Renewable Energy Technology Assessment: Case Study of Senegal, Ghana & Cote d'Ivoire

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ABSTRACT
Energy access remains a key problem in Sub-Saharan Africa with roughly 620 million people of its 915 million population still without access to electricity (ECOWAS, 2012) and those with access faced with a situation where the supply is erratic and of a very high cost of about $0.13 per kilowatt-hour compared to global costs in other developing countries of $0.04 -$0.08 per kilowatt-hour, in a business as usual scenario and at the current population growth rate the figures will keep increasing. There is a global call from the UN sustainable energy for all initiative (SE4ALL) to double the share of renewable energy sources in the global energy mix (REN21, 2014). Renewable energy sources provide sources of energy which are naturally replenishing, environmentally friendly and easily accessible (as off grid stations can be set up in rural areas). In order to increase the share of renewable energy sources in the energy mix of a region there needs to be a basic understanding of the current energy situation in the region, the current share of renewables in the region and the potentials for an increase in capacity. This work provides a review of the energy situation in three ECOWAS countries thus Senegal, Ghana and Cote d'lvoire and comparing their energy situation with South Africa. The report focuses on available renewable energy resources, the energy mix and energy consumption in respective countries.

Keywords: Renewable energy, Energy mix and Energy consumption

INTRODUCTION
Assessing Renewable Energy Technologies is a crucial step for a country to know how to move toward the Renewable Energies integration in the Energy Mix. It helps to understand the Energy situation in the country. And also, enable to know how Renewable Energies sources can affect the Energy scenario of a Specific country. This Work is about the Presentation of energy situation and RET assessment of 3 countries located in the ECOWAS. The countries in question are Senegal, Ivory Coast and Ghana.

Senegal is a country in West Africa. It is bordered by the Atlantic Ocean to the west, Mauritania to the north, to the east by Mali, Guinea and Guinea-Bissau to the south. The Gambia forms a quasi-enclave in Senegal, penetrating more than 300 km inland. The Cape Verde Islands are located 560 km from the Senegalese coast. The country owes its name to the river which borders it to the east and to the north and which takes its source in Fouta Djallon in Guinea. The climate is tropical and dry with two seasons: the dry season and the rainy season.

Ghana is located on the Gulf of Guinea, just north of the equator. It shares borders with Côte d'Ivoire to the west, Togo to the east and Burkina Faso to the north. The country is made up of dense tropical forests to the south and savanna to the north. The tropical climate is rainy, mainly in May-June (great rainy season or wintering). The Black Volta, the White Volta, and the Oti and Daka rivers meet in Ghana to form Lake Volta. The Akosombo Dam, located to the south of the lake, produces much energy for the country.

Côte d'Ivoire is a member country of the African Union. With an area of 322,462 km2, it is bounded to the north by Mali and Burkina Faso, to the west by Liberia and Guinea, to the east by Ghana and to the south by the Atlantic Ocean. The population is estimated at 26 578 367 inhabitants.

The work here assesses the existing Renewable Energy Resources, and the installed technologies. And finally, a comparison Between them and with South Africa which is the most developed country in Sub-Saharan Africa.

I) Case study 1: SENEGAL

1. ENEGY SITUATION

Senegal is one of the ECOWAS members located at the extreme west of Africa. It is bordered by the Atlantic Ocean in his total West, Mauritania and Mali in the North and East and the Two Guinea. It is a small country with an area of 196,712Km, and a population of about 13million (ANSD 2012). Rural population dominates the composition with 57% and the 43% lives in urban area mostly in the capital 20%(ANSD, 2013). Senegal, like many countries in West Africa, is facing a problem of access to electricity. Indeed, it shows an access rate of 56.5% in 2012. This rate masks high disparities since nearly 90% of urban but only 26% of rural people have access to electricity.

The country heavily relies on oil and oil derived products imports. Indeed, fossil fuels are the main type of energy used in Senegal. In addition, the electricity produced is predominantly from thermal generation 90% and the only source of hydropower is the Manantali dam with only 10% of the total production. This strong dependence on thermal generation is combined with a weak level of production efficiency 30% on average. There is also a strong dependence on biomass (firewood and charcoal) that heavily weights on household budgets. However, the country has taken the measure of the problem since the installed capacity has increased from 584 MW in 2012 to 864 MW in 2015.

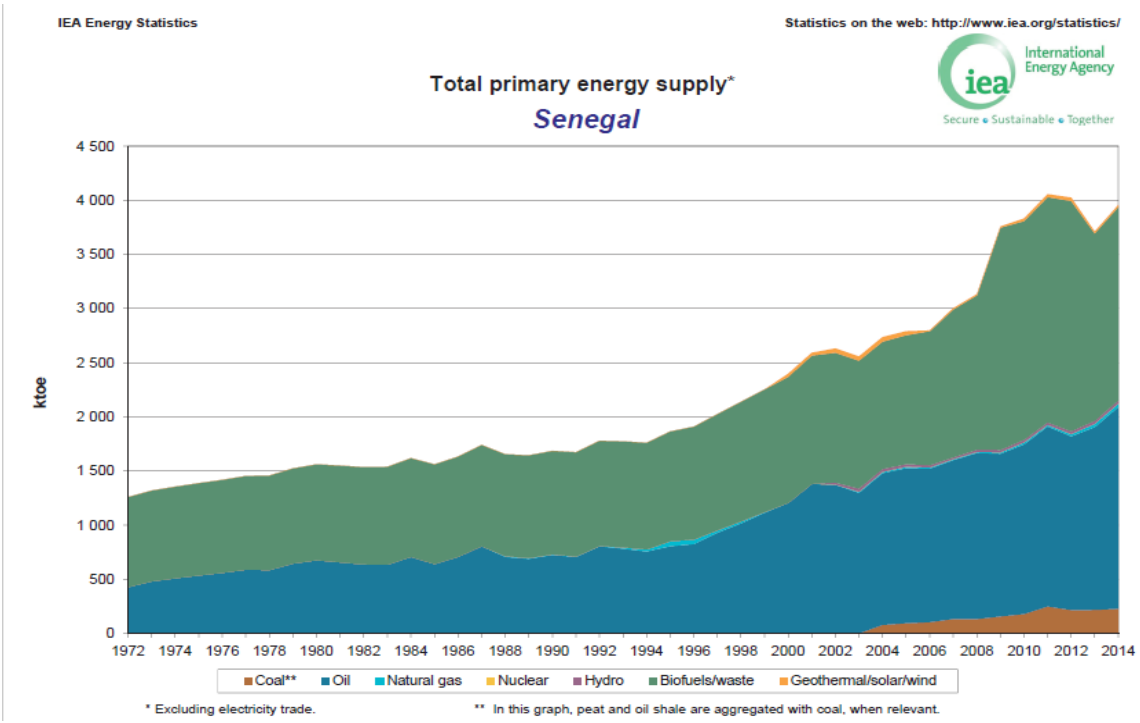


Figure 1:Total Primary Energy Supply

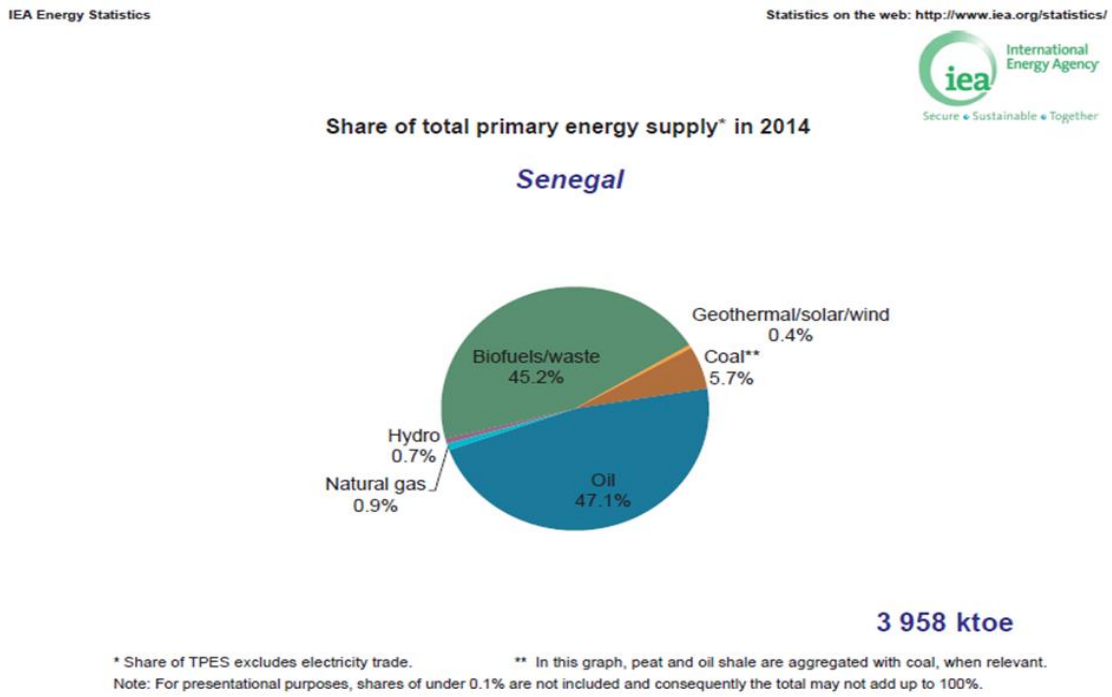


Figure 2: Share of Primary Energy Supply

2. RENEWABLE ENERGY SCENARIOS

a) Solar

Senegal is endowed with a large solar energy resource. Over most of country's territory, the solar irradiation is above 2 000 kWh /m2/year for Global Horizontal Irradiation and above 1,800 kWh/m2/year for Direct Normal Irradiation (Ministere des Energies Renouvelables, 2011). This provides good prospects for photovoltaic solar power projects. The falling prices of photovoltaic panels and system components make solar a very attractive solution.

Installed projects

Only 2 MWp of solar photovoltaic power were connected to the grid. But Recently a new solar power plant producing 11MWp was inaugurated at Bokhol (North of the country) in 2016. However, panels are often used on an individual basis, and photovoltaic street lamps have developed over the past 5 years.

Upcoming projects

A program of 400 MW of photovoltaic installations was launched by the government. A first tranche of 200 MW is carried out with the support of the World Bank and consists of a series of calls for tenders offering guaranteed purchase contracts (PPPs) to independent producers (PPIs). The construction of a 30 MWp power plant was launched on 4 March 2016. Located in Santhiou Mékhé, 160 km from Dakar, the investment cost of € 41 million is shared between Proparco, Meridiam and the FONSIS sovereign fund. In addition, the operator has a purchase warrant for 25 years.

b) Wind Energy

Although even if it does not have any wind farms, the country has interesting potential along the coast from Dakar to St Louis with winds of 4 to 6 m / s. Under the law for 15% of primary energy produced from renewable sources (excluding biomass) in 2025, an estimated 150 MW of wind capacity is installed by 2020.

Upcoming projects

Thus, a project of 152 MW in Taiba Ndiaye launched in 2008 obtained in 2014 PPA from SENELEC. Its French developer Sarreole has recently won the support of an American investment fund through a promise of investment of 76 M €, one quarter of the 305 M € required for construction. The remaining funds will be provided through bank loans and bonds.

c) Hydro

The country is crossed by two large rivers: the river Senegal and the river Gambia. The Organization for the Development of the Senegal River (OMVS) and the equivalent for the Gambia River (OMVG) estimate the potential for hydropower plants at 2,000 MW by 2025, which is almost equally distributed between the two rivers.

Despite this strong potential, these two rivers show very irregular flows during the year. In addition, dams are slow and expensive to develop with an investment cost of more than 2 USD / W of installed capacity. Finally, the construction of the necessary interconnection lines poses difficulties because of their cost and their transnational character. Therefore, hydroelectricity cannot be the unique answer to the needs of increasing electrical power.

Installed projects

Most of the country's hydroelectric power comes from the Manantali Dam in Mali (200 MW), of which 1/3 of the production is sold in Senegal. This capacity was recently increased by the commissioning in Mali in December 2013 of the dam Felou (60MW) which resells 25% of its production in Senegal. Guinea inaugurated on 28 September 2015 the dam of Kaléta (240MW), of which 20% of the production is expected to return to Senegal once a line of interconnection of 1600 km realized. Thus, the "installed" power in the country is 80MW through regional agreements sharing the production of large hydroelectric works. Senegal therefore benefits from the regional interconnection of electricity grids.

Upcoming projects

In the wake of Kaléta, Guinea plans numerous projects in the basin of its eponymous river, such as Samba Ngalou (128 MW) and Gouina (140 MW). Senegal will have to wait for the construction of interconnection to benefit from these new installations.

d) Biomass and Biofuel

Solid biomass (agricultural and agribusiness by-products) and liquid biofuels also have potential in parts of the country. As mentioned earlier, biomass is the dominant source of energy in Senegal providing more than 50% of the national energy balance. Biomass resources, such as agricultural by-products (approximately 3.3 million dry tons of agricultural residues) agribusiness (rice husk, bagasse, peanut shells, cotton stalks, etc.), also have the potential for grid-distributed and off-grid electricity generation (Ibid). Plant species (plant oil, jatropha curcas,

cat-tails, sunflower, cotton, castor, sweet sorghum etc.) also have potential for biofuel production.

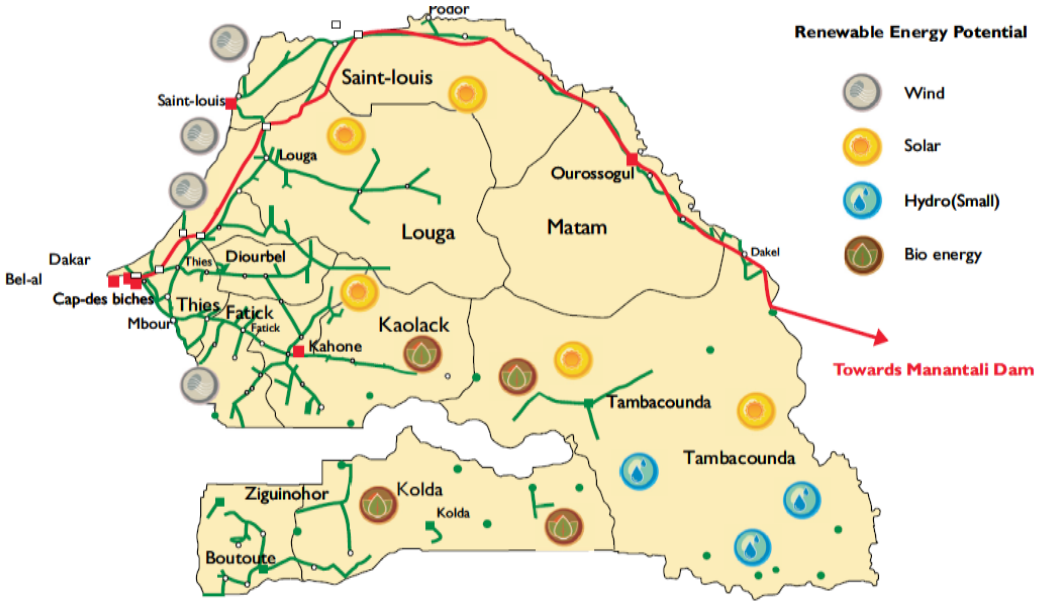


Figure 3: Renewable Energies Potential Map

II) Case Study 2: GHANA

1. ENEGY SITUATION

Ghana is on the West Coast of Africa. In 2014, the population stood at 27 million, with a relatively high rate growth rate of 2.4% per annum (Ghana Statistical Service n.d). Its gross domestic product (GDP) has been increasing by about 5.5% per year on average, peaking at 15% in 2011 due to the start of crude oil production (Ghana Statistical Service, 2013). Biomass, consisting mainly of wood fuel like firewood and charcoal and to a lesser extent crop residues, accounts for half the Total Primary Energy Supply. Oil is the second most widely used source of energy in Ghana, accounting for 40% of primary energy supply, followed by hydropower and natural gas accounting for 7% and 3% respectively. Large hydropower and oil-fired plants provide most of the electricity 64% and 36% respectively (National Energy Statistics, 2014)

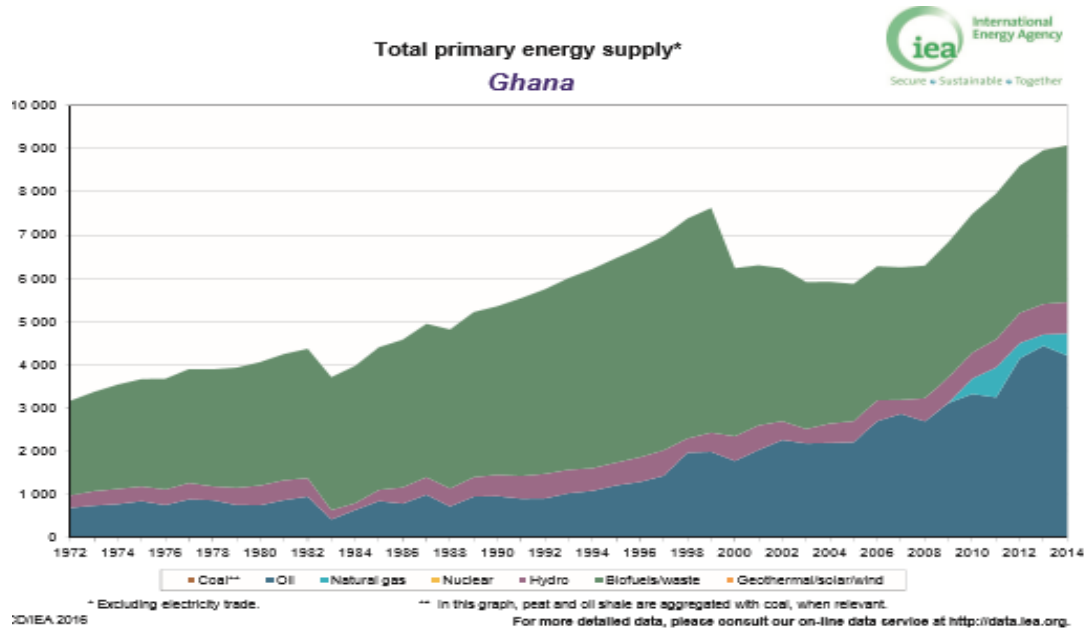


Figure 4:Total Primary Energy in Ghana

2. RENEWABLE ENERGY SCENARIOS

a) solar energy

Solar radiation and sunshine duration data have been collected by the Ghana Meteorological Services Agency for over 50 years. Ghana, being a few degrees north of the equator, is endowed with enormous solar energy resource spread across the entire country. Daily solar radiation level ranges from 4 kWh/m^2 to 6 kWh/m^2. Over 4,500 solar systems have been installed in over 89 communities throughout the country. Currently, the Volta River Authority has erected 10MW Solar Power Plant in northern Ghana. Solar water heaters also have been known and their potential tested and demonstrated in Ghana over the past two decades. They are used in residential dwellings, health institutions, hotels, restaurants, and laundries. The main problem that has limited their wider application is their comparatively higher initial costs as compared to electric or gas water heaters.

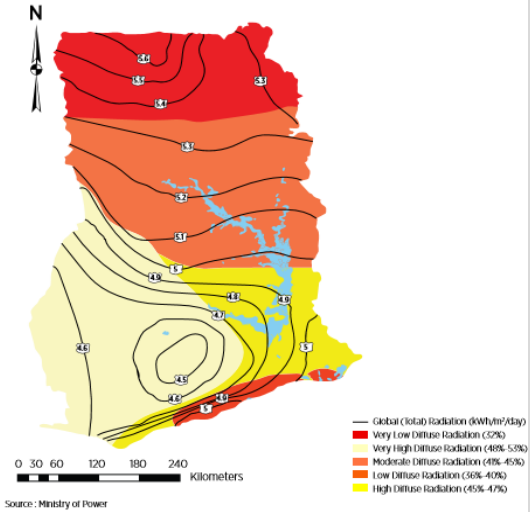


Figure 5:Global Solar Radiation

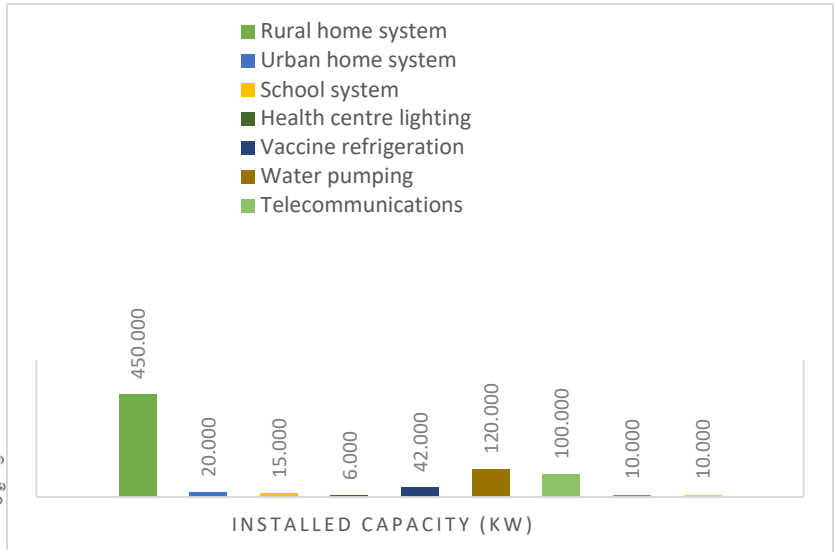


Figure 6:Solar PV installations in Ghana

b) Hydropower

The prospect of harnessing the hydropower potential of small rivers in Ghana has been investigated for many years, and many potential mini-hydropower sites have been identified. ECREEE defines small hydropower as plants with production capacity less than 30 MW, but hydropower schemes of up to 100 MW qualify for renewable electricity Feed-in Tariff (FiTs) under Ghana's Renewable Energy Act. Table 7 in appendix shows potential hydropower sites in the different regions with individual capacities of 4 kilowatt (kW) to 2,000 kW.

The three-major hydropower plant in Ghana are Akosombo, Kpong and Bui dam with a total installed capacity of 1580MW which provide 60-70% of the electricity requirement (Energy Commission, 2011). 2013.

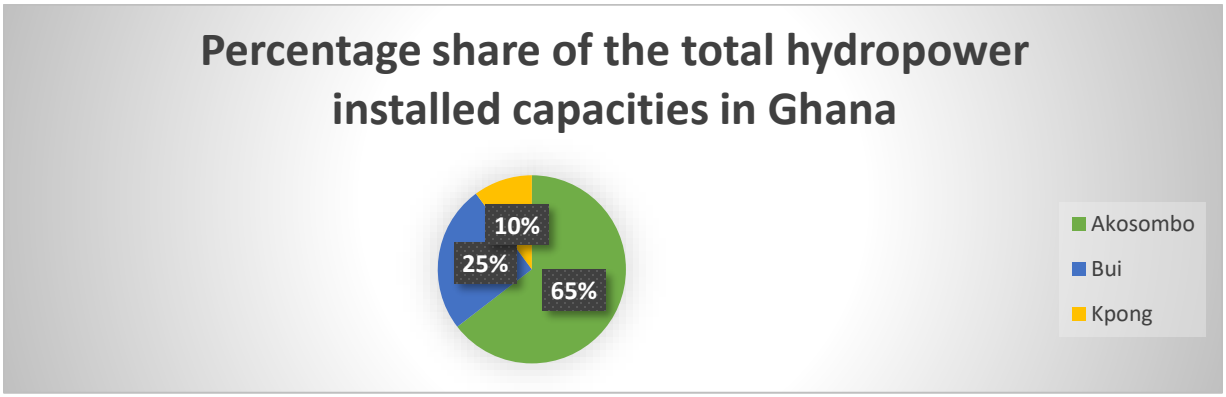


Figure 7:Share of Hydropower installed capacity

Source: Energy Commission, 2010

c) Biomass/biofuels

Ghana's total stock of direct wood fuel is around 832 million tons. Unless there are dramatic improvements in energy efficiency, demand for wood fuel, the dominant energy source, is expected to rise. The increase from 14 million tons in 2000 is projected to reach 38-46 million tons by 2015 and 54-66 million tons by 2020. If this trend were to continue as projected, it would put pressure on the nation's dwindling forests, leading to major deforestation, with all the associated consequences for climate change, agriculture and water resources. However, wood fuel consumption seems to have stabilized over the last decade or so, with a 14.6% reduction in demand between 2000-2014.

Besides wood residues and municipal waste, energy crops could be used for biofuel production in Ghana. They include jatropha, oil palm, sunflower, soybean and coconut for biodiesel and cassava, maize, sugar cane and sweet sorghum for ethanol (Ahiataku-Togobo and Ofosu-Ahenkorah, 2009).

d) Wind Energy

Ghana's technical wind power potential has been estimated at more than 5,000 MW. Average wind speeds are 6.4-7.5 meters per second (m/s). Overall, the most promising areas for deployment of wind power plants are along the mountains in the south-eastern part of the country and along the eastern coastal areas of the country. It has been estimated that 200-400

MW of onshore wind power could be established there with wind speeds in excess of 8 m/s (Essandoh, Osei and Adam, 2014).
The Volta River Authority has erected a 100MW Wind Power Plant at Kpone, near Tema which was commissioned in 2015 to support the national grid (Volta River Authority, 2015)

III) Case Study 3: Ivory Coast

1) ACTUAL ENERGY SITUATION

Cote d'Ivoire is a country in Western Africa and it covers 322,463 km² (equivalent to Germany). It is bordered by the Gulf of Guinea to the south (the Atlantic Ocean), west by Liberia and Guinea, to the north by Mali and Burkina Faso, to the east by Ghana (see below: map of the Cote d'Ivoire).
The population of Cote d'Ivoire is estimated at 23 865 564 inhabitants in 2016, 26% of immigrants mainly from countries in the sub region. (World Bank)
Further information about such as GDP, GDP Growth Annual rate, Human development Index, Mortality rate, Major export for recent years are given in the table below.

Côte d'Ivoire electricity access reached 88% of the population in urban areas, while in rural areas is still limited to 29%, although increasing. The national overall electricity access rate is 56%. This rate is one of the highest in the sub region. The figure below shows the proportion of electricity access in Cote d'Ivoire (rural, urban areas and access of total population).

A study leaded by The Global Tracking Framework estimates the national access to clean cooking solutions at 19%. Cote d'Ivoire has four primary energy sources: hydropower, oil, natural gas and biomass. 70% of energy consumption comes from biomass for cooking. The residential sector accounts for nearly 70% of total energy consumption, followed by commercial and public services, transportation, industry and agriculture. A policy on access to electricity based on the exploitation of its water resources was developed, and the exploitation of its oil resources will enable it to strengthen that policy by providing households in modern cooking sources. In terms of energy efficiency and renewable energy, the country has vast untapped resources. Energy is at the heart of the Côte d' Ivoire development strategies. The three key pillars of sustainable development are concerned: the economy, society and environment.

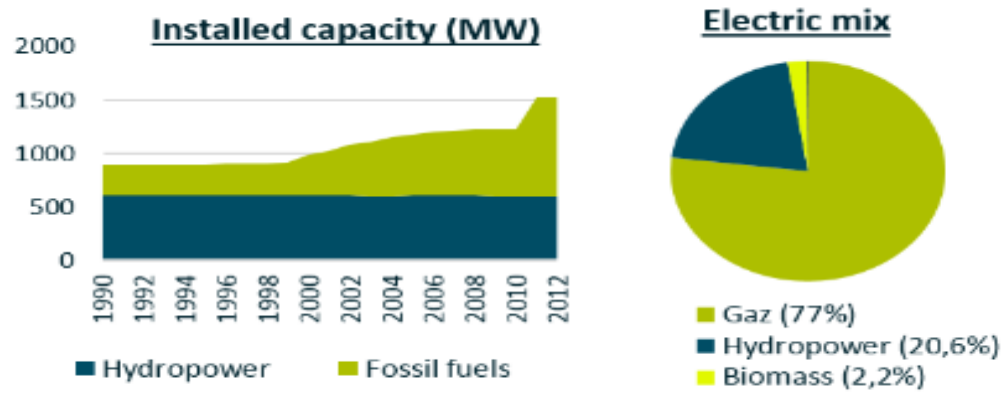


Figure 8:Cote d'Ivoire's energy mix

2) RENEWABLE ENERGY SCENARIO

a) Hydro

Cote d'Ivoire has an undeveloped potential of hydropower is estimated at 7000 MW, of which **1847 MW could be economically exploitable.** (Beaujard, 2016)**. As** part of the 2020 plan, **7 new projects totaling a capacity of 1150 MW** have been announced. These new projects will use PPP (Public Private Partnership) processes.
Cote d'Ivoire six hydropower plants with installed capacity of 604 MW which forms 29 % of its electricity (Koffi, 2012). The table 4-1 below shows the existing hydropower plants in Cote d'Ivoire.

Table 3 Existing Hydroelectric power stations

Hydropower Plant	Commissioning Date	Installed Capacity	Type of Turbines
Ayame I	1959	20 MW	Kaplan
Ayame II	1965	30 MW	Kaplan
Kossou	1972	174 MW	Francis
Taabo	1979	210 MW	Francis
Buyo	1980	165 MW	Kaplan
Grah	1983	5 MW	Kaplan
Total		**604 MW**	

Table 1:existing Hydro Power plant in Ivory Coast *Source: (Koménan K., 2012)*

b) Solar

Cote d'Ivoire is well endowed with solar energy with an average GHI of 2077 kWh/m². Especially, the northern part of the country has a strong potential thanks to abundant solar irradiation. (Beaujard, 2016)
As part of the electricity for all objective, the State is getting interested in mini-grids, for which photovoltaic is perfectly suited. Indeed, numerous public lighting projects using solar street-lamps have already emerged.

Solar water heater technology is not yet widely adopted in Cote d'Ivoire. It is mainly used in homes and hotels. The most commonly used type is the thermos syphoning type shown in figure 4-1 below. The solar water heaters used in Cote d'Ivoire are mostly in the capacity range of 120litres and 200 liters the purchase price of the device is certainly high (750,000 to 2,000,000 CFA francs CFA). (Yelly, 2007). The figure 4-1 below shows the technology.

Cote d'Ivoire has no operational grid solar plant. Solar PV is mainly used as standalone for domestic lighting. Pilot projects of electrification which distributing PV panels to households were started in 2008. Through this project, four villages Gligbeuadji, Debo, Dédégbeu and Détroya have benefitted. (Koffi Komenan, 2008).

c) Wind

At **3.76 m/s at 10-15 meter, the average wind speed is rather low**. Only a few regions (west coast, north area) have interesting winds. (Beaujard, 2016)

d) Biomass

Cote d'Ivoire has one of the best potentials in Africa, with an **annual capacity valued at 12 million tons** of biomass. In addition, there are also another 1.7 Million tons of cocoa shells providing in the cocoa plantation because Cote d'Ivoire is first world cocoa producer. (AFP, 29 October 2014).

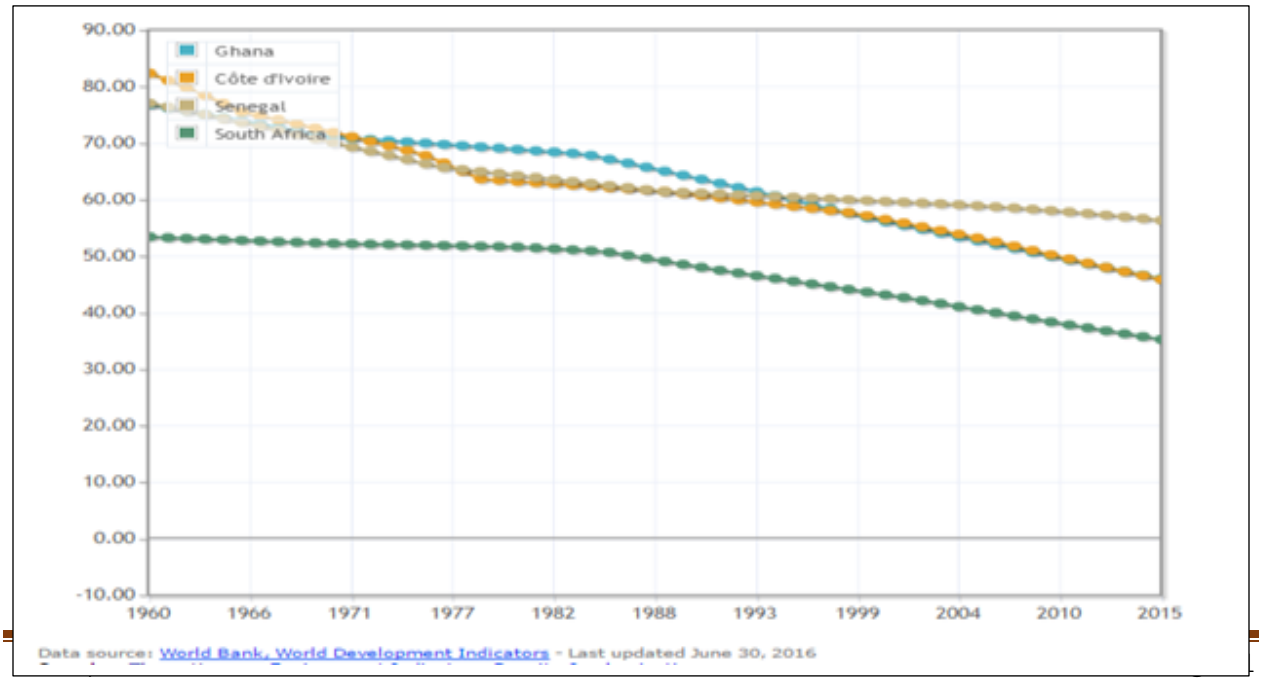
This resource is decentralized and abundant, which makes it the **most promising renewable energy in the short term.** That's why biomass is expected to fulfill most of the objective to reach 15% renewables in 2020.

The **Biokala** project, realized by SIFCA and EDF, will become **the largest biomass plant of Africa with 46 MW.** The plant will be fueled by 400 000 tons of vegetal waste from palm oil production. Other projects (Sitrade, Groupe Eoulee) are being developed

The most commonly used cook stove in Cote d'Ivoire is the three-stone cook stove though there are also improved stoves. The three-stone cook stove was efficiency as low as 5% in practice though laboratory result shows efficiency of up to 20 %. Through NGO such as GIZ, improved biomass cook stoves with higher efficiencies has been provided especially in the north of Cote d'Ivoire.

IV) COMPARISON BETWEEN THE 3 COUNTRIES AND SOUTH AFRICA

The three countries here have almost a similar situation. Senegal, Ghana and Cote d'Ivoire are all developing countries and need to improve economy, and life quality. The population is not too big 27 million inhabitants for Ghana, 23 million in Cote d'Ivoire and just 14 million in Senegal (World Bank, 2013). We note that all three countries are gradually modernizing. Their rural population ranges from around 80% in 1960 to 45% for Ghana and Cote d'Ivoire and 56% for Senegal (see figure 10). Compare to South Africa which is the most Developed country in the Sub-Saharan part of Africa. Its Population is 54 million in 2014 with Just 36% living in rural areas (World Bank, 2015).



The Energy situation also is totally different. In 2014 the total primary energy consumption of South Africa was **181 Mtce**(IEA). Compare to the 3 West African countries which are consuming more than 10 time less. Senegal for example consumed just 5.65 **Mtce in** 2014 (IEA). Ghana is consuming More, **12.85 Mtce** is the total Energy consumed in the country in 2014. For

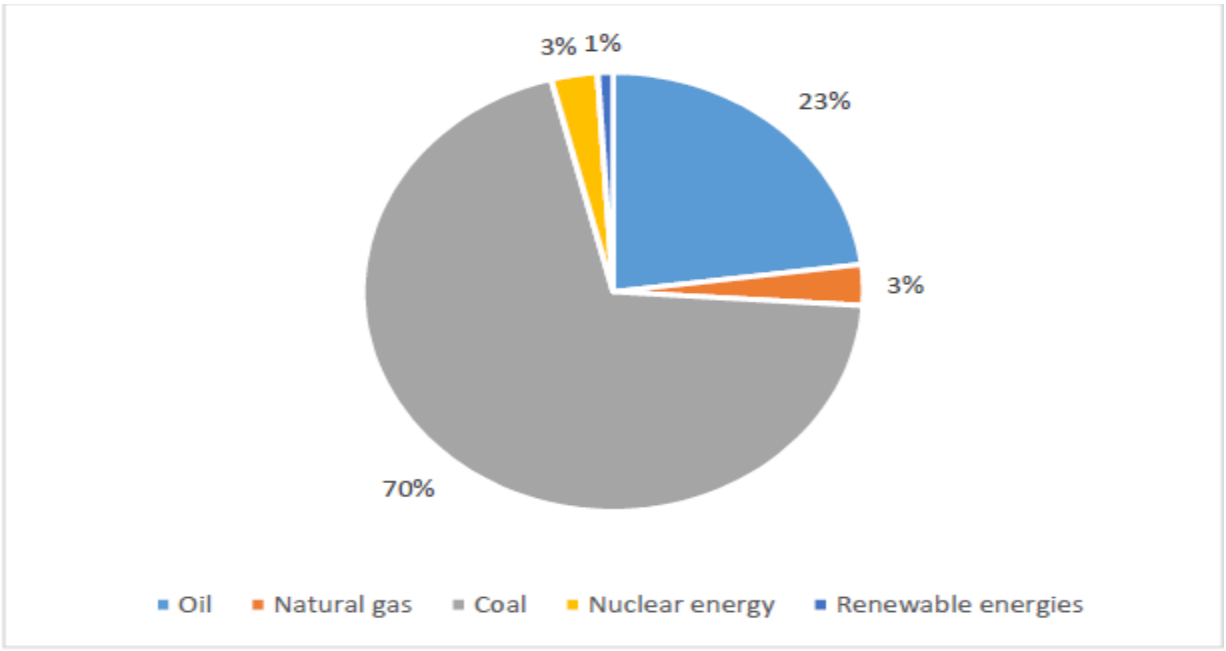


Figure 10: South Africa Energy Mix in 2014: Source IEA

Figure 9: Pourcentage of Rural Population

Cote d'Ivoire, there are not enough data about the Energy consumption.

The Energy mix is also quite different, South Africa relies a lot on the coal produced in the Country, about 70% of the Energy consumption. Renewable energy represents about 10% of the overall primary energy consumption with 1% in the electricity production in the Country. This contrast with Ghana and Cote d'Ivoire whose energy consumption mostly depend on Biomass and Hydro (see figure below). Senegal on the other side depend a lot on imported fuel (oil and coal). Traditional Biomass is the most important renewable energy consumed in the country (45%). The other Renewable Energy sources represent less than 1%.

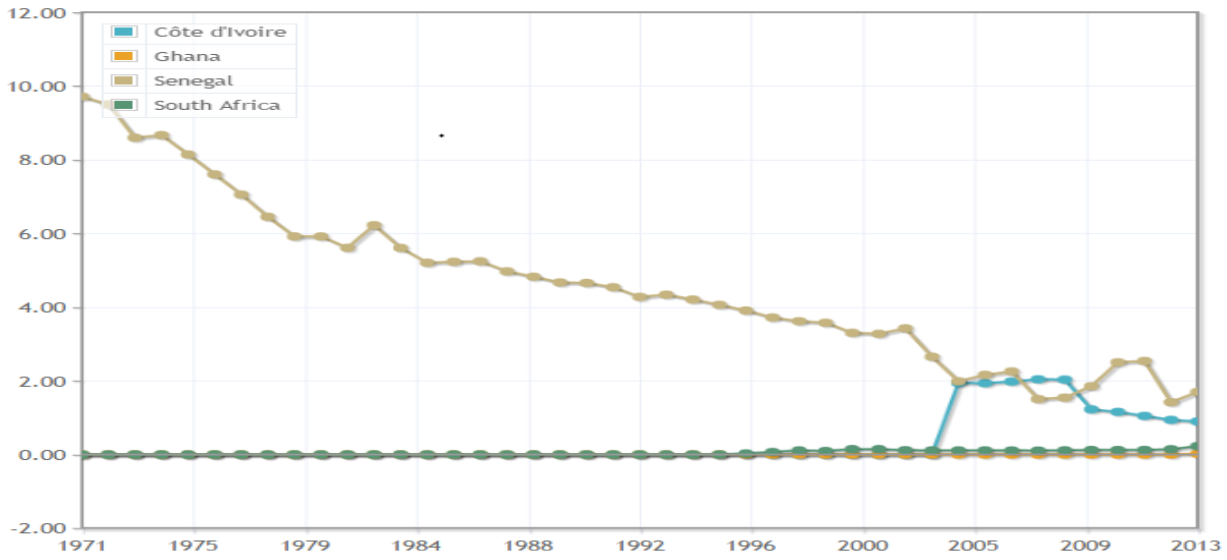


Figure 11: % Renewable Energy part in the Energy mix excluding Hydro (for electricity)

From figure 12, hydro is the most consumed renewable resource in Ghana, Cote d'Ivoire followed Senegal and then South Africa. The fluctuating trend in the consumption line for Ghana and Cote d'Ivoire could be as result of high demand due to increase in population and also reduction of water level in the dam. Breakdown of turbines could also be the result as it happened in Ghana in 1999. South Africa seems to have a flat trend which means that hydro is less consumed since South Africa depends mostly on fossil based fuel such as coal.

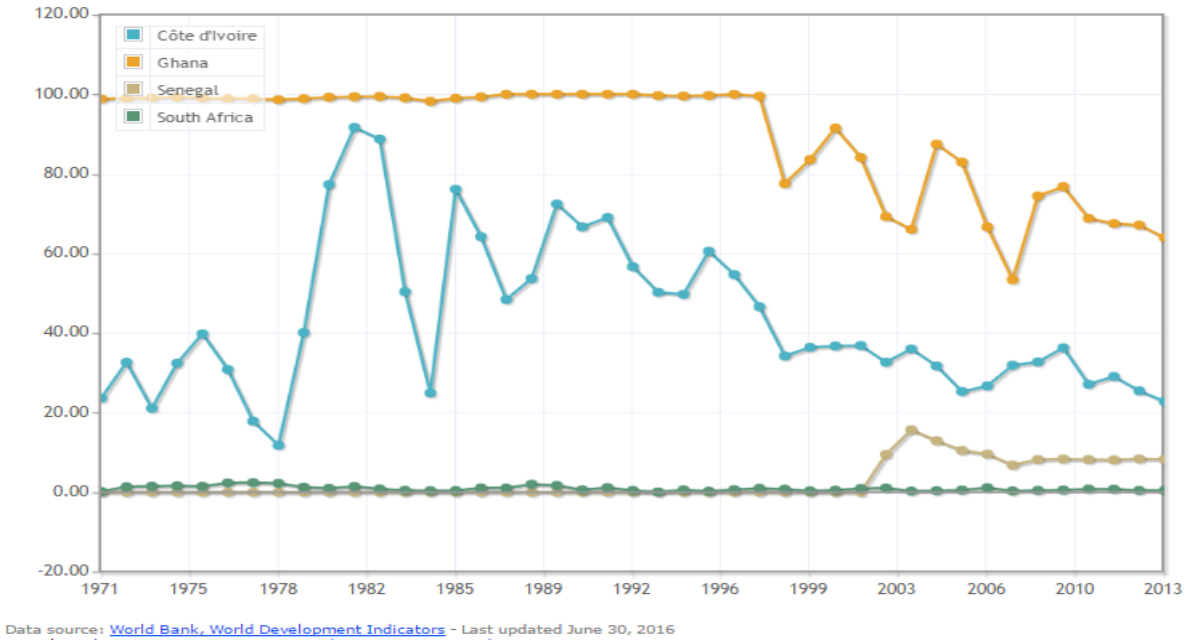


Figure 12: % of Hydro in the Energy consumption

Renewable resources such as Solar, Wind and hydro are most dominant resources for electricity generation in Ghana, Cote d'Ivoire and Senegal. However, this resources are not tapped to meet their energy demand. Majority of the population depends on biomass to meet their energy needs. The renewable energy mix in these countries are less than 3% of the total primary energy resources. There is a decline in renewable energy in the energy mix of Ghana as result of government failure to implement the renewable energy technologies in its strategic national energy plan (see figure 13). In addition, most of the renewable energy technologies are capital intensive and require financial assistant. Senegal and Cote d'Ivoire are doing well in implementing renewable energy technologies in their countries. Due to dependence of fossil based fuel in South Africa, renewable energy technologies tend to be stagnant from 1990 to 2012.

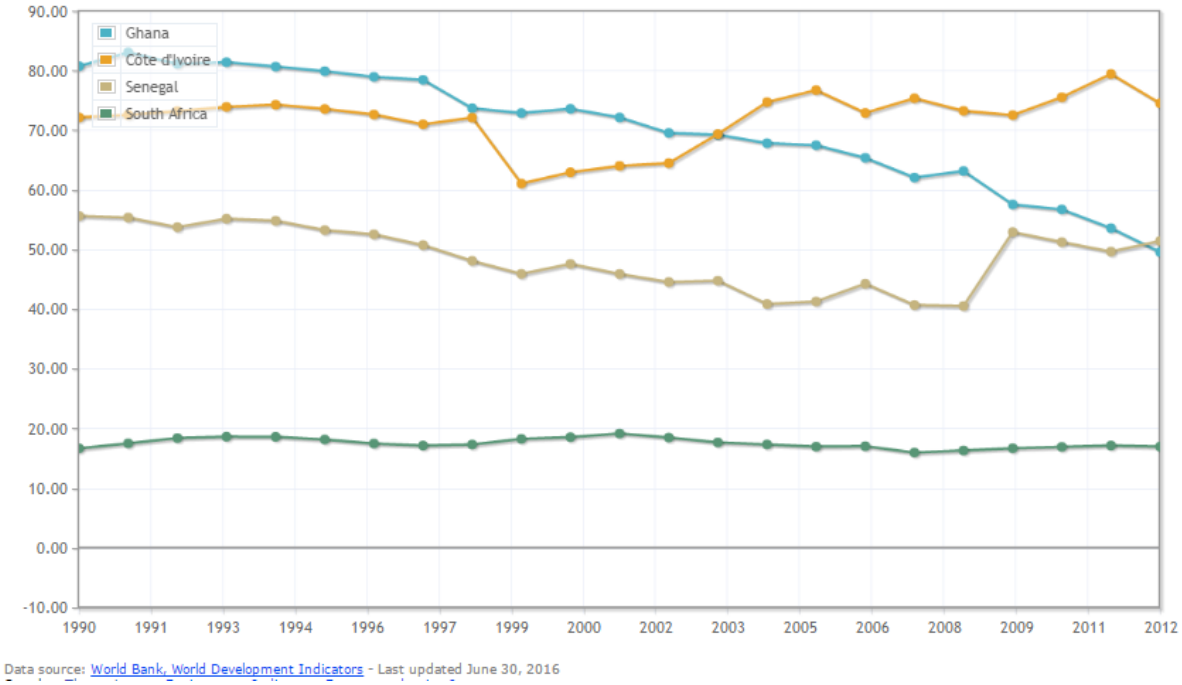


Figure 13:% of Renewable Energy in the Energy Consumption

Conclusion

All the 3 countries located in the West of Africa have huge renewable energy resource potential. However, these resources are not fully tapped. The dependence on traditional biomass is still high. Since Senegal has huge solar resource potential, the tree countries can go into partnership to invest into Solar PV and CSP project. Ghana and Cote d'Ivoire should also include into their energy mix solar and wind since they have a huge potential to augment the hydro. Senegal should make a program mostly based on Solar, wind and small hydro to reduce his dependence on fossil fuel. After comparison with South Africa it is obvious that the scenarios are totally different and South Africa depend less on renewable energy and mostly depend on fossil based fuel even though renewable energy resource potential is good. There is a global call from the UN sustainable energy for all initiative (SE4ALL) to double the share of renewable energy sources in the global energy mix to reduce GHG emission from fossil based fuel.

References

For Ghana

Ghana Statistical Service (n.d.), www.statsghana.gov.gh/, accessed 19 June 2014.

National Energy Statistics, Strategic Planning and Policy Division, 13 April.

Ghana Statistical Service (2013), Provisional Gross Domestic Product 2013, Ghana Statistical Service, Accra.

Essandoh, E.O., E.Y. Osei and F.W. Adam (2014),"Prospects of Wind Power Generation in Ghana", International Journal of Mechanical Engineering and Technology, Vol. 5, No. 10, pp. 156-179.

Volta River Authority (2015),"Power Generation: Facts & Figures", www.vraghana.com/resources/facts.php, accessed 19 June 2015.

Energy Commission 2011. Energy Outlook 2011.
Ahiataku-Togobo, W., and A. Ofosu-Ahenkorah (2009), "Bioenergy Policy Implementation in Ghana",
COMPETE International Conference, Lusaka.
ECOWAS (Economic Community Of West African States) (2012), Ecowas Renewable Energy Policy, ECOWAS Center for Renewable Energy and Energy Efficiency, Praia.

For Senegal

IMF (2013): Senegal: Letter of Intent, Memorandum of Economic and Financial Policies, and Technical Memorandum of Understanding Available at:http://www.imf.org/external/np/loi/2013/sen/060313.pdf Accessed 19th February 2014

HELIO International : Systèmes énergétiques : Vulnérabilité – Adaptation – Résilience(VAR) 2009 Written by Moussa DIOP (IN French)

Senegal Energy Sector Recovery Development Policy Financing : BY the World Bank
http://www.worldbank.org/projects/P105279/senegal-energy-sector-recovery-development-policy-financing?lang=en

Energy Security in West Africa the Case of Senegal: BY ENDA
file:///C:/Users/Utente/Downloads/enda%20senegal_energy_security%20(1).pdf

Senegal renewables readiness assessment 2012: by IRENA

Bioenergy for rural development in West Africa the case of Ghana, Mali and Senegal
https://energypedia.info/wiki/Senegal_Energy_Situation

https://www.iea.org/statistics/topics/renewables

http://www.indexmundi.com/facts/indicators/SP.RUR.TOTL.ZS/compare#country=ci:gh:sn:za

http://senegal.opendataforafrica.org/search?query=renewable%20energy

For Cote d'ivoire

AFP. (29 octobre 2014, 29 octobre 2014 29 octobre 2014). *Jeune Afrique*. Consulté le février 13, 2016, sur jeuneafrique.com/depeches/9544/politique/cote-divoire-construction-dune-centrale-a-biomasse-en-2015/: http://www.jeuneafrique.com/depeches/9544/politique/cote-divoire-construction-dune-centrale-a-biomasse-en-2015/

Banque mondiale. (2015, Octobre). *Statistiques mondiales*. Consulté le février 13, 2016, sur http://www.statistiques-mondiales.com/cote_divoire.htm: http://www.statistiques-mondiales.com/cote_divoire.htm

Beaujard, A. (2016, June 3). *Renewables Overview : Ivory Coast*. Consulté le December 13, 2016, sur http://www.renewable-energy-africa.com/renewables-overview-ivory-coast/

Direction des Services Socioculturels et de la. (2004). *Rapport sur le contexte socio-économique en cote d'ivoire* . Abidjan: eloise.

Koffi Komenan, K. Y. (2008). *Formation sur les systeles energetiques.* Marrakech.

Koffi, K. (2012). *Atelier regional de la CEDEAO sur la petite hydroelectricité.* Monrovia.

Komenan, K. (2008). *Atelier regional de la CEDEAO sur la petite hydroelectricite.* Monrovia..

Moussa K. (2004). Bilan sur l'accès à l'énergie des pays de l'Afrique subsaharienne,. *séminaire international sur l'accès à l'énergie et la lutte contre la pauvreté*. Ouagadougou.

World Bank. (2016). *The World Bank, IBRID-IDA*. Consulté le December 03, 2016, sur data.worldbank.org/indicator/EG.USE.PCAP.KG.OE?locations: http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE?locations

World Bank. (s.d.). *Banque mondiale.* Récupéré sur Banque mondiale. (2015). Statistiques-mondiales. République de Cote d'ivoire Statistique.

Yelly, T. (2007, Octobre 5). *Energie renouvelable-Chauffe eau solaire*. Consulté le février 13, 2016, sur koffi.net/koffi/actualite/24135-Energie-renouvelable-Des-chauffe-eau-solaires-sur-le-marche.htm: http://www.koffi.net/koffi/actualite/24135-Energie-renouvelable-Des-chauffe-eau-solaires-sur-le-marche.htm