	81.2	0.04	2	1.81	83.2
Sierra Leone	0.23	0.23	100	0	0	0.23	100
Togo	0.21	0.11	50	0	0	0.11	50
ECOWAS*	20.37	8.73	42.9	3.74	18.3	12.47	61.2
ECOWAS	42.79	10.08	23.5	18.56	43.4	28.64	66.9
Cameroon	6.05	1.54	25.5	0.46	7.6	20.0	33.1
Central African Republic	0.14	0.0001	0.1	0	0	0.000	0.1
Congo	0.46	0	0	0.07	16	0.07	16
Gabon	1.49	0.54	36.4	0.29	19.7	0.83	56.1
Equatorial Guinea	0.13	0.06	47.6			0.06	47.6
Chad	0.18	0.18	100	0	0	0.18	100
EMCCA	8.44	2.32	27.5	0.83	9.8	3.15	37.3
ECOWAS+EMCCA	51.22	12.4	24.2	19.39	37.8	31.79	62.1

Note: the data from Guinea is incomplete, because the sum of the various sources is not the same as the total amount of electricity generated.

ECOWAS and EMCCA zones

		Generation from renewable energy sources (excluding biomass)						2008
Biomass[1]		Hydraulic		Other renewables (wind, solar power)		Total for renewables		
TWh	%	TWh	%	TWh	%	TWh	%	
0	0	0.001	3	0	0	0.001	3	Benin
0.09	13.4	0.15	22.6	0	0	0.23	36	Burkina Faso
0	0	0	0	0.006	2.1	0.006	2.1	Cape Verde
0.12	2.1	1.74	31.2	0	0	1.86	33.4	Ivory Coast
0	0	0	0	0	0	0	0	Gambia
0	0	4.09	53.4	0	0	4.09	53.4	Ghana
0	0	0.44	35.7	0	0	0.44	35.7	Guinea
0	0	0	0	0	0	0	0	Guinea-Bissau
0	0	0	0	0	0	0	0	Liberia
0	0	0.8	53.4	0	0	0.8	53.4	Mali
0	0	0	0	0	0	0	0	Niger
0	0	6.25	27.9	0	0	6.25	27.9	Nigeria
0.05	2.3	0.29	13.4	0.004	0.2	0.35	16	Senegal
0	0	0	0	0		0	0	Sierra Leone
0.01	5	0.09	45	0	0	103	50	Togo
0.27	1.3	7.60	37.3	0.01	0.05	7.87	38.6	ECOWAS*
0.27	0.6	13.85	32.3	0.01	0.02	14.12	33	ECOWAS
0	0	4.04	66.9	0	0	4.04	66.9	Cameroon
0	0	0.14	99.9	0	0	0.14	99.9	Central African Republic
0	0	0.38	84	0	0	0.38	84	Congo
0.01	0.5	0.65	43.4	0	0	0.65	43.9	Gabon
		0.002	2					Equatorial Guinea
0	0	0	0	0	0	0	0	Chad
0.007	0.1	5.22	61.8			5.22	61.9	EMCCA
0.27	0.5	19.06	37.2	0.01	0.02	19.34	37.8	ECOWAS+EMCCA

1.3 Efficiency of electricity generation

The efficiency of an electricity generating system is equal to the ratio of the quantity of electricity generated to the quantity of fossil fuels and biomass consumed upstream of generation at thermal power plants, plus the primary energy value of electricity derived from hydraulic means and other renewables.

The table above shows that the efficiency of thermal electricity generation (oil, gas, coal and biomass) is around 33%. A number of countries, such as the Gambia (16.4%), Togo (21%) and Niger (13.8%) have levels of efficiency that are considerably lower than the general mean (by half). Sierra Leone, on the other hand, has an efficiency level of

1 - Biomass also refers to the unconventional energies referenced in the diagrams above.

51% (the highest). The reason for this is the poor state of repair of the power plants in operation in the Gambia and the low efficiency levels of primary energy used: coal in Niger and biomass in Togo.

As far as total electricity generation is concerned, efficiency levels are considerably better. Integrating renewable primary electricity into the energy mix has improved the efficiency of the electricity generating system. 99% of electricity in the Central African Republic is hydraulically generated, and the efficiency of its systems is in the region of 99%; a number of other countries - such as Cameroon (52%) and the Congo (77%) in the EMCCA

Table 2: Efficiency of electricity generating systems in ECOWAS and

2008	Generation by thermal power plants				
	Inputs				
	Oil Mtoe	Natural gas Mtoe	Coal Mtoe	Biomass Mtoe	Total Mtoe
Benin	0.031				0.031
Burkina Faso	0.11			0.0234	0.133
Cape Verde	0.072				0.072
Ivory Coast	0.006	0.877		0.041	0.924
Gambia	0.055				0.055
Ghana	0.919				0.919
Guinea	0.208				0.208
Guinea-Bissau	0.016				0.016
Liberia	0.083				0.083
Mali	0.201				0.201
Niger	0.011		0.112		0.123
Nigeria	0.575	3.27	0		3.845
Senegal	0.489	0.009		0.066	0.564
Sierra Leone	0.039				0.039
Togo	0.029			0.018	0.047
ECOWAS*	2.27	0.886	0.112	0.149	3.417
ECOWAS	2.846	4.156	0.112	0.149	7.262
Cameroon	0.363	0.292			0.655
Central African Republic	0.00002				0.000025
Congo	0	0.018			0.018
Gabon	0.119	0.133		0.006	0.258
Equatorial Guinea	0.023	0.025			0.048
Chad	0.053				0.053
EMCCA	0.558	0.468		0.006	1.032
ECOWAS+EMCCA	3.404	4.624	0.112	0.155	8.295

EMCCA countries

Electricity		Hydraulic	Total production		2008
Generated Mtoe	Efficiency %	Inputs Mtoe	Inputs Mtoe	Efficiency %	
0.012	38.7	<0.001	0.0315	38.7	Benin
0.043	32.3	0.013	0.146	38.1	Burkina Faso
0.024	33.3	--	0.072	34	Cape Verde
0.33	35.7	0.15	1.074	44.6	Ivory Coast
0.009	16.4	--	0.055	16.4	Gambia
0.307	33.4	0.35	1.27	51.8	Ghana
0.068	32.7	0.038	0.246	43.1	Guinea
0.006	37.5	--	0.016	37.5	Guinea-Bissau
0.030	36.1	0	0.083	36.1	Liberia
0.06	29.8	0.069	0.269	47.7	Mali
0.017	13.8	--	0.123	13.8	Niger
1.39	36.1	0.537	4.383	44	Nigeria
0.162	28.7	0.025	0.59	31.9	Senegal
0.02	51.3	--	0.039	51.3	Sierra Leone
0.01	21.3	0.01	0.055	32.2	Togo
1.098	32.1	0.653	4.071	43	ECOWAS*
2.488	34.3	1.191	8.454	43.5	ECOWAS
0.172	26.2	0.348	1.003	51.9	Cameroon
0.0000086	34.4	0.012	0.012	99.8	Central African Republic
0.0063	35	0.033	0.051	76.9	Congo
0.072	27.9	0.056	0.313	40.8	Gabon
0.011	22.9	<0.001	0.048	22.5	Equatorial Guinea
0.0153	28.9	--	0.0535	28.9	Chad
0.277	26.8	0.45	1.481	49	EMCCA
2.765	33.3	1.64	9.935	44.3	ECOWAS+EMCCA

zone and Ghana (52%) and Mali (48%) in the ECOWAS zone - have very high levels of efficiency, as more than 50% of their electricity is generated using renewable means (hydraulic).

1.4 Installed capacity for generating electricity, per source and per country

Table 3: Installed capacity for different electricity paths in ECOWAS and EMCCA countries

2008	Total	Thermal	Oil	Natural gas	Other renewables (wind)	Hydraulic	2008
	MW	MW	MW	MW	MW	MW	
Benin	106.5	73	73			33.5	Benin
Burkina Faso	252	220	220			32	Burkina Faso
Cape Verde	91.4	89.3	89.3		2.1		Cape Verde
Ivory Coast	1,209	610	199	406		604	Ivory Coast
Gambia	93	93	93				Gambia
Ghana	2,164	930	930			1,234	Ghana
Guinea	314	184	184			130	Guinea
Guinea-Bissau	9.3	9.3	9.3				Guinea-Bissau
Liberia	203	198	198			5	Liberia
Mali	273	107	107			166	Mali
Niger	95.5	95.5	95.5				Niger
Nigeria	8,124	6,324	900	5,424		1,800	Nigeria
Senegal	782.6	722.6	722.57			60	Senegal
Sierra Leone	59.8	55.8	55.8			4	Sierra Leone
Togo	101.5	67	67			34.5	Togo
ECOWAS*	5,754.6	3,454.5	2,528.5	406	2.1	2,303	ECOWAS*
ECOWAS	13,878.6	9,778.5	3,428.5	5,830	2.1	4,103	ECOWAS
Cameroon	967.2	245.2	245.2			722	Cameroon
Central African Republic	56.9	38.24	38.24			18.7	Central African Republic
Congo	145.3	56.3	56.3			89	Congo
Gabon	378.6	208	208			170.6	Gabon
Equatorial Guinea	47	41.4	31	10.4		5.6	Equatorial Guinea
Chad	30	30	30				Chad
EMCCA	1,625.0	619.1	608.7	10.4	0	1,005.9	EMCCA
ECOWAS+EMCCA	15,503.6	10,397.6	4,037.2	5,840.4	2.1	5,108.9	ECOWAS+EMCCA

In ECOWAS countries, 70% of installed capacity is derived from thermal fossil fuel power generation - 9778 MW (including 6324 MW for Nigeria), for total production of 28.64 TWh (including 16 TWh for Nigeria). Electricity production from renewable energy sources provides 4103 MW of installed capacity (including 1800 MW for Nigeria) for total production of 14.12 TWh (including 6.25 TWh for Nigeria).

In EMCCA countries, thermal fossil fuel power generation provides 619 MW of installed capacity (38% of the total) for a total production of 3.15 TWh, with renewable sources providing 1006 MW of installed capacity for a total production of 5.2 TWh.

What emerges from this data about installed capacity and the energy generated is that on average (at nominal power output), thermal power plants operate 3000 hours per year and renewable energy sources for approximately 3500 hours for generating electricity in ECOWAS countries. In EMCCA countries, thermal power plants run 5100

hours and renewables 5200 hours per year. This significant difference can be explained by the type of primary energy used (mainly natural gas in ECOWAS countries and oil in EMCCA countries), as well as the different designs of the hydraulic installations in use in both zones (high potential in EMCCA countries).

1.5 Losses over transport and distribution networks

Table 4: Losses over transport and distribution networks

2008	Electricity transported	Losses		2008
Country	TWh	TWh	%	Country
Benin	0.755	0.125	16.5	Benin
Burkina Faso	0.733	0.097	13.2	Burkina Faso
Cape Verde	0.275	0.073	26.6	Cape Verde
Ivory Coast	5.852	1.497	25.6	Ivory Coast
Gambia	0.107	0.04	37.4	Gambia
Ghana	7.95	1.434	18	Ghana
Guinea	0.626	0.06	9.6	Guinea
Guinea-Bissau	0.068	0		Guinea-Bissau
Liberia	0.332	0.042	12.6	Liberia
Mali	0.993	0.206	20.7	Mali
Niger	0.464	0.037	8	Niger
Nigeria	21.661	2.646	12.2	Nigeria
Senegal	1.820	0.543	29.8	Senegal
Sierra Leone	0.1338	0.030	30	Sierra Leone
Togo	0.708	0.106	15	Togo
ECOWAS*	20.82	4.29	20.6	ECOWAS*
ECOWAS	42.48	6.94	16.3	ECOWAS
Cameroon	1.478	0.841	56.9	Cameroon
Central African Republic	0.141	0.011	7.8	Central African Republic
Congo	0.896	0.424	47.3	Congo
Gabon	1.177	0.292	24.8	Gabon
Equatorial Guinea	0.126	0.044	34.9	Equatorial Guinea
Chad	0.178	0.022	12.3	Chad
EMCCA	4	1.63	40.9	EMCCA
ECOWAS+EMCCA	46.5	8.57	18.4	ECOWAS+EMCCA

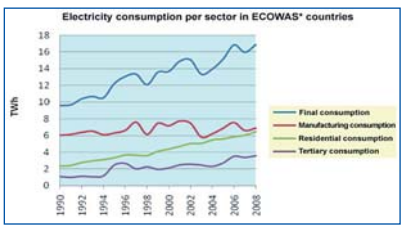
Electricity losses over transport and distribution networks in EMCCA countries account for approximately 40% of all electricity transported, as opposed to only 16% in ECOWAS countries. These losses are the highest in Cameroon (57%) and in the Congo (47%). The lowest quantities of electricity are lost over the transport and distribution networks of the Niger, Guinea and the Central African Republic - 8%, 9% and 7%, respectively. The surface areas of these countries cannot be the main causes of these losses, since electricity is not distributed across the entire extent of these countries, and some large nations lose lower quantities of electricity than smaller countries. Causes include the quality of the equipment used to transport electricity (electric power lines), and theft, etc.

2. Electricity consumption

2.1 Increase in electricity consumption

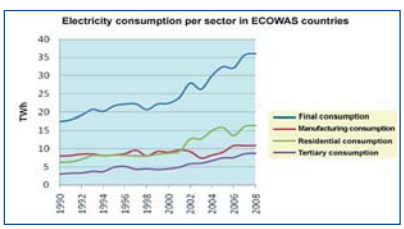
• ***Per sector***

Diagram 4: Increase in electricity consumption per sector in ECOWAS* countries



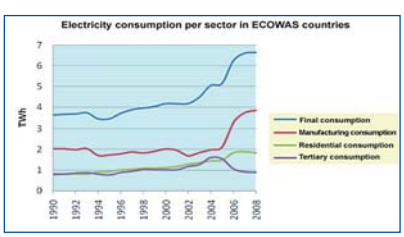
Electricity consumption in ECOWAS* countries (excluding Nigeria) increased at an average annual rate of 4.2% between 1990 and 2008. This increase was stimulated by rising consumption in the residential and tertiary sectors, which grew at average annual rates of 10% and 12%, respectively.

Diagram 5: Increase in electricity consumption per sector in ECOWAS countries



In ECOWAS countries (including Nigeria), final electricity consumption increased at an average annual rate of approximately 5.9% between 1990 and 2008. It can be deduced that Nigeria's final electricity consumption increased dramatically compared with that of other ECOWAS countries. All sectors contributed to this increase, unlike ECOWAS* countries where it was mainly due to growth in the residential and tertiary sectors.

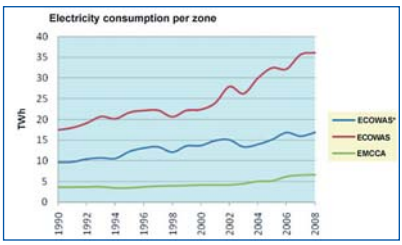
Diagram 6: Increase in electricity consumption per sector in EMCCA countries



Final electricity consumption increased by approximately 4.6% per year between 1990 and 2008. Its growth became even more pronounced in 2005 as a result of increased electricity consumption in the manufacturing sector - which practically doubled between 2005 and 2008 (2.10 TWh to 3.84 TWh). Before this period, consumption in the manufacturing sector was stable. Electricity consumption in the residential sector increased at a rate of 7% a year, whereas it remained stable for the whole period in the tertiary sector.

• ***By zone***

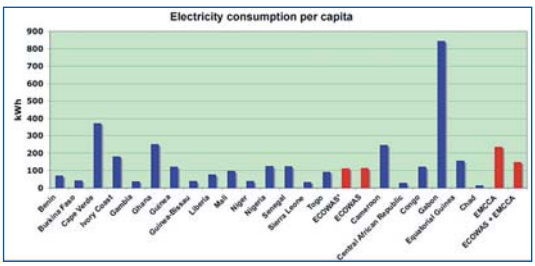
Diagram 7: Increase in electricity consumption per zone



2.2 Electricity consumption in 2008

• ***Per capita final electricity consumption***

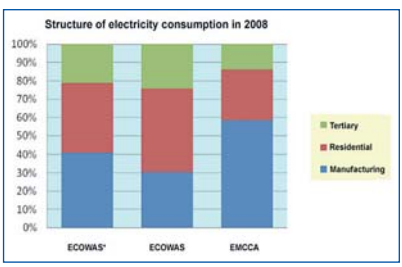
Diagram 8: Per capita electricity consumption for each country in 2008



There is a considerable disparity[2] between per capita electricity consumption in the two zones, ranging from 14 kWh per capita per year in Chad to 826 kwh per capita per year in Gabon. In 2008, Gabon's electricity generation was eight times greater than Chad's, with a population equivalent to an eighth of Chad's. Average per capita electricity consumption is around 124 kwh per year in ECOWAS countries, and around 165 kwh per year in EMCCA countries.

• ***Structure per zone and per sector of electricity consumption***

Diagram 9: Structure per sector of electricity consumption for each zone



2 - *The reason for this disparity is the ratio between each country's electricity generation and its population size (some countries have relatively small populations, others relatively large populations).*

• ***Electricity consumption per sector and per country***

Table 5: Electricity consumption per sector and per country

2008	Internal consumption		Energy sector		Total Final Consumption		Manufacturing	
	Total	Per capita						
Unit	GWh	KWh	GWh	%	GWh	%	GWh	%
Benin	659	70.6	0		659	100	120	18.2
Burkina Faso	663.5	43.4	0		663.5	100	251.5	37.9
Cape Verde	202	371.7	0		202	100	47	23.3
Ivory Coast	3541	181	0		3541	100	944	26.7
Gambia	67	38.2	0		67	100		
Ghana	6024	251	0		6024	100	2765	46
Guinea	1166.4	122.3	0		1166.4	100	600	51.4
Guinea-Bissau	68	39	0		68	100	6	9
Liberia	290	76.4	0		290	100	214	73.8
Mali	1247	98	0		1247	100	831	66.6
Niger	576.3	39.1	0		576.3	100	302.3	52.5
Nigeria	19190	126.4	0		19190	100	4059	21
Senegal	1570	123.6	0		1570	100	460	29.3
Sierra Leone	201.5	32.8	0		201.5	100	149.3	74
Togo	621	91.7	0		621	100	198	32
ECOWAS*	16896	122	0		16896	100	6887	40.8
ECOWAS	36087	124.2	0		36087	100	10947	30.3
Cameroon	4681	246.6	0		4681	100	3146	67.2
Central African Republic	129.4	29.4	0		129.4	100	61	47
Congo	472	122.3	0		472	100	232	49
Gabon	1142.5	844.2	25	2	1117.5	98	302	26.5
Equatorial Guinea	82	157.1	0		82	100	24.5	30
Chad	156	14	0		156	100	79	50.6
EMCCA	6663	165	25	0.4	6638	99.6	3845	57.7
ECOWAS+EMCCA	42749	129.2	25	0.1	42724	99.9	14792	34.6

The tertiary and residential sectors account for 60% of electricity consumption in the ECOWAS zone, with the exception of a few countries such as Guinea, Liberia, Mali, Niger and Sierra Leone, where it accounts for 40%, 26%, 33%, 47% and 26%, respectively. In the EMCCA zone, however, more than half (58%) the electricity generated is used for manufacturing purposes. This is particularly the case in Cameroon, where 67% of total electricity consumption is used for manufacturing. It is worth pointing out that in Cam-

Transport		Residential/Tertiary/ Agriculture		Residential		Tertiary		Agriculture		2008
GWh	%	GWh	%	GWh	%	GWh	%	GWh	%	Unit
		539	81.8	323.3	49.1	215.5	32.7			Benin
		412	62.1	95	14.3	312	47	5	0.8	Burkina Faso
		155	76.7	105	52	50	24.7			Cape Verde
		2597	73.3	1262	35.6	1324	37.4	11	0.3	Ivory Coast
		67	100	32	47.8	35	52.2			Gambia
		3259	54	2351	39	908	15	0		Ghana
		566.4	48.6	522	44.8	44.4	3.8			Guinea
		62	91	62	91					Guinea-Bissau
		76	26.2	45	15.5	31	10.7			Liberia
		416	33.4	416	33.4					Mali
		274	47.5	258	44.7	16	2.8			Niger
		15131	79	9952	52	5179	27			Nigeria
		1110	70.7	585	37.3	525	33.4	0		Senegal
		52.2	26	38.2	19	14	7			Sierra Leone
		423	68	342	55	81	13			Togo
		10009	59.2	6438	38.1	3554	21	16	0.1	ECOWAS*
		25140	69.7	16390	45.4	8734	24.2	16	0.1	ECOWAS
		1535	32.8	818	17.4	673	14.4	44	1	Cameroon
		68.4	53	65.4	51	3	2			Central African Republic
		239	51	239	51					Congo
4.3	0.4	811.2	71	580.2	50.8	231	20.2			Gabon
		57.1	70	57	70					Equatorial Guinea
		77	49.4	77	49.4					Chad
		2788.2	41.9	1837	27.6	907	13.6	44	0.7	EMCCA
		27928	65.3	18227	42.6	9641	22.6	60	0.1	ECOWAS+EMCCA

eroon, one single company (ALUCAM[3]) consumes approximately half of all electricity generated. This explains the high levels of electricity consumption in Cameroon's manufacturing sector. Electricity is mainly used in these countries for lighting and cooking in the residential sector. In manufacturing, it is used in particular for carrying out electrolysis on alumina which is extracted from bauxite (in Ghana and Cameroon).

3 - Which specialises in producing aluminium.

2.3 Electricity overview for ECOWAS and EMCCA countries

Table 6: Detailed electricity overview: generation through to final consumption (2008)

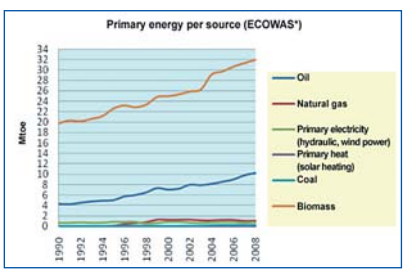
Electricity overview	ECOWAS	EMCCA
	GWh	GWh
GROSS GENERATION, made up of	42788	8437
Hydraulic	13846	5217
Wind power	5.5	0
Thermal, of which	28932	3220
From Oil	10076	2321
From Natural gas	18561	892
From Biomass	267	7
IMPORTS	2159	504
EXPORTS	- 679	-0
Gross availability	44268	8941
Private consumption (-)	- 1182	- 644
Gross generation	41606	7793
Internal availability	43086	8297
Loss during transport/distribution (-)	- 6937	-1635
TOTAL CONSUMPTION	36086	6662
Energy sector consumption	0	25
FINAL CONSUMPTION	36086	6637
Manufacturing	10947	3845
Transport	0	4
Residential, tertiary, agriculture	25140	2788

V - PRIMARY ENERGY CONSUMPTION

1. Growth and structure of total primary energy consumption

1.1 Growth in primary energy consumption per source in the two zones

Diagram 1: Growth in primary energy consumption per source in ECOWAS* countries (with and without biomass)



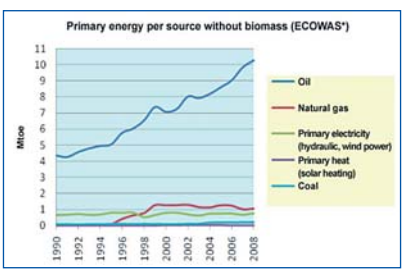
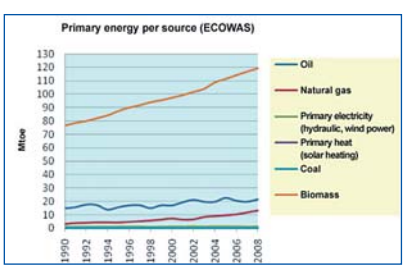


Diagram 2: Growth in primary energy consumption per source in ECOWAS countries (with and without biomass)



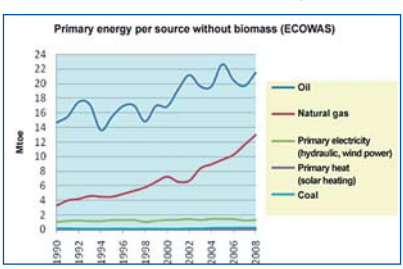
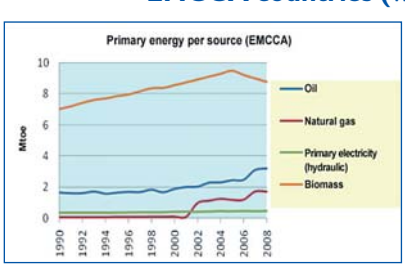
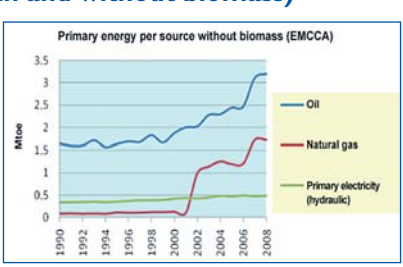


Diagram 3: Growth in primary energy consumption per source in EMCCA countries (with and without biomass)

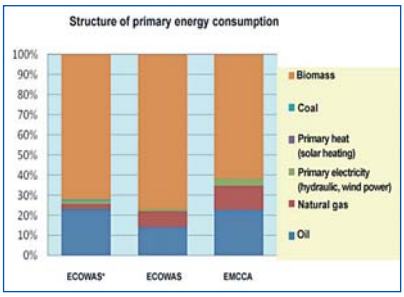


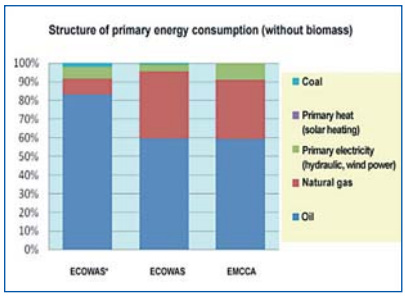


Biomass is by far the most commonly used source of energy in West Africa and Central Africa. In addition to biomass, oil is also one of the main sources of energy, much more so than natural gas, primary electricity and coal. Oil consumption has been increasing steadily in both zones since 1990. Natural gas consumption started to increase throughout Central Africa in 2001, whereas biomass consumption has been falling since 2005. Primary electricity generation has been increasing throughout the period, but almost imperceptibly.

1.2 Structure per zone of primary energy consumption (2008)

Diagram 4: Structure per source of primary energy consumption for each zone (with and without biomass)





Biomass is the main source of primary energy in ECOWAS* (72%), in ECOWAS (77%)[1] and in EMCCA (62%). Oil is the second source of primary energy - 23% in ECOWAS*, 14% in ECOWAS and 22% in EMCCA. Higher quantities of natural gas are consumed in EMCCA (12%) than in ECOWAS (7%)[2].

2. Consumption of primary energy per source and per country

Tables 1 and 2 show primary energy consumption per country and per zone, with biomass (table 1) and without biomass (table 2).

• *Oil*

Average per capita consumption in ECOWAS (0.07 toe) is approximately equivalent to average per capita consumption in EMCCA (0.08 toe). Per capita consumption in Cape Verde (0.21 toe) is three times greater than the average for the whole ECOWAS zone, whereas per capita consumption in Gabon and Equatorial Guinea are 5 and 4 times greater respectively than average per capita consumption in the EMCCA zone.

A number of countries, such as Niger, the Central African Republic and Chad have very low levels of per capita oil consumption (0.01 toe, 0.02 toe and 0.01 toe, respectively).

1 - Considerably higher quantities of biomass are consumed in Nigeria compared with other countries in the ECOWAS zone.
2 - Most of this is consumed by Nigeria: apart from in the Ivory Coast and Ghana, no natural gas is consumed.

• *Natural gas*

Seven countries in both zones consume natural gas: The Ivory Coast, Nigeria and Senegal in the ECOWAS zone and Cameroon, the Congo, Gabon and Equatorial Guinea in the EMCCA zone. In Nigeria (0.08 toe) and Gabon (0.1 toe), per capita consumption is twice as high as average per capita consumption in both zones (0.04 toe). Natural gas is the main source of energy in Equatorial Guinea - per capita consumption is 2.36 toe, 59 times higher than average per capita consumption across the whole zone.

• *Coal*

Only two countries in the ECOWAS zone consume coal: Niger and Senegal. Per capita consumption in both these countries is very low compared with other energy sources - 0.01 toe.

Table 1: Primary energy consumption per source in ECOWAS and EMCCA

2008	Population	Primary energy consumption			Oil		Natural gas	
	Million	Total	%	Per capita	Total	%	Total	%
Unit		Mtoe		toe	Mtoe		Mtoe	
Benin	9.33	3.01	1.8	0.32	1.13	37.5		
Burkina Faso	15.27	3.52	2.1	0.23	0.58	16.5		
Cape Verde	0.54	0.14	0.1	0.26	0.11	81.6		
Ivory Coast	19.57	10.25	6	0.52	1.23	12	1.04	10.2
Gambia	1.76	0.28	0.2	0.16	0.12	43.3		
Ghana	24.01	9.78	5.8	0.41	3.14	32.1		
Guinea	9.54	3.42	2	0.36	0.61	18		
Guinea-Bissau	1.75	0.22	0.13	0.13	0.12	54.9		
Liberia	3.8	1.76	1	0.46	0.25	13.9		
Mali	12.72	2.52	1.5	0.20	0.71	28.4		
Niger	14.73	2.49	1.5	0.17	0.20	7.9		
Nigeria	151.82	111.12	65.5	0.73	11.23	10.1	11.9	10.7
Senegal	12.71	2.725	1.6	0.21	1.33	48.9	0.01	0.32
Sierra Leone	6.15	1.65	1	0.27	0.37	22.2		
Togo	6.77	2.55	1.5	0.38	0.35	13.6		
ECOWAS*	138.65	44.31	26.1	0.32	10.25	23.1	1.05	2.4
ECOWAS	290.47	155.43	91.6	0.53	21.5	13.8	12.94	8.3
Cameroon	18.98	7.115	4.2	0.37	1.72	24.2	0.34	4.8
Central African Republic	4.41	0.59	0.3	0.13	0.11	19.3		
Congo	3.86	1.30	0.8	0.34	0.48	37.1	0.02	1.4
Gabon	1.35	1.87	1.1	1.38	0.62	33.2	0.13	6.9
Equatorial Guinea	0.52	1.48	0.9	2.85	0.15	9.9	1.23	83.1
Chad	11.19	1.82	1.1	0.16	0.11	6.2		
EMCCA	40.31	14.17	8.3	0.35	3.20	22.6	1.72	12.2
ECOWAS+EMCCA	330.78	169.6	100	0.51	24.68	14.6	14.66	8.6

• *Biomass*

More biomass is consumed in ECOWAS and EMCCA countries than any other energy source, with average per capita consumptions of 0.41 toe and 0.21 toe, respectively. Nigeria and Gabon have the highest levels of per capita consumption - 0.57 toe and 0.79 toe, respectively. A country such as Equatorial Guinea has a per capita consumption level that is close to the average for the whole EMCCA zone, although biomass only accounts for 7% of its total primary energy consumption.

• *Primary electricity (hydraulic and wind power3)*

Average per capita consumption of primary electricity (hydraulic) in EMCCA countries (0.012 toe) is twice that of ECOWAS countries (0.006 toe). Most electricity in EMCCA countries is generated from hydraulic means, and is derived from fossil fuels in ECOWAS countries.

3 - Wind power is used extensively in Cape Verde.

countries

Coal		Biomass		Primary heat		Primary electricity		2008
Total	%	Total	%	Total	%	Total	%	
Mtoe		Mtoe		Mtoe		Mtoe		Unit
		1.83	60.7			0.06	1.8	Benin
		2.91	82.8			0.02	0.7	Burkina Faso
		0.03	18			0.0005	0.3	Cape Verde
		7.86	76.7			0.11	1.1	Ivory Coast
		0.16	56.7					Gambia
		6.27	64.1			0.37	3.8	Ghana
		2.77	80.9			0.04	1.1	Guinea
		0.1	45.1					Guinea-Bissau
		1.52	86.1			0	0	Liberia
		1.73	68.9			0.07	2.7	Mali
0.11	4.4	2.15	86.2			0.04	1.5	Niger
0.005	0	87.45	78.7			0.54	0.5	Nigeria
0.12	4.4	1.23	45.1	0.01	0.4	0.03	0.9	Senegal
		1.28	77.8					Sierra Leone
		2.15	84.3			0.05	2.1	Togo
0.23	0.52	32	72.2	0.01	0.02	0.78	1.8	ECOWAS*
0.24	0.15	119.4	76.8	0.01	0	1.32	0.8	ECOWAS
		4.7	66.1			0.35	4.9	Cameroon
		0.47	78.7			0.01	2	Central African Republic
		0.72	55.6			0.08	5.9	Congo
		1.06	56.9			0.06	3	Gabon
		0.1	7			0.0002	0.00	Equatorial Guinea
		1.7	93.8					Chad
		8,8	61.8			0.49	3.5	EMCCA
0.24		128.2	75.6	0.01	0	1.81	1.1	ECOWAS+EMCCA

Table 2: Primary energy consumption per source excluding biomass in ECOWAS

2008	Population	Primary energy consumption excluding biomass			Oil		Natural
	Million	Total	%	Per capita	Total	%	Total
Unit		Mtoe		toe	Mtoe		Mtoe
Benin	9.33	1.2	2.9	0.13	1.13	95.3	
Burkina Faso	15.27	0.6	1.5	0.04	0.58	96	
Cape Verde	0.54	0.11	0.3	0.21	0.11	99.6	
Ivory Coast	19.57	2.4	5.8	0.12	1.23	51.7	1.04
Gambia	1.76	0.12	0.3	0.07	0.12	100	
Ghana	24.01	3.51	8.5	0.15	3.14	89.5	
Guinea	9.54	0.65	1.6	0.07	0.61	94.2	
Guinea-Bissau	1.75	0.12	0.3	0.07	0.12	100	
Liberia	3.8	0.245	0.6	0.06	0.25	100	
Mali	12.72	0.8	1.9	0.06	0.71	91.2	
Niger	14.73	0.34	0.8	0.02	0.20	56.9	
Nigeria	151.82	23.7	57.1	0.15	11.23	47.4	11.9
Senegal	12.71	1.5	3.6	0.12	1.33	89.1	0.01
Sierra Leone	6.15	0.37	0.9	0.06	0.37	100	
Togo	6.77	0.4	1	0.06	0.35	86.8	
ECOWAS*	138.65	12.3	29.8	0.09	10.25	83.2	1.05
ECOWAS	290.47	36	86.9	0.12	21.5	59.7	12.94
Cameroon	18.98	2.41	5.9	0.13	1.72	71.3	0.34
Central African Republic	4.41	0.13	0.3	0.03	0.11	90.4	
Congo	3.86	0.58	1.4	0.15	0.48	83.6	0.02
Gabon	1.35	0.8	1.9	0.6	0.62	77	0.13
Equatorial Guinea	0.52	1.38	3.3	2.65	0.15	10.6	1.23
Chad	11.19	0.11	0.3	0.01	0.11	100	
EMCCA	40.31	5.41	13.1	0.13	3.20	59.1	1.72
ECOWAS+EMCCA	330.78	41.4	100	0.12	24.68	59.6	14.66

and EMCCA countries

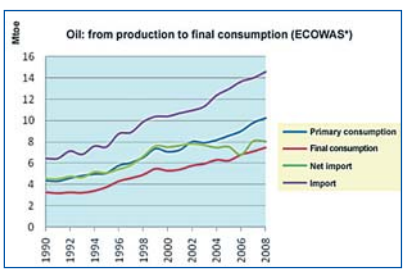
gas	Coal		Primary heat		Primary electricity		2008
%	Total	%	Total	%	Total	%	
	Mtoe		Mtoe		Mtoe		Unit
					0.06	4.7	Benin
					0.02	4	Burkina Faso
					0.0005	0.4	Cape Verde
43.6					0.11	4.7	Ivory Coast
							Gambia
					0.37	10.5	Ghana
					0.04	5.8	Guinea
							Guinea-Bissau
					0	0	Liberia
					0.07	8,8	Mali
	0.11	32.3			0.04	10.6	Niger
50.3	0.005	0.02			0.54	2.3	Nigeria
0.6	0.12	8	0.01	0.7	0.03	1.7	Senegal
							Sierra Leone
					0.05	13.2	Togo
8.5	0.23	1.9	0.01	0.1	0.78	6.3	ECOWAS*
36	0.24	0.7	0.01	0.03	1.32	3.7	ECOWAS
14.3					0.35	14.4	Cameroon
					0.01	9.6	Central African Republic
3.1					0.08	13.2	Congo
16.1					0.06	6.9	Gabon
89.4					0.0002	0.01	Equatorial Guinea
							Chad
31.8					0.49	9.1	EMCCA
35.4	0.24	0.6	0.01	0.02	1.81	4.4	ECOWAS+EMCCA

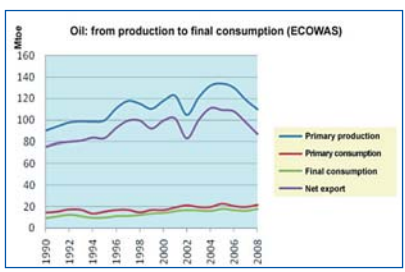
3. Oil and oil products

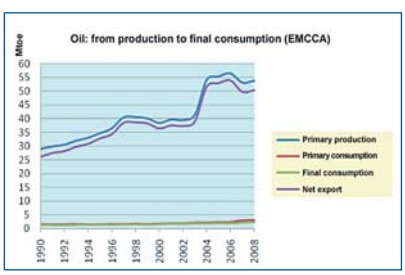
3.1 Growth in oil consumption in ECOWAS and EMCCA countries

- ***Production, trade, consumption***

Diagram 5: Growth in oil production, trade and consumption for each zone





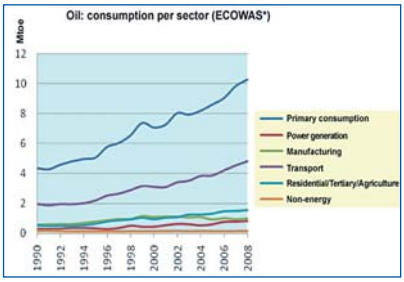


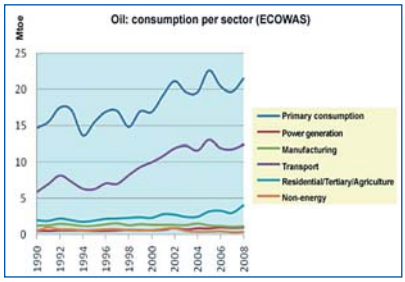
In EMCCA countries and Nigeria, most oil production - more than 90% - is for export.

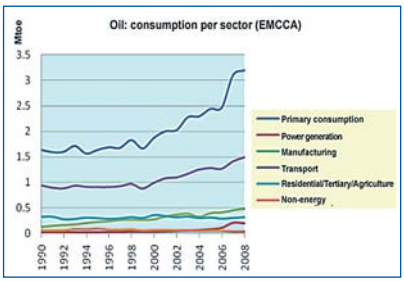
In 2008, ECOWAS* countries (excluding Nigeria) produced 2.8 Mtoe of crude oil, while its primary oil consumption stood at 10.3 Mtoe. Net imports were at 8 Mtoe and the rate of dependency on imports was approximately 75%.

3.2 Consumption per sector

Diagram 6: Growth in oil consumption per sector for each zone







• *Transport*

Oil consumption has increased by 143% in the transport sector since 1990 across the ECOWAS* zone, by 59% across the ECOWAS zone (with Nigeria) and by 60% across the EMCCA zone.

• *Electricity sector*

In the electricity sector, oil consumption has increased by 156% across the ECOWAS* zone, by 96% across the ECOWAS zone and by 900% across the EMCCA zone.

• *Manufacturing*

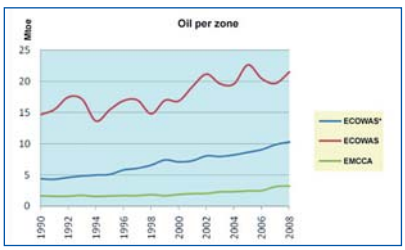
In the manufacturing sector, oil consumption has increased by 72% across the ECOWAS* zone, it has fallen by 8% across the ECOWAS zone and increased by 300% across the EMCCA zone.

• *Residential, tertiary, agriculture*

Oil consumption increased by 177% across the ECOWAS* zone and by 105% across the ECOWAS zone, and remained stable at 0.32 Mtoe across the EMCCA zone.

3.3 Consumption per zone

Diagram 7: Growth per zone in oil consumption



Since the start of the 1990s, oil consumption in ECOWAS and EMCCA countries has been increasing steadily. In ECOWAS countries, it peaked in 2005 at 22.6 Mtoe before dropping down to 20 Mtoe in 2006 and then climbing back up to 21 Mtoe in 2008.

3.4 Oil production and consumption per country

Table 3: Oil production and consumption per sector and per country

2008 Mtoe	Production	Net imports	Primary consumption	Final consumption	Manufacturing	Transport	Residential	Tertiary	Agriculture	Non-energy uses
Benin	0	1.16	1.13	1.1	0.05	0.69	0.35	0		0
Burkina Faso		0.58	0.58	0.47	0.07	0.35	0.05			
Cape Verde		0.12	0.11	0.04	0	0.02	0.02			
Ivory Coast	2.9	-1.73	1.23	0.83	0.13	0.40	0.14	0.06	0.07	0.03
Gambia		0.12	0.12	0.06	0	0.05	0.01			
Ghana	0	3.27	3.14	2.24	0.31	1.33	0.26	0.01	0.25	0.08
Guinea		0.61	0.61	0.41	0.11	0.25	0.04			
Guinea-Bissau		0.12	0.12	0.10	0.03	0.05	0.01			0.02
Liberia		0.25	0.25	0.16	0	0.16	0			0.0
Mali		0.71	0.71	0.51	0.12	0.38	0.02			
Niger		0.20	0.20	0.18	0.01	0.15	0.02			
Nigeria	107.36	-94.96	11.23	10.39	0.16	7.60	2.49	0	0.0	0.15
Senegal	0	1.84	1.33	0.77	0.06	0.57	0.13	0	0.0	0.02
Sierra Leone		0.42	0.37	0.31	0.08	0.18	0.05			
Togo		0.34	0.35	0.30	0.01	0.23	0.05			0.0
ECOWAS*	2.9	8.01	10.25	7.5	0.98	4.81	1.15	0.07	0.32	0.15
ECOWAS	110.3	-86.95	21.5	17.9	1.14	12.41	3.64	0.07	0.32	0.3
Cameroon	4.6	-2.72	1.72	0.97	0.09	0.73	0.14	0		0.02
Central African Republic		0.11	0.11	0.11	0	0.08	0.03			0.0
Congo	13.38	-12.87	0.48	0.44	0.01	0.40	0.03			0.01
Gabon	10.85	-10.13	0.62	0.62	0.32	0.18	0.05	0.04	0.01	0.02
Equatorial Guinea	18.26	-18.11	0.15	0.12	0.05	0.06	0.01			
Chad	6.83	-6.72	0.11	0.06	0.01	0.03	0.02			
EMCCA	53.92	-50.44	3.2	2.32	0.48	1.48	0.28	0.04	0.01	0.05
ECOWAS+EMCCA	164.22	137.4	24.7	20.22	1.62	13.89	3.92	0.11	0.33	0.35

The difference between "Production + Net imports" and "Primary consumption" is mainly due to consumption of "sea fuels". The difference between primary consumption and final consumption can be attributed to consumption in the energy sector.

The Ivory Coast and Nigeria are the only oil exporting countries in the ECOWAS zone[1] and the Central African Republic is the only country which imports oil in the EMCCA zone. Apart from Nigeria, Ghana is the main consumer and importer in the ECOWAS* zone (3.14 Mtoe), just ahead of Senegal (1.33 Mtoe), the Ivory Coast (1.23 Mtoe) and Benin (1.13) Mtoe. Together, these four countries account for 66% of all oil consumption in the ECOWAS* zone, mainly in the transport sector (2.99 Mtoe).

Cameroon is the number one oil consuming country in the EMCCA (1.7 Mtoe) and Equatorial Guinea is the leading oil exporting country. Unlike the ECOWAS zone, manufacturing consumes more oil in the EMCCA zone than any other sector (2.32 Mtoe).

3.5 From crude oil to refined oil products and their uses: an overview of oil

The oil overview table shown below provides all values resulting from industrial refining operations, together with a breakdown of importers and exporters of these products.

For example, the columns in the "production" line give quantities for various products manufactured by refining, and the "total consumption" line is the sum of crude oil used for refining and oil products which are the result of refining, or imported.

Table 4: Oil overview for ECOWAS*(excluding Nigeria)

2008 Unit: Mt	Crude oil	LPG	Petrol	Fuel oil	Paraffin oil	Domestic heating oil	Heavy fuel oil	Naphtha	Other products	TOTAL
Production	2.83	0.11	1.32	0.2	0.04	2.14	0.97	0.032	0	4.82
Import	7.18	0.27	1.59	0.47	0.11	3.22	0.78		0.04	6.49
Export	-2.4	-0.02	-0.95	-0.03	-0	-1.16	-0.6		-0	-2.75
Sea and air fuels				-0.51		-0.23	-0.09			-0.83
Inventory changes	0.07	-0.0005	0.03	0.008		-0.003	0.015	0.003		0.06
Consumption (including returns and transfers)	7.65	0.37	2.08	0.14	0.15	3.92	1.12	0.035	0.04	7.87
Energy sector consumption, of which	7.65	0	0	0.01	0	0.64	0.69	0.035	0	1.38
Electricity power plants	0.9			0.01		0.64	0.67	0.035		1.365
Refineries	6.75						0.02			0.02
Final consumption		0.37	2.08	0.13	0.15	3.28	0.43	0	004	6.485
Manufacturing		0.05				0.5	0.42		0.016	0.98
Transport			2.04	0.13		2.47	0.007		0.004	4.66
Residential, tertiary, agriculture		0.32	0.04		0.15	0.31	0.003			0.82
Non-energy uses								0	0.02	0.02

1 - Ghana will start exporting oil very soon.

Table 5: Oil overview for ECOWAS (including Nigeria)

2008 Unit: Mt	Crude oil	LPG	Petrol	Fuel oil	Paraffin oil	Domestic heating oil	Heavy fuel oil	Naphtha	Other products	TOTAL
Production	108.1	0.11	1.52	0.8	0.04	3.37	1.64	0.032	0	7.53
Import	7.18	0.27	7.78	0.47	0.11	3.79	0.78		0.04	13.24
Export	103.2	-0.02	-0.95	-0.03	-0	-1.16	-0.67		-0	-2.83
Sea and air fuels				-1.11		-0.83	-0.09			-2
Inventory changes	0.17	-0.0005	0.03	0.008		-0.02	0.01	0.003		0.04
Consumption (including returns and transfers)	12.1	0.38	8.47	0.14	0.15	5.11	1.72	0.035	0.04	16.04
Energy sector consumption, of which	12.1	0.002	0	0.013	0	0.93	1.16	0.035	0	2.14
Electricity power plants	0.9			0.013		0.87	1.03	0.035		1.95
Refineries	11.2	0.002				0.06	0.13			0.19
Final consumption		0.38	8.47	0.13	0.15	4.18	0.56	0	004	13.9
Manufacturing		0.05				0.53	0.55		0.016	1.14
Transport			8.43	0.13		3.34	0.007		0.004	11.9
Residential, tertiary, agriculture		0.33	0.04		0.15	0.31	0.003			0.83
Non-energy uses								0	0.02	0.02

Table 6: Oil overview for EMCCA

2008 Unit: Mt	Crude oil	LPG	Petrol	Fuel oil	Paraffin oil	Domestic heating oil	Heavy fuel oil	Naphtha	Other products	TOTAL
Production	52.86	0.04	0.52	0.1		1.11	0.91			2.67
Import	1.81	0.04	0.27	0.15	0.04	0.75	0.005		0.012	1.27
Export	-51.16	-0	-0.1	-0.022		-0.31	-0.68			-1.11
Sea and air fuels				-0.04		-0.12	-0.115			-0.275
Inventory changes	-0.06	-0.002	-0.015	-0.01		0.01	0.14			0.125
Consumption (including returns and transfers)	3.44	0.084	0.58	0.19	0.04	1.5	0.25		0.012	2.65
Energy sector consumption, of which	3.44	0	0	0	0	0.46	0.12		0	0.58
Electricity power plants						0.46	0.09			0.55
Refineries	3.44						0.03			0.03
Final consumption		0.084	0.58	0.19	0.04	1.04	0.13		0.012	2.07
Manufacturing		0.003				0.31	0.13		0.011	0.45
Transport			0.58	0.19		0.66			0.0003	1.43
Residential, tertiary, agriculture		0.081			0.04	0.07				0.19
Non-energy uses									0.0003	0.0003

Note: The values in the "Sea and air fuels" line for the Fuel oil column were not available in the Enerdata database for each country. They were therefore obtained by calculating the difference for the "Sea and air fuels" between the total for oil products in each country's Energy overview and the sum of Domestic heating oils and Heavy fuels in the oil overview for the corresponding countries. They were also checked by the difference between the values for production, import, export, inventory changes and the values for total consumption for the Fuel oil column in each country's oil overview.

3.6 Crude oil reserves

Table 7: Oil reserves

OIL								
Consumption 2008 (Mt)			Proven economic reserves (Mt)			Years of consumption**		
ECOWAS*	NIGERIA	EMCCA	ECOWAS*	NIGERIA	EMCCA	ECOWAS*	NIGERIA	EMCCA
7.6	4.4	3.4	16.8	4941	873	2	1122	256

** ECOWAS excluding Nigeria.*

*** Number of years it would take to consume the reserves at 2008 consumption levels for countries in the ECOWAS zone - other than Nigeria - and countries in the EMCCA zone.*

4. Natural gas

4.1 Natural gas overview for countries that produce and/or consume natural gas in the ECOWAS and EMCCA regions

Table 8: Gas overview

Gas overview	Cameroon	Congo	Ivory Coast	Gabon	Equatorial Guinea	Nigeria	Senegal
	Gm^3	Gm^3	Gm^3	Gm^3	Gm^3	Gm^3	Gm^3
PRODUCTION	0.42	0.02	1.3	0.16	6.7	35.4	0.01
Import							
Export					-5.2	-20.8	
Inventory changes							
TOTAL CONSUMPTION	0.42	0.02	1.3	0.18	1.5	14.8	0.01
Energy sector consumption, of which	0.42	0.02	1.1	0.18	0.03	12.3	0.01
Electricity power plants	0.36	0.02	1.1	0.16	0.03	4	0.01
LNG factories					5.4	21.6	
FINAL CONSUMPTION			0.2	0.002	1.5	2.4	
Manufacturing				0.002	1.5	2.4	
Transport							
Residential, Tertiary…			0.2				
Non-energy							

Seven countries produce natural gas in the ECOWAS and EMCCA zones: Cameroon, the Congo, Ivory Coast, Gabon, Equatorial Guinea, Nigeria and Senegal. Apart from Nigeria and Equatorial Guinea (which export much of the gas that they produce), most of the gas which the other countries produce is mainly for domestic use (producing electricity, household consumption[2]). Nigeria and Equatorial Guinea are among a very limited number of companies which export LNG (Liquefied Natural Gas). Cameroon may start exporting LNG in 2015[3].

4.2 Natural gas reserves

Table 9: Natural gas reserves[4]

Natural Gas (2008)								
Consumption 2008 (Gm^3)			Proven economic reserves (Gm^3)			Years of consumption**		
ECOWAS*	NIGERIA	EMCCA	ECOWAS[5] *	NIGERIA	EMCCA	ECOWAS*	NIGERIA	EMCCA
1.31	14.8	2.12	55	5292	514	42	357	242

It should be possible to mine natural gas reserves in Nigeria and countries in the EMCCA zone for more than two decades (if consumption continues at current levels).

5. Coal

5.1 Coal overview for countries that produce and/or consume coal in the ECOWAS region

Table 10: Coal overview (tar sands)

Coal overview 2008	Niger	Nigeria	Senegal
	Mt	Mt	Mt
PRODUCTION	0.17	0.008	
Import		0	0.2
Export		-0	
Inventory changes		0	
TOTAL CONSUMPTION	0.17	0.008	0.2
Energy sector consumption, of which	0.17	0	0
Electricity power plants	0.17	0	
LNG factories			
FINAL CONSUMPTION		0.008	0.2
Manufacturing		0.008	0.2
Transport			
Residential, Tertiary…			
Non-energy			

2 - Only in the Ivory Coast.

3 - Jourdain KENGNE & ISMA EL FODIL, le Gaz Naturel Liquéfié en Afrique: quelles évolutions futures, (Liquefied Natural Gas in Africa: future developments), school project, IFP School/INSTN, January 2009.

4 - Four countries have natural gas reserves in the ECOWAS zone: Ivory Coast, Ghana, Nigeria and Senegal. The EMCCA zone also has four countries: Cameroon, the Congo, Gabon and Equatorial Guinea.

5 - Including reserves in Ghana (although Ghana has not yet started to extract its natural gas reserves).

Three countries consume coal in the ECOWAS zone: Niger, Nigeria and Senegal. Two of these countries - Nigeria and Niger - produce coal. Consumption in Nigeria and Senegal is for manufacturing purposes, where as in Niger, it is used to generate electricity.

5.2 Coal reserves

Table 11: Coal reserves in ECOWAS countries

Coal					
Consumption 2008 (Mt)		Proven economic reserves (Mt)		Years of consumption	
NIGER	NIGERIA	NIGER	NIGERIA	NIGER	NIGERIA
0.17	0.008	70	190	411	19000

At current levels of consumption, Niger can continue to mine its coal reserves for more than 4 decades, and Nigeria for more than 19,000 years.

6. Biomass

The biomass consumed in countries in the ECOWAS and EMCCA zones is mainly made up of wood and charcoal. The wood column represents the total amount of biomass energy. Charcoal is counted within statistics for wood, since it a sub-product of wood, transformed in order to more conveniently meet cooking needs. A part from charcoal, the rest of wood wood is consumed directly in order to meet the same cooking needs. This energy may be considered non-commercial or commercial[6]. In the biomass overviews, it can be seen that other farm and household waste (apart from wood) are not represented (owing to data not being available)[7].

In some countries in the ECOWAS and EMCCA zones, the biomass used is not in any way transformed before final consumption.

This energy is consumed by the residential sector in particular (90%, or 102 Mtoe). Nigeria consumes more biomass than any other countries in the ECOWAS zone (80%), followed by Ghana (4.5%) and the Ivory Coast (4%). But in the EMCCA zone, Cameroon is the main consumer of biomass (60%), followed by Gabon (14%).

6 - Each country has a different name for the data it passes on to international organisations (see Introduction).

7 - The reason for this data not being available is the lack of a system for converting household and farming waste into energy.

6.1 Biomass production and consumption per country

Table 8: Biomass production and consumption per sector and per country

2008 Mtoe	Production	Primary consumption	Final consumption	Manufacturing	Transport	Residential	Tertiary
Benin	1.83	1.83	1.47	0		1.22	0.24
Burkina Faso	2.91	2.91	1.74	0		1.74	
Cape Verde	0.03	0.03	0.03			0.03	
Ivory Coast	7.86	7.86	4.19			3.74	0.45
Gambia	0.16	0.16	0.05			0.05	
Ghana	6.28	6.28	4.73	0.43		4.3	
Guinea	2.8	2.8	2.1	0.01		2.08	
Guinea-Bissau	0.1	0.1	0.1			0.1	
Liberia	1.52	1.52	1.07	0		1.07	
Mali	1.73	1.73	1.48	0.02		1.46	
Niger	2.14	2.14	1.2			1.2	
Nigeria	87.45	87.45	85.13	8.61		76.52	
Senegal	1.23	1.23	0.72			0.72	
Sierra Leone	1.28	1.28	0.53	0		0.53	
Togo	2.15	2.15	1.16	0		1.02	0.14
ECOWAS*	32	32	20.57	0.46		19.26	0.83
ECOWAS	119.4	119.4	105.7	9.07		95.8	0.83
Cameroon	4.7	4.7	4.48	0.56		3.90	0.01
Central African Republic	0.46	0.46	0.42			0.42	
Congo	0.72	0.72	0.46			0.46	
Gabon	1.06	1.06	1.06	0.21		0.85	
Equatorial Guinea	0.10	0.10	0.1			0.1	
Chad	1.7	1.7	0.91	0.11		0.8	
EMCCA	8.76	8.76	7.43	0.88		6.53	0.01
ECOWAS+EMCCA	128.2	128.2	113.1	9.95		102.3	0.84

6.2 Biomass overviews per zone

The biomass overviews highlight the consumption of wood to produce charcoal and, on the same line, the resulting production of charcoal.

Table 9: Biomass overviews for ECOWAS*

2008 Unit: Mtoe	Wood	Charcoal	TOTAL
Production	32		32
Primary consumption	32		32
Energy sector consumption, of which:	- 15.01	3.59	- 11.42
Electricity power plants	- 0.15	0	- 0.15
Charcoal production	- 14.9	3.59	- 11.3
Final consumption, of which:	17	3.59	20.6
Manufacturing	0.47		0.47
Transport	0		0
Residential, tertiary, agriculture	16.51	3.59	20.1

Table 10: Biomass overviews for ECOWAS

2008 Unit: Mtoe	Wood	Charcoal	TOTAL
Production	119.4		119.4
Primary consumption	119.4		119.4
Energy sector consumption, of which	- 18.1	4.4	- 13.7
Electricity power plants	- 0.15	0	- 0.15
Charcoal production	- 18	4.4	- 13.6
Final consumption, of which:	101.3	4.4	105.7
Manufacturing	9.1		9.1
Transport	0		0
Residential, tertiary, agriculture	92.2	4.4	96.6

Table 11: Biomass overviews for EMCCA

2008 Unit: Mtoe	Wood	Charcoal	TOTAL
Production	8,8		8,8
Primary consumption	8,8		8,8
Energy sector consumption, of which	-1.9	0.6	1.32
Electricity power plants	- 0.006		- 0.006
Charcoal production	– 1.9	0.6	- 1.3
Final consumption, of which	6.9	0.6	7.5
Manufacturing	0.9		0.9
Transport			
Residential, tertiary, agriculture	6	0.6	6.6

7. Contribution of primary sources to final energy consumption

The contribution of various primary energy sources to final energy consumption is worked out as follows:

i) Direct contributions of fossil fuels and biomass are known and can be found in the previous tables (final energy consumptions per product).

ii) Final electricity consumption expressed in toe is distributed according to each source's contribution to a country's electricity generation. Electricity imports and exports are not taken into account.

Table 12: Contribution to total final energy consumption with biomass

2008	Final Energy Consumption	Fossil fuels	Renewables	2008
	Mtoe	%	%	
Benin	2.62	44	56	Benin
Burkina Faso	2.27	22.3	77.7	Burkina Faso
Cape Verde	0.08	69.7	30.3	Cape Verde
Ivory Coast	5.50	21.8	78.2	Ivory Coast
Gambia	0.121	58.5	41.5	Gambia
Ghana	7.50	33.1	66.9	Ghana
Guinea	2.60	18.1	81.9	Guinea
Guinea-Bissau	0.21	52.6	47.4	Guinea-Bissau
Liberia	1.254	14.9	85.1	Liberia
Mali	2.10	26.9	73.1	Mali
Niger	1.44	16.2	83.8	Niger
Nigeria	99.18	13.7	86.3	Nigeria
Senegal	1.75	57.6	42.4	Senegal
Sierra Leone	0.85	37.8	62.2	Sierra Leone
Togo	1.52	21.6	78.4	Togo
ECOWAS*	29.82	29.1	70.9	ECOWAS*
ECOWAS	129	17.3	82.7	ECOWAS
Cameroon	5.86	18.9	81.1	Cameroon
Central African Republic	0.55	20.8	79.2	Central African Republic
Congo	0.94	47.2	52.8	Congo
Gabon	1.77	38	62	Gabon
Equatorial Guinea	1.44	92.5	7.5	Equatorial Guinea
Chad	0.98	21.5	78.5	Chad
EMCCA	11.54	32.5	67.5	EMCCA
ECOWAS+EMCCA	140.54	18.5	81.5	ECOWAS+EMCCA

Table 12 shows that countries in the ECOWAS and EMCCA zones are dependent on fossil fuels (mainly oil, with the exception of Equatorial Guinea[8]) for an average of 20% of their final energy requirements met. Some countries in the ECOWAS zone are much more dependent than average on fossil fuels: these are Benin (44%), Cape Verde (70%), Gambia (58%), Guinea-Bissau (52%), Senegal (57%) and Sierra Leone (37%). In EMCCA countries, only Equatorial Guinea (92%), the Congo (47%) and Gabon (38%) are more than averagely dependent on fossil energies (the average being 20%). With regards to renewable energies in these countries, biomass is mainly used for household cooking.

Nigeria, Africa's leading oil producing country, is dependent on fossil fuels for getting 13% of its final energy requirements met. This is considerably lower than other countries in the ECOWAS and EMCCA zones.

8 - Equatorial Guinea consumes mostly natural gas (83%).

VI - ENERGY ACCOUNTS AND BALANCE OF PAYMENTS FOR 2008

1. Energy accounts

An energy account is a two-way table. Energy products appear in the columns (primary and final) and the various stages involved in the energy system are shown on the lines: production, trade, transformation, transport and distribution (energy sector) and final consumption.

The energy account should be read in the following way:

- ***From primary production to primary consumption:***

a) **The "Primary production" line** gives national production levels for various primary energy sources:
   - Value in toe for raw material production for coal (coal and lignite), crude oil, gas (natural gas) and biomass (wood, organic farming or household waste).
   - The "Hydraulic" cell on the "primary production" line is for electricity that is produced hydraulically, using wind power, using photovoltaic solar power and geothermal power.

b) **The "Import" and "Export" lines** do not refer only to primary product trading (coal, natural gas, crude oil, biomass). They also include the trade of oil products (expressed in toe) and electricity.
   Values expressed in toe for electricity imports and exports are calculated based on an equivalence factor of 1 TWh = 0.086 Mtoe. If a country exports electricity that has been generated by burning fossil fuel or biomass, the proportional fuel reduction is not recorded in the primary account - only the electricity exported. Conversely, a country that imports electricity will only have the electricity imported expressed with the same equivalence coefficient attributed to its consumption. Consequently, electricity trading is in the "electricity" column.

c) **The "sea and air fuels" line** includes energy supplies for fleets which refuel in the ports and airports in the zone in question. It concerns oil products only. This energy consumption is not counted as consumption for the country or zone for which the account is being presented.

d) **The "inventory changes" line** is for coal, oil, oil products, gas and biomass.

e) **The "Primary consumption" line** is the sum, column by column, of all the corresponding cells (taking account of their + sign or - sign). It is seen that import-export balances and for oil products and electricity taken into account in primary consumption (in accordance with the rule mentioned above).

• *Primary consumption to final consumption:*

Consumption and production for the energy sector are between the "Primary consumption" and "Final consumption" lines:

a) **Refineries:** consumption in toe (- sign) of crude oil (and maybe small amounts of coal and gas) and production in toe (+ sign) of oil products.

b) **Electricity power plants:**
- Consumption in toe of coal, oil products, gas and biomass (- sign), contribution in toe of hydraulic (- sign)
- Electricity generation by power plants plus electricity imported in the "electricity" column

c) **Private consumption and losses:** private consumption by mines, refineries, electricity power plants and losses over the transport and distribution networks (gas and especially electricity).

This line, with the - sign, is for actual consumption of various different energy products which are consumed by different operations in the energy sector.

d) For each energy product, the values on the "Final consumption" line are obtained by the algebraic sum of the values for primary consumption.

• *Final consumption:*

The lines in the "Final consumption" area show energy product consumption per sector.

It is seen that consumption related to non-energy uses - consumption of energy raw materials (mainly oil products and gas) for the chemical industry - is very low (it is considerably higher in industrialised countries… in European countries, for example). These consumption figures do not represent final consumption for energy requirements, but they need to be taken into account to get a complete and coherent account of energy product consumption.

Tables 1 to 4 are energy accounts accountof the zones looked at in this document. Given the importance of Nigeria in the ECOWAS zone that has been mentioned in each of the previous chapters, an energy account for accountNigeria is provided in table 3.

Table 1: Energy accounts for the ECOWAS* zone (without Nigeria)

2008 Unit: Mtoe	Coal	Crude Oil	Oil products	Gas	Hydraulic	Electricity	Biomass	TOTAL
Primary Production	0.11	2.9		1.05	0.65		32	36.7
Import	0.12	7.32	7.28			0.19		15
Export		-2.45	-4.12			-0.06	-0.004	-6.6
Sea and air fuels			-0.9					-0.9
Inventory changes		0.075	0.12					0.2
Primary Consumption	0.23	7.84	2.42	1.05	0.65	0.13	32	44.3
Refineries		-6.9	6.46					-0.4
Electricity power plants	-0.11	-0.92	-1.35	-0.9	-0.65	1.75	-0.15	-2.3
Private consumption, losses	0	-0.03	-0.03	0		-0.43	-11.3	-11.8
Final Consumption	0.12		7.5	0.16		1.5	20.6	29.8
Manufacturing	0.12		1			0.6	0.5	2.2
Transport			4.8					4.8
Residential, tertiary, agriculture			1.52	0.16		0.9	20.1	22.7
Non-energy uses			0.15					0.15

Table 2: Energy account for the ECOWAS zone (with Nigeria)

2008 Unit: Mtoe	Coal	Crude Oil	Oil products	Gas	Hydraulic	Electricity	Biomass	TOTAL
Primary Production	0.12	110		30	1.2		119.5	261
Import	0.12	7	15.5			0.2		23.1
Export	-0	-105	-4.4	-17		-0.6	-0.004	-126.8
Sea and air fuels			-2.1					-2.1
Inventory changes	0	0.2	0.1					0.3
Primary Consumption	0.24	12.4	9	13	1.2	0.13	119.5	155.4
Refineries		-11.5	10.9					-0.6
Electricity power plants	-0.11	-0.9	-1.9	-4.2	-1.2	3.7	-0.15	-4.8
Private consumption, losses	0	-0.03	-0.13	-6.6		-0.7	-13.6	-21.1
Final Consumption	0.13		17.9	2.2		3.1	105.7	129
Manufacturing	0.13		1.14	2		0.9	9.1	13.3
Transport	0		12.4					12.4
Residential, tertiary, agriculture	0		4	0.2		2.2	96.6	103
Non-energy uses			0.3					0.3

Table 3: Energy account assessment for Nigeria

2008 Unit: Mtoe	Coal	Crude Oil	Oil products	Gas	Hydraulic	Electricity	Biomass	TOTAL
Primary Production	0.005	107.36		28.9	0.54		87.45	224.3
Import	0		8.2					8.2
Export	-0	-102.9	-0.29	-17		-0		-120.2
Sea and air fuels			-1.25					-1.25
Inventory changes	0	0.1	-0.02					0.08
Primary Consumption	0.005	4.6	6.6	-11.9	0.54	0	87.45	111.1
Refineries		-4.6	4.4					-0.16
Electricity power plants	-0		-0.6	-3.3	-0.54	1.93		-2.45
Private consumption, losses	0	-0.00012	-0.1	-6.6		-0.28	-2.32	-9.3
Final Consumption	0.005		10.4	2		1.65	85.13	99.18
Manufacturing	0.005		0.16	2		0.35	8.6	11.12
Transport			7.6					7.6
Residential, tertiary, agriculture			2.5			1.3	76.5	80.3
Non-energy uses			0.15					0.15

Table 4: Energy account for the EMCCA zone

2008 Unit: Moe	Coal	Crude Oil	Oil products	Gas	Hydraulic	Electricity	Biomass	TOTAL
Primary Production		53.2		6	0.45		8.76	69.1
Import		1.84	1.4			0.04		3.26
Export		-52.2	-1.45	-4.2		-0		-57.9
Sea and air fuels			-0.36					-0.36
Inventory changes		-0.06	0.12					0.06
Primary Consumption		3.52	-0.32	1.7	0.45	0.04	8.76	14.2
Refineries		-3.51	3.4					-0.12
Electricity power plants			-0.56	-0.5	-0.45	0.7	-0.006	-0.75
Private consumption, losses		-0.01	-0.2	-0.05		-0.2	-1.32	-1.76
Final Consumption			2.3	1.2		0.6	7.43	11.54
Manufacturing			0.5	1.2		0.33	0.9	2.9
Transport			1.5			0.0004		1.5
Residential, tertiary, agriculture			0.3	0		0.24	6.55	7.1
Non-energy uses			0.04					0.04

2. External energy balance of payments for each country

We are using 2005 as our basis because of the absence of data for the following years. Imports mainly involve oil, with the average import price in 2005 standing at US$430 per oil toe (US$60 per barrel).

Table 5 shows for each country, respectively:

- In columns 1, 2 and 3, value for imports (I), total and for energy products and the share of energy in imports.
- In columns 4, 5 and 6, value for exports (E), total and for energy products and the share of energy in exports.
- In columns 7 and 8, value for net exports (E-I) (exports - imports) total and for energy products.
- In column 9: the external energy bill (E-I) Energy divided by the number of inhabitants.

Table 5: External energy balance of payments for countries in the ECOWAS and EMCCA zones

2005	Imports[1]			Exports (E)			Exports – Imports (E-I)		Energy bill per capita	2005
	Total for all products	Energy	Energy Share	Total for all products	Energy	Energy Share	Total	Energy	(E-I) Energy/pop	
	Million US$		%	Million US$		%	Million US$		US$	
Benin	894	182.8	20.4	569	3.9	0.6	-325	-17	-21	Benin
Burkina Faso	1280			347			-933			Burkina Faso
Cape Verde	438	38.9	8.9	17.6			-420.6			Cape Verde
Ivory Coast	5,350	1499.4	28	7488	2082	27.8	2138	583	31	Ivory Coast
Gambia	237	38	16	8			-229			Gambia
Ghana	5755	448.2	7.8	2803	158	5.6	-2952	-290	-13	Ghana
Guinea	820			890			70			Guinea
Guinea-Bissau	119			99			-20			Guinea-Bissau
Liberia	310			131.3			-178.6			Liberia
Mali	1622			1135			-487			Mali
Niger	805	118	14.6	500	9.3	1.9	-305	-10	-8.2	Niger
Nigeria (1)	21809	626	2.8	58,726	57,692	98.2	36,917	57,066	- 376	Nigeria (1)
Senegal	3,197	732.5	22.9	1536	324	21.1	-1661	-409	-35	Senegal
Sierra Leone	344.7			158.5			-186			Sierra Leone
Togo	1000	289.8	29	586	7.3	1.2	-414	-283	-45	Togo
Cameroon	2735	720.8	26.3	2798	1389	49.6	63	668	38	Cameroon
Central African Republic	171	28.8	16.8	128	0.5	0.4	-43	-28	-6.7	Central African Republic
Congo	1415			4800			3385			Congo
Gabon	1471	53.5	3.6	4860	4084	84	3389	4031	3101	Gabon
Equatorial Guinea	2109			7136			5027			Equatorial Guinea
Chad	1117			3032			1915			Chad

[1] *2006 values for Nigeria.*

We do not have data about trade in energy products for all countries. Nor do we have data for the years after 2005 for most countries (although 2006 values for Nigeria do appear in the table).

The data shown in table 5 shows some very different situations:

a) A small number of countries have very favourable circumstances:
   - The Ivory Coast has a positive net balance for its trade (it exports more than it imports), for both its total and for energy. And energy accounts for 20% of its exports and imports.
   - Cameroon's total trade balance is almost positive, thanks to a very positive energy trade balance. Energy accounts for 26% of overall imports and approximately 50% of the country's total exports.
   - Gabon also has very high net energy exports, considerably more than its total energy balance.
   - Nigeria has a very positive trade balance thanks to its very high energy exports.

b) But many countries (and these countries are probably more representative than the ones mentioned above of the general situation in which most countries in these two zones find themselves) have very low figures for their foreign trade (exports which are lower than their imports), in which the share of energy in overall imports is considerably higher than the share of energy in overall exports[1].

These figures highlight just how vulnerable the economies of these countries are to fluctuations and increases in the international prices of the hydrocarbons that they import.

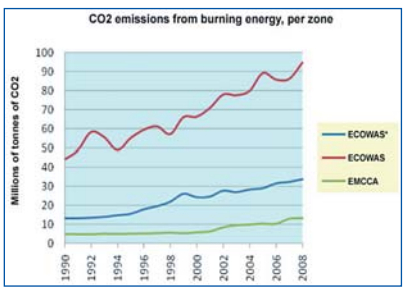
1 - They have a foreign trade deficit.

VII – CARBON DIOXIDE EMISSIONS

1. CO_2 emissions in the ECOWAS and EMCCA zones

1.1 Increase in CO_2 emissions resulting from burning fossil fuels

Diagram 1: Increase in CO_2 emissions resulting from burning fossil fuels per zone

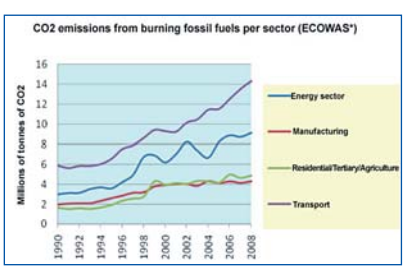


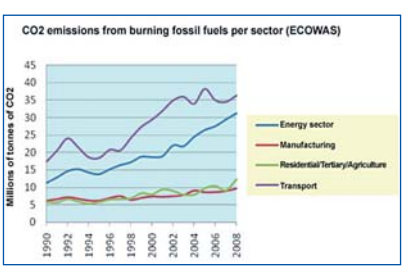
There has been a significant increase in CO_2 emissions since 1990. In EMCCA countries, for example, the high levels of natural gas which have been produced since the early 2000s in Equatorial Guinea have dramatically increased emissions levels in the zone. In both the ECOWAS and EMCCA zones, this increase is due to higher demand for fossil energies (oil and gas) in order to meet electricity generation requirements and for transport purposes.

1.2 Increase in CO_2 emissions per economic sector

• ***ECOWAS***

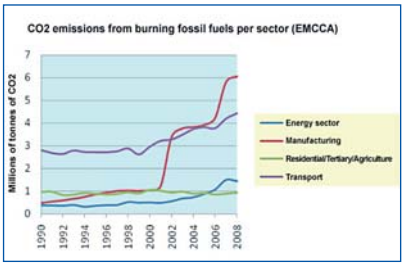
Diagram 2: Increase in CO_2 emissions per economic sector in the ECOWAS zone





• ***EMCCA***

Diagram 3: Increase in CO_2 emissions per economic sector in the EMCCA zone



These three diagrams show that the transport sector was the principal source of CO_2 emissions from 1990 until the early 2000s for countries in the EMCCA zone, after which manufacturing became the main CO_2 emitter. This trend is the result of the high production of natural gas in Equatorial Guinea which began during this period. Furthermore, other sectors, such as the residential and tertiary sectors for both zones, the energy sector in EMCCA countries and the manufacturing sector in ECOWAS countries emit the lowest amounts of CO_2. CO_2 emissions in the residential/tertiary/agriculture sector for EMCCA countries have been stable since 1990. Emissions in the energy sector were stable from 1990 to 2000, after which they began to increase, while emissions for all sectors in ECOWAS countries have been increasing since 1990 (a growth rate of 100% for the whole period).

2. CO_2 emissions per country

2.1 Total emissions and per capita emissions

Table 1: CO_2 emissions per country and their indicators in 2007[1]

2007	Combustion	Manufacturing processes	Total	Per capita	Per PPP GDP	2007
	$MtCO_2$	$MtCO_2$	$MtCO_2$	tCO_2	$kgCO_2$/US $ 2005	
Benin	3.1	2.34	5.44	0.6	0.48	Benin
Burkina Faso	1.6	0.015	1.615	0.11	0.1	Burkina Faso
Cape Verde	0.32	-				Cape Verde
Ivory Coast	6.4	0.32	6.72	0.35	0.22	Ivory Coast
Gambia	0.34	-				Gambia
Ghana	8.5	0.75	9.25	0.39	0.31	Ghana
Guinea	1.7	0.17	1.87	0.2	0.18	Guinea
Guinea-Bissau	0.32	-				Guinea-Bissau
Liberia	0.65	0.08	0.73	0.2	0.57	Liberia
Mali	1.9	0.005	1.905	0.15	0.15	Mali
Niger	0.92	0.023	0.943	0.07	0.11	Niger
Nigeria	54.2	3.24	57.44	0.39	0.24	Nigeria
Senegal	4.41	1.02	5.43	0.44	0.28	Senegal
Sierra Leone	0.84	0.12	0.96	0.16	0.26	Sierra Leone
Togo	0.87	0.4	1.27	0.19	0.26	Togo
ECOWAS*	31.54	5.25	36.13	0.27	0.24	ECOWAS*
ECOWAS	85.8	8.5	93.57	0.33	0.24	ECOWAS
Cameroon	3.3	0.63	3.93	0.21	0.10	Cameroon
Central African Republic	0.34	-				Central African Republic
Congo	1.23	0	1.23	0.33	0.10	Congo
Gabon	2.2	0.11	2.31	1.74	0.12	Gabon
Equatorial Guinea	2.94	-				Equatorial Guinea
Chad	0.29	-				Chad
EMCCA	10.3	0.74	7.47	0.31	0.11	EMCCA
ECOWAS+EMCCA	96.04	9.24	101.04	0.33	0.22	ECOWAS+EMCCA

1 - Because of the lack of data for 2008, we have used the most recent emissions declaration - the one for 2007 - although the declarations for some countries are not available yet.

Table 1 shows a very small difference between average per capita emissions in the EMCCA zone. In both ECOWAS and EMCCA countries, per capita emissions levels vary dramatically from country to country: from 0.07 t per capita for Niger to 0.44 t per capita for Senegal or 0.39 t per capita for Nigeria, and from 0.21 t per capita for Cameroon to 1.74 t per capita for Gabon.

Emissions intensities per dollar of PPP GDP produced vary significantly from 0.24 in ECOWAS countries to 0.11 in EMCCA countries. There is also a great deal of variation among countries within the ECOWAS zone: 0.14 Burkina Faso and 0.57 for Liberia.

Table 2: Direct and indirect CO_2 emissions of economic sectors in countries

2007	Manufacturing			Transport			Residential	
$MtCO_2$	direct	indirect	total	direct	indirect	total	direct	indirect
Benin	0.18	0.018	0.198	1.87		1.87	0.97	0.043
Burkina Faso	0.2	0.13	0.33	0.916		0.916	0.13	0.05
Cape Verde	0.003	0.041	0.044	0.067		0.067	0.048	0.12
Ivory Coast	0.44	0.54	0.98	1.26		1.26	0.4	0.74
Gambia	0.012		0.012	0.15		0.15	0.032	0.08
Ghana	0.96	1.21	2.17	3.78		3.78	0.72	0.94
Guinea	0.36	0.33	0.69	0.69		0.69	0.12	0.29
Guinea-Bissau	0.098	0.0045	0.102	0.15		0.15	0.022	0.045
Liberia	0	0.19	0.19	0.42		0.42	0.009	0.04
Mali	0.76	0.39	1.15	0.98		0.98	0.074	0.19
Niger	0.035	0.25	0.285	0.43		0.43	0.053	0.21
Nigeria	4.8	2.09	6.89	20.97		20.97	4.45	4.87
Senegal	0.84	0.45	1.29	1.69		1.69	0.32	0.55
Sierra Leone	0.21	0.088	0.3	0.47		0.47	0.12	0.023
Togo	0.046	0.025	0.07	0.62		0.62	0.13	0.043
ECOWAS*	4.15	3.67	7.82	13.53		13.53	3.16	3.38
ECOWAS	8.95	5.76	14.71	34.5		34.5	7.61	8.24
Cameroon	1.56	1.15	2.71	2.06		2.06	0.38	0.3
Central African Republic	0.016	0	0.016	0.25		0.25	0.075	0
Congo	0.028	0.02	0.05	1.11		1.11	0.067	0.021
Gabon	1.18	0.21	1.4	0.49	0.0023	0.49	0.12	0.41
Equatorial Guinea	2.98	0.037	3.02	0.17		0.17	0.031	0.086
Chad	0.033	0.076	0.11	0.098		0.098	0.046	0.074
EMCCA	5.8	1.5	7.3	4.18		4.18	0.72	0.9
ECOWAS+EMCCA	14.76	7.26	22.02	38.68		38.68	8.33	9.14

2.2 Direct and indirect emissions per sector

Table 2 shows the distribution of direct and indirect emissions resulting from combustion in different sectors of final consumption energy. Indirect emissions are mainly those generated by electricity power plants (fossil thermal plants), which are used to supply electricity to corresponding final consumption sectors.

It can be seen that in countries in the ECOWAS zone, the transport sector is the biggest CO_2 emitter - 34.5 Mt of CO_2 (49%), followed by the residential sector - 15.85 Mt (22%). Manufacturing is in third position with 14.7 Mt (21%), ahead of the tertiary sector with 4.8 Mt (7%) and agriculture with 0.95 Mt (1%). In countries in the EMCCA zone, however, manufacturing is the biggest CO_2 emitter with 7.3 Mt (54%), ahead of the transport sector with 4.2 Mt (31%), followed by the residential sector with 1.6 Mt (12%). The tertiary sector is just behind it with 0.52 Mt (4%) and agriculture with 0.06 Mt (0.5%).

in the ECOWAS and EMCCA zones

	Tertiary			Agriculture			
total	direct	indirect	total	direct	indirect	total	
1.01	0.003	0.03	0.033				Benin
0.18		0.16	0.16		0.003	0.003	Burkina Faso
0.17		0.054	0.054				Cape Verde
1.14	0.18	0.78	0.96	0.21	0.006	0.22	Ivory Coast
0.11		0.085	0.085				Gambia
1.66	0.032	0.36	0.39	0.72	0	0.72	Ghana
0.41		0.025	0.025				Guinea
0.07							Guinea-Bissau
0.05		0.028	0.028				Liberia
0.26							Mali
0.26		0.013	0.013				Niger
9.32	0	2.53	2.53	0			Nigeria
0.87	0.006	0.49	0.5	0	0		Senegal
0.14		0.008	0.008				Sierra Leone
0.17		0.01	0.01				Togo
6.54	0.22	2.05	2.27	0.94	0.009	0.95	ECOWAS*
15.85	0.22	4.6	4.82	0.94	0.009	0.95	ECOWAS
0.68	0.009	0.25	0.26		0.02	0.02	Cameroon
0.07		0	0				Central African Republic
0.09							Congo
0.53	0.11	0.16	0.27	0.04		0.04	Gabon
0.12							Equatorial Guinea
0.12							Chad
1.62	0.11	0.41	0.52	0.04	0.02	0.06	EMCCA
17.5	0.34	5	5.3	0.98	0.03	1.01	ECOWAS+EMCCA

VIII - REGIONAL ENERGY POLICIES

Regional energy policies are characterised by joint decisions with respect to the directions and strategies of national policies, and by the way in which energy trade is structured, particularly electricity trade through the construction of international transport networks for interconnecting regions.

1. Energy policy in ECOWAS countries

The energy policies of countries in the ECOWAS zone are structured around four main areas:

- The West African Power Pool (WAPP), together with an emergency security Energy Supply plan (for boosting electricity generation capacity and implementing energy efficiency measures).
- The White Paper on access to modern energies for a significant proportion of the population.
- The development and promotion of renewable energy through the creation of a regional centre in Praia.
- The Regional Electricity Regulatory Authority (ARREC) for countries in the ECOWAS zone.

1.1 White paper[1]

The White Paper was adopted in January 2006 in Niamey (Niger) by ECOWAS heads of state and government. The main objective of this policy was to provide at least half the population with access to modern energy services by 2015.

In order to meet this main objective, a number of subsidiary objectives were also defined:

- Strengthen regional integration by sharing good practice and exchanging information in order to develop and increase capacity.
- Promote harmonised political and institutional frameworks which further support access to energy services as one of the main priorities for human development and for achieving the millennium development goals (MDGs).
- Develop coherent energy investment programmes centred around reducing poverty in rural and suburban areas.

These national investment programmes for providing access to energy services are based on three major pillars:

- Access to cooking fuels: 100% of the population will have access to a modern cooking service;

1 - From the ECOWAS/WAEMU White Paper presentation, 2nd session by Kouo Dibongue, 17-20 April 2007/ Yaoundé/Cameroon.

- Access to mechanical power: 60% of the population will live in areas with access to mechanical power;
- Access to electricity services: 66% of the population will have access to household electricity supply - 100% in urban and suburban areas and 36% in rural areas.

In order to meet these objectives, around US$50 billion needs to be invested over a ten-year period - or US$16 per capita per year.

1.2 Regional centre for the promotion of renewable energies and energy efficiency

In January 2008, at the 35th ordinary summit of ECOWAS heads of state and government, the ECOWAS and the WAEMU (West African Economic and Monetary Union) decided jointly[2] to create a regional centre for renewable energies and energy efficiency which will be based in Praia in Cape Verde. This regional regulatory agency for the electricity sector in ECOWAS countries will be responsible for introducing and managing cross-border electricity trade regulations, and so for providing support to the various regulatory mechanisms in place.

1.3 Regional Electricity Regulatory Agency for ECOWAS countries[3]

ECOWAS has decided to set up a Regional Electricity Regulatory Authority (ARREC), based in Accra (Ghana). The implementation of this regional electricity regulatory body was launched in March 2006. This regional regulatory agency for the electricity sector in ECOWAS countries will be responsible for introducing and managing cross-border electricity trade regulations, and so for providing support to the various regulatory mechanisms in place.

The missions with which the ARREC is entrusted involve the following:

- Developing and tracking the application of standardised technical regulations for managing trade between interconnected systems so as to maximise their technical efficiency;
- Tracking wholesale electricity sales between different purchasers within the member states and analysing their efficiency in order to avoid anti-competitive practices;
- Ensuring that the partners comply with commercial regulations and respect their contractual commitments and developing procedures for resolving disputes;
- Implementing effective communications channels between governments, regulators and the electricity services of member states with regard to mutual interest issues, such as preventing anti-competitive practices.

2 - It is worth remembering that the WAEMU also has an energy policy made up of several components, including the Regional Initiative for Sustainable Energy, to which the 8 Francophone countries of the ECOWAS zone belong.
3 - Source: http://www.ecowas.int/services/expression_of_interest/fr/afd/EOI_BENCHMARKINGFINAL_FR1.pdf

2. Energy policy in EMCCA countries[4]

The energy sector's sub-regional programme mainly involves two projects:

- The energy information system, developed in partnership with the Institut de l'Energie et de l'Environnement pour la Francophonie (Institute of Energy and Environment for Francophone Countries);
- The sustainable development initiative for rural and suburban development in the EMCCA zone.

2.1 The regional and national energy information system

This project was implemented in accordance with a well-defined methodology:

- Provide precise information based on the experience of other African countries, practical methods for implementing national and regional energy information systems within the EMCCA zone.
- Take stock of the situation with regard to energy data and energy accounts available in the EMCCA zone's member states.
- Draw up terms of reference for the sub-regional study for implementing the EMCCA zone's Energy Information System.

2.2 The "Sustainable development for rural and suburban development" initiative

The energy action plan for the EMCCA zone can be summed up in 10 points:

- **Support for electricity sector planning (SIG):** this mainly involves strengthening national capacity (training and equipment provision), the aim being to develop or consolidate national rural electrification plans involving links in the community area.
- **Coordinated development of hydroelectric power:** This involves a sequence of studies per catchment area to be drawn out among the zone's abundant sources of renewable energy.
- **Converting biomass surplus from agro-manufacturing units (target: companies):** this will involve boosting the capacity of business frameworks with regard to co-generation techniques, producing and managing an action plan on the basis of survey data, putting together coherent energy investment projects.
- **Rural energy service promotion zone:** this will involve defining - in operational terms - the feasibility of promoting energy services across a given area.
- **Intensive suburban electricity projects:** this involves linking a home population up as clients grouped together under a single transformer and connecting 125,000 households up.
- **Promoting photovoltaic solar energy:** this involves leading a themed cross-category initiative in which the various players involved can share their experience over a network.

4 - Extract from the report presented at the 21st Workshop on regional activities for accessing energy, Dakar, 15 April 2008, by Pierre YETE, Deputy-director in charge of energy at the EMCCA commission.

- **Optimising the domestic fuels market:** this involves setting up a concrete development programme following notice from companies, NGOs, and project managers for optimising the domestic fuels market.
- **Dialogue on the hydrocarbon policy:** this involves carrying out studies with a view to highlighting the refining and distribution problem, without forgetting issues relating to substitute fuels and creating a EMCCA zone oil club, a framework for dialogue designed to improve the regulation of oil and gas contracts, and to create added value.
- **Developing an energy charter** which will commit member states within the framework of a community energy policy to drawing up an EMCCA national energy code integrating hydroelectricity, solar energy and hydrocarbons.
- **Setting up an energy monitoring body:** this body will be responsible for holding discussions to ensure the sustainability of the process.

Implementing all of these initiatives require approximately 236 million over a five-year period (2007-2012).

3. Electricity trading system between countries in both zones

3.1 Interconnections among countries in the ECOWAS zone[5]

The West African Power Pool (WAPP) was set up in the ECOWAS zone in 1999 as a result of Decision A/DEC 5/12/99 taken at the 22nd Summit for heads of state and government in the region. This specialist institution sets out to meet the electricity deficit in West Africa.

This organisation's main aim is to integrate national electricity system operations into a unified regional electricity market, in the hope that in the mid- to long-term, this mechanism would provide a stable, reliable electricity supply at a reduced cost.

A number of projects have so far emerged, the main ones of which are the following.

5 - Source: www.ecowapp.org

WAPP Priority Projects[6]

Projects implemented (million US dollars)

No.	Project	Objective	Year brought into servic
1	330 kV Sakété - Ikeja West Line (Nigeria-Benin interconnection)	To interconnect Nigeria and Niagara with the rest of zone A of the WAPP	Q1, 2007
2	330 kV Aboadze - Volta Transmission Line	To provide adequate capacity for unconstrained electricity trade among Nigeria, Benin, Togo, Ghana and Ivory Coast	Q3, 2010
3	330 kV Volta - Lome 'C' - Sakété (Ghana-Togo-Benin Interconnection)	To provide adequate capacity for unconstrained electricity trade among Nigeria, Benin, Togo, Ghana and Ivory Coast	Q4, 2012
4	225 kV Bobo - Ouagadougou Transmission Line (Burkina Faso)	To extend the electricity supply from the Ivory Coast to Ouagadougou	Q4, 2009
5	225/150 kV Ferke - Sikasso - Ségou (Mali - Ivory Coast Interconnection)	To interconnect networks in the Ivory Coast and Mali in order to export low-cost power from the Ivory Coast to Mali	
6	60 MW hydro power project in the OMVS[7]	To increase the hydroelectric capacity of the OMVS power system	2013
7	225 kV OMVG Loop (Gambia, Guinea Bissau-Senegal-Guinea Interconnection) + hydro site at Kaleta and Sambangalou	To interconnect the national power systems of the Gambia, Guinea, Guinea-Bissau and Senegal	2015
8	Bumbuna 50 MW hydroelectric power project	To provide hydroelectric power for Sierra Leone	2009
9	Emergency power supply security plan - Aboadze, 400 MW - Maria Gleta, 450 MW - OMVS, 150 MW	To curtail power outages in the medium term and reinforce power supply security in WAPP	2011
10	147 MW Adjarala hydroelectric project	To increase the hydroelectric power capacity of Togo and Benin	2013
11	National Electricity Control Centres (Ivory Coast (CIE), Ghana (VRA), Benin/Togo (CEB), Nigeria (PHCN)	Modernise the SCADA system: communications and telemetry systems in particular to minimise power outages and improve efficiency	- VRA (Q3, 2010) - CEB (Q4, 2012)
12	National Electricity Control Centre (Burkina Faso (SONABEL)	Modernise the SCADA system: communications and telemetry systems in particular to minimise power outages and improve efficiency	2008
13	Guinea-Bissau emergency programme	To provide emergency support to Guinea-Bissau as required in anticipation of the advent of the OMVG[8]	2010
14	Cross border project (Ghana, Benin, Togo, Burkina Faso, Ivory Coast, Liberia)	To increase access to energy in the border communities of Ghana, Togo, Burkina Faso, Ivory Coast, Liberia	2010
15	Cross border project (Gambia-Senegal, Guinea-Bissau-Senegal)	To increase access to energy in the border communities of Senegal, Gambia and Guinea-Bissau	
16	WAPP operations manual	To ensure the smooth, coordinated operation of the WAPP interconnected system	2011

VRA: *Volta River Authority*; **CIE:** *Ivory Coast Electricity Company*; **CEB:** *Benin Electricity Community*; **PHCN:** *Power Holding Company of Nigéria*; **IDA:** *International Development Association*; **SOPIE:** *Ivory Coast Electricity Holding Company*;

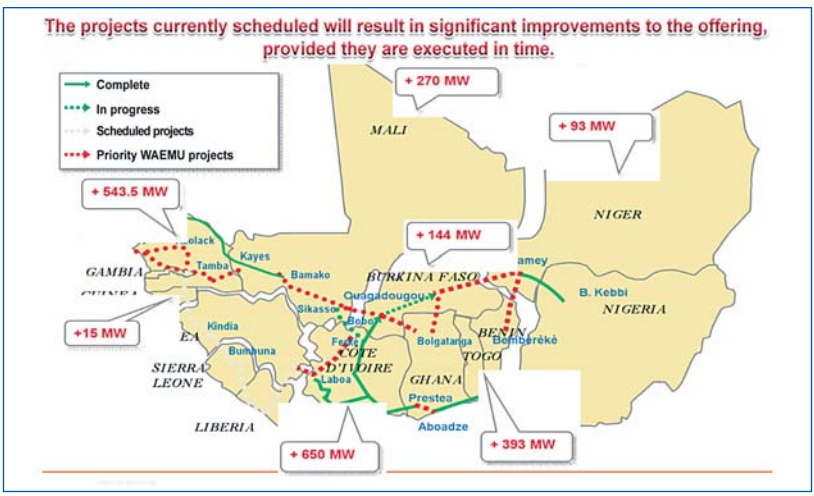
6 - Source: http://www.ecowapp.org/status_wapp_projects.pdf
7 - Organisation set up to make use of the Senegal River.
8 - Organisation set up to make use of the Gambia River.

Project Cost	Funds secured	Funds under negotiation	Financing gap	Funding sources	Project status
achevé	achevé			BOAD, AfDB, EBID	Completed
38	38			Kuwait Fund, EIB, World Bank and IDA	In progress: erection of transmission line towers started in July 2008. 80% of construction work on the line is complete, over 70 km of line have been set up.
105	67	38		World Bank, AfDB, KfW, VRA (Ghana), CEB (Benin/Togo)	In progress
130	130		0	AFD, World Bank/IDA, EIB, Nordic fund, DANIDA	Completed
102	102	0	0	Government of India, BOAD	Relaunched: In progress
236	135	31		World Bank/IDA, EIB, SOGEM	In progress: contract signed
1451		855,6	595,3	AfDB, World Bank/IDA, EIB, AFD, EBID, KfW, Abu Dhabi fund, BOAD, IDB	In progress: pre-investment studies completed. Financing in the process of being mobilised.
88	88			World Bank, ADB, OPEC Fund	Completed
- 800 - 893 - 380		- 20	- 800 - 873 - 380	EBID	In progress:
321			321		Relaunched: feasibility study is complete
40	20		18	World Bank/IDA	In progress: financing received for VRA and CEB
10			10	World Bank/IDA	Funding Required
10			10	ECOWAS - WAPP donors	In progress
19810	19810			EU, VRA (Ghana), CEB (Benin/Togo), SONABEL (Burkina Faso), SOPIE (Ivory Coast), LEC (Liberia)	In progress: in the process of being finalised
6 860			6 860	AfDB, German government	Funding Required
14.43			14.43	WAPP donors	In progress: Manual developed and approved by the executive board for deployment throughout the interconnected WAPP system.

LEC: *Libéria Electricity Company;* **AfDB:** *African Development Bank;* **ADB:** *Asia Development Bank;* **EBID:** *Ecowas Bank For Investment and Development;* **BOAD:** *West African Development Bank;* **EIB:** *European Investment Bank;* **KfW:** *Kreditanstalt fur Wiederaufbau Privatkundenbank;* **AFD:** *French Development Agency;* **IDB:** *Inter-American Development Bank*

• ***330 kV Ikeja West - Sakété line (Nigeria-Benin interconnection)***

• 330 kV Volta – Mome Hagou – Sakété line (Ghana – Togo – Benin)



3.2 Interconnections among countries in the EMCCA zone[9]

In Central Africa, the West African Energy Pool (PEAC) is the body responsible for structuring and running the electricity market. Its aim is to ensure that the region's energy needs are met through the implementation of an interconnected electricity network. The PEAC was set up in April 2003 and has six members from within the EMCCA and a further five from outside it (Angola, Burundi, the Democratic Republic of Congo, Rwanda, and the Democratic Republic of São Tomé and Príncipe).

The following are priority projects for interconnecting countries in the region:

N°	Name of project	Country	Type	Estimated cost (Million US$)
1	Inga - Calabar interconnection	DR Congo, Congo, Gabon, Equatorial Guinea, Cameroon, Nigeria	TRANSPORT	Studies: 3
2	Work: 1770	RD Congo, Angola, Congo	TRANSPORT	Études : 1 Réalisation : 97,3
3	Inga – Cabinda – Pointe Noire interconnection	DR Congo, Angola, Congo	TRANSPORT	Studies: 1
4	Cross-border electrification of Zongo (DRC) from Bangui	DR Congo, Central African Republic	HYD. GEN + OTHER	Studies: 0.13 Work: 28
5	Cross-border electrification of 7 villages (CAR) from Mobaye (DRC)	DR Congo, Central African Republic	OTHER	Studies: 0.39 Work: 13.8
6	Electrification of LéRé, Para, Ribao, Momboré, Mamboroua and Binder (Chad) from Guider (Cameroon)	Chad, Cameroon	OTHER	Studies: 0.26 Work: 9.8
7	Electrification of Kyo-Ossi (Cameroon), Ebebiyin (Equatorial Guinea) and Meyo-Kye (Gabon)	Cameroon, Equatorial Guinea, Gabon	OTHER	Studies: 0.26 Work: 7.5

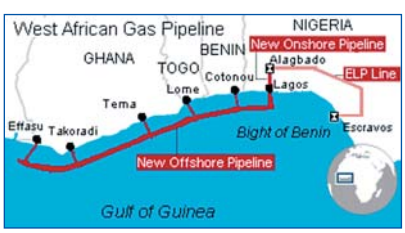
9 - Source: Panorama 3rd Session PEAC.

A number of other projects have been identified within the framework of the EMCCA zone's "intensive suburban electrification" initiative.[10]

Project	Country	Hydroelectric power	MT/BT cost (M€)	Production Cost excl. VAT (M€)
DIMBOLI	Cameroon, Congo, Central African Republic	188 MW	97.4	466.6
Cameroon - Gabon interconnection	Cameroon, Gabon, Equatorial Guinea	200 MW	28.8	63.7
MINI Hydro Cameroon - Congo	Cameroon, Congo	20 MW	12.6	72
Congo - Gabon interconnection	Gabon, Congo		14	40
Cameroon - N'Djamena	Cameroon, Chad, Nigeria	179 MW		591.4
Cameroon - Malabo interconnection	Cameroon, Equatorial Guinea	0		83.2
Southern Congo - Gabon interconnection	Gabon, Congo	100 MW	26.7	343.5
Cameroon - centre CAR	Cameroon, CAR	15 MW	27.2	65.2
Cameroon, Chad, CAR	Cameroon, Chad, CAR	53 MW	154.1	197.4
Northern CAR - East Congo	CAR, Congo, DRC	39 MW	23.6	128.1

4. The West African Gas Pipeline Project[11]

In February 2003, during the 26th ordinary ECOWAS summit, 4 West African heads of state (Nigeria, Ghana, Togo and Benin) signed a treaty for the production and extraction of natural gas. This project will enable Ghana, Benin and Togo to get natural gas from Nigeria. It involves the construction of a 600 km long gas pipeline, with a maximum discharge of 5.5 million m³. The pipeline will start in Alagbado in the suburbs of Lagos (Nigeria) and will link up the towns of Cotonou in Benin, Lomé in Togo and Tema, Takoradi and Effasu in Ghana.



Source: http://www.foei.org/fr/publications/pdfs/wagp-fr.pdf

The project is worth some US$500 million and is being financed by a consortium made up of 6 companies: Nigeria National Petroleum Coorperation (25%), Chervon Nigéria Ltd (36,3%), Shell Nigeria (18%), Volta River Authority of Ghana (16%), Société Béninoise de Gaz S.A (2%) and Société Togolaise de Gaz S.A. (2%).

It is being managed by the West African Gas Pipeline Company (SOGAO).

10 - Report of the 2nd regional committee meeting for coordinating the EMCCA zone's "intensive suburban electrification" project, 11 and 12 November 2009.

11 - http://www.togo-confidentiel.com/texte/Economie/Gazoduc_ouest_africain.htm

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