



Università Commerciale
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White Paper

WHERE TO INVEST IN RENEWABLES IN SUB- SAHARAN AFRICA

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EXECUTIVE SUMMARY

The objective of the project was to report a market analysis of the 49 Sub-Saharan African countries (SSA), to assess each country's proficiency in attracting renewables energy investments, especially for wind power and solar PV. The criteria that reflect the availability of SSA countries to receive investment from private companies were identified, analysed and measured. In the analysis, all the relevant parameters were taken into account such as the electricity demand growth, the political stability, the renewable resources availability and the regulatory framework. After the evaluation of the different countries, the final goal was to present two different ranks, respectively one for wind power and one for solar PV, of the top 10 Sub-Saharan countries that are more likely to attract profitable investments for foreign energy companies.

1. INTRODUCTION

Our team is made up of five students from the Master in Green Management, Energy and Corporate Social Responsibility (MaGER) at Bocconi University of Milan: Leonhard Braun, Umberto Garini, Francesca Pulvirenti, Lorenzo Rasini and Alessandro Spagarino. The White Paper is the result of the so called “field project”, a long- term project we were assigned, from our course coordinator, to execute for Res4Africa organisation. In the last five months, we became quite familiar with the world of the renewables and their potential exploitation in a country such as the SSA. We have understood the barriers, limits but also the opportunities that investors could face in investing in renewables. During the work period, our team has had the opportunity to come to know Res4Africa organization and how they work. We have had the pleasure to work with two amazing people, Luca Marena and Daniele Paladini, who have always supported us in our task with no hesitation. Moreover, we have had the chance to meet honour guests such as Silvia Piana and Anna Acanfora, from Enel Green Power, and Paolo Marino, from Poyry Management Consulting. The two meetings were useful to understand the dynamic of renewable investments and how they work in a country such as the Sub-Saharan Africa. Finally, we also had the opportunity to attend the “Enel - Open Africa Power” event where feedback from African PhD students and from energy experts helped us refine our project.

2. CURRENT CONTEXT IN SUB-SAHARAN AFRICA

2.1 Economic Scenario

Thanks to favourable external and domestic conditions, the economic activity in Sub - Saharan Africa continues to strengthen. Output growth increased from 1.5 percent in 2016, the lowest pace in more than two decades, to an estimated 2.6 percent in 2017, broadly in line with expectations.

According to the Africa's Pulse Report "An Analysis of issue shaping Africa's economic future", economic growth in Sub-Saharan Africa is estimated to pick up to 3.1 percent in 2018 and to achieve an average of 3.6% in 2019–20, reflecting expectations that oil and metals prices will remain stable, global trade will continue to increase, and external financial market conditions will remain supportive. Growth performance will be uneven across countries. While Nigeria, South Africa, and Angola are expected to see a gradual pick-up in growth, economic expansion will continue at a solid pace in the West African Economic and Monetary Union (WAEMU) and strengthen in most of East Africa. Despite the overall increase in the economic activity, in some countries important vulnerabilities remain. These are mainly due to slow structural transformations, lack of employment opportunities, the increase the public debt to GDP ratio and the spread of poverty. It is necessary to undertake policy actions that boost domestic revenue mobilization and improve the efficiency of public expenditure. Faster progress on poverty reduction in the region will require further acceleration in per capita income growth, supported by structural reforms that increase productivity and facilitate export diversification. In order to achieve development goals, it would be critical improving the quantity and quality of public infrastructure, especially electricity infrastructure.



2.2 Geopolitical Scenario

The area called “Sub Saharan Africa” covers 49 countries of both the hemispheres, from the Sahara Desert to the Cape of Good Hope. This is a huge area of more than 24 millions of square kilometres which has different climates and different political situations. It crosses different natural habitats: savannas, tropical forests, deserts, mountain ranges, highlands and islands. It includes some of the largest

rivers in the world as Niles, Zambezi and Congo. In the Rift Valley it’s possible to find high mountains like the Kilimanjaro (5895 m) and active volcanoes. The area includes some deserts as Kalahari. Madagascar is the biggest island while Seychelles and Comoro are two archipelagos. The population was 770.3 million in 2006. The 0.5% are European and the 2% are Asiatic. The population growth rate is 2.3% per year so that the UN forecasted that by 2050 population will reach 1.5 billion.

The continent mainly lies within the intertropical zone between the Tropic of Cancer and the Tropic of Capricorn. The region just under the Sahara Desert and the African Corn still has a semi-arid and arid climate. The same is in the Kalahari Desert. Approaching the Equator, the climate becomes tropical, very humid with the highest level on annual precipitation and the tropical monsoons during the summer. At the Equator latitude it is equatorial climate. Also Madagascar has a tropical climate. On the mountains in the African Corn and the Rift Valley the climate is alpine with permanent snow. In general, it is a hot continent with high levels of humidity.

Most of the Sub Saharan African countries refer to themselves as democratic and have leaders who are elected democratically. The democracy in Sub Saharan Africa is multi party regimes which means that there is more than one party that seeks for votes at the various levels. The majority of the countries have presidential form of government and the presidents are the rulers of the countries. Despite of these democratic situation, it is still diffused the political corruption both at

elections and after them. In November 2017, Robert Mugabe, the President of Zimbabwe was forced to resign after almost forty years of power. This 94-old man was considered one of the last former dictators of Sub Saharan Africa. Still there are few authoritarian regimes with presidents remaining at the head of the country until their death or a revolution which usually installs a democracy or another “dictator”.

The maturity of the elections in Africa is becoming more evident as the interest on issue-based politics as opposed to partisan politics becomes more pronounced. For example, Namibia was the first African country to use electronic vote in 2014. Even the social situation is changing and particularly the gender equality: in Rwanda women hold 64% of the country’s parliamentary seats. While other countries as Namibia, and South Africa women account for more than 40% of parliamentary seats and many other for a percentage from 25% to 30%.

2.3 Energy Scenario

The Africa’s energy sector plays a crucial role for the future development of the Region. The continent is huge in scale and while it has energy resources more than sufficient to meet domestic needs, more than two-thirds of its population does not have access to energy.

Economic growth and living conditions are severely constrained by a lack of power generation, transmission and distribution capacity. Over 590 million people live without electricity in the region. The Sub-Saharan Africa power sector needs greater access to capital funds, technologies and capacity building to allow the implementation of clean energy solutions. Significant investments are needed to support power sector development, and ultimately enable economic growth.

In the last years, many developing countries in Sub-Saharan Africa have made investments in national electrification that represent a key element of their national economic development strategies. Countries such as Gabon, Swaziland and Kenya perceive improved household access to electricity as valuable for enhancing economic well-being and quality of life, and improved availability and reliability of electricity for businesses as necessary for increased productivity and economic growth.

In these countries the pace of electrification has been rapid, with access rates increasing by more than 50 percent between 2000 and 2016. In contrast, electrification rate is low in Zimbabwe

declined. Overall, the household electrification rate in Sub-Saharan Africa is the lowest in the world, averaging 42 percent in 2016. There are also huge gaps in electricity access between rural and urban households. Access rates among urban households are about 71 percent, compared with 22 percent among rural households. (IEA 2014). These gaps reflect the income and wealth inequalities in the region (World Bank 2016).

National electrification plans in Sub-Saharan Africa typically have focused mainly on the expansion of the national electricity grid, with large-scale fossil fuel and hydroelectric generation facilities and, more recently, some investment in grid-scale wind and solar energy as well.

Improved electricity sector governance is a top priority for effectively expanding electricity access in Sub-Saharan Africa. Especially important are steps to rationalize electricity pricing, reduce regulatory barriers that limit private sector investment on grid or off-grid power production, make utility operations more efficient and transparent, and foster more independent sector regulation. These steps are essential to raise economic efficiency, provide a more positive investment environment, expand private sector participation, and protect the public interest. To do so, two steps are needed; first, the technological knowledge and innovation already existing in the electricity sector must be exploited. These should be taken from the more developed countries. The second step is to have local governments that are willing to support the development of the market through specific policies and regulation that boost the country's electrification.

Many countries are actively developing or are considering developing their renewable energy resource potential. Renewables potentially improve energy security by reducing the dependency on imported fuels and help diversify the power mix, improving the energy security.

Renewable energy will make up almost half of Sub-Saharan Africa's power generation growth by 2040, according to the IEA report "Africa Energy Outlook: a focus on energy prospects in Sub-Saharan Africa" (2014). The report predicts that, over the next 26 years, Sub-Saharan Africa will start to unlock its "vast renewable energy resources" and that solar energy will lead the growth in renewables in the region. In addition, much of Africa has excellent solar potential, and coastal regions hold potential for wind energy.

Renewable sources availability

Hydropower is the dominant renewable source of energy in Africa, reaching 95% of all renewable energy production on the continent, and bringing up to 20% the total power generation (on grid) coming from renewable sources. Despite this dominance, the potential of hydropower generation is still to be exploited for the most part; for now, the leading producers are Democratic Republic of Congo, Mozambique, Nigeria and Ethiopia, where the Grand Renaissance Dam will deliver more than 6000 MW to the country once completed, thus becoming the largest plant of this kind in Africa, as well as one of the largest in the world.

As for solar and wind energy, the enormous potential is yet to be fulfilled; solar plants in desert areas could cover the costs of construction in just three years, and wind energy could become a relevant source of renewable energy in Africa. Although the wind power dwindles heading southwards, in some parts of Sub-Saharan Africa the wind speed can be very high, and new projects are currently under construction in this region, that could increase power generation by 230 MW.

Another interesting possibility is the development of geothermal, as a renewable energy source concentrated mainly along the East African Rift, a particular geological formation that covers the distance between Eritrea and Mozambique (4800 km); the total potential has been estimated to be of around 15,000 MW, with Kenya leading its exploitation with ambitious future plans (5000 MW of installed capacity by 2030). Geothermal though, requires large initial investments, thus calling for the participation of private investors and experts.

3. METHODOLOGY

The final objective of the project is to develop countries ranking, listing the 10 top countries in Sub-Saharan Africa in terms of the potentials of their renewable energy investments, particularly in wind and solar PV.

The entire methodology, including the weighing of the different parameters is a result of multiple meetings with RES4Africa and thus reflects their preferences and highlights their priorities regarding renewable energy investments in Africa.

As there are 49 Sub-Saharan countries, the first approach was to do a pre-screening in order to eliminate all the countries without an acceptable profile for the investments.

First of all, all countries which are experiencing a conflict, or a post war situation were excluded:

- Mali, a civil war started between two distinct groups: the Tuareg and the separatists of the Azawad a region between Mali, Burkina Faso and Niger which are allied of Mali in the war against the separatists
- Nigeria, different groups resort to violence. The militant Islamist movement Boko Haram is active in northern Nigeria. A new generation of Niger Delta militants threatens war against the state. Government soldiers kill civilians indiscriminately. Police are notorious for extrajudicial murder.
- Central African Republic, one of the poorest countries with a civil war which moved the UN to intervene with the blue berets.
- Somalia, after the fall of the dictator Siad Barre in 1991 the country has experienced the war and in recent times also the presence of Islamic fundamentalist groups.
- Sudan, after the 20 years civil war which ended with the separation of Sud Sudan, now the country is facing a conflict with the separatist of Darfur.
- Sud Sudan; the blue berets started a new mission in this new and violent country which is risking precipitating in a new civil war.
- Eritrea, after years of civil wars and wars against Ethiopia still the situation is not normalised.
- Democratic Republic of Congo, a new epidemy of the Ebola virus spread out.

After the pre-screening phase, the different parameters that reflect the availability of SSA countries to receive investments from private companies were identified, analysed and measured, taking into consideration opportunities and barriers, such as political and economic stability, electricity demand growth, technological potential and the regulatory framework for renewables.

First of all, all countries were ranked according to the availability of wind and solar resource. The second step was to individuate the 15 countries with the highest availability of these two natural resources and to analyse the investment situation in those countries. In fact, while the solar source is well widespread across all the SSA countries, the same is not valid for the wind availability. Two of the top countries that will emerged from that final ranking of both Wind and Solar were assessed on a more specific level to provide an in-depth analysis for large equity providers that are interested in building new capacity in that country.

In order to portray all the risks involved in a new investment in that country, the individual steps of building a new solar or wind capacity were analysed and respectively all the potential risks were outlined. The analysis provided a qualitative perspective and included the assessment regarding the investment environment.

3.1 Indices

Once the 15 countries with the highest availability of wind and solar resources were selected, all the Sub-Saharan African countries taken into account were ranked based on the following indices:

1. Energy Demand Growth (5 years GDP growth forecast as proxy)
2. Political / country risks, including corruption
3. Government Credit Rating
4. Regulatory framework for renewable energy
5. Level of Grid Development

3.2 Score approach

Each parameter within the five pillars comprises a series of indices that were converted into a score ranging from 0- 100 and were weighted to generate parameter scores. In order to standardise the individual indices on the scale from 0-100, the following formula was applied:

$$Final\ Score = (Index - Min) * \left(\frac{100}{max - Min} \right)$$

With the example of Energy Demand Growth, this method results in a final score of 0 for the Sub-Saharan Country with the worst proxy which is South Sudan with an expected GDP growth of -8.2% over the next 5 years. The best country on the other hand will receive a score of 100 which in this example is Ethiopia with an expected GDP growth of 40.4% over the next 5 years, according to the IMF.

3.3 Weight approach

Having identified five determinant parameters for the screening analysis (political risk, GDP/Energy demand growth, regulatory framework, government Credit rating and electricity access), the crucial task of assigning different weights to each of them was undertaken.

First, the hierarchies between the variables were established and then the weights were assigned.

Apart from the availability of the sources, which was used to make a first screening, the political risk was considered the most important variable and as an absolutely determining factor in this investment decision, given the general uncertainty surrounding African institutions and the precariousness of the intricate political situations.

No plant can be profitable nor useful if the energy demand is scarce; the more energy is needed in that country, the more interesting an investment of this kind would be. This bare evidence was the reason why the growth in energy demand was considered the second most important drive.

The regulatory framework came a close third, since from an investor's point of view, it is one of the most difficult obstacles to overcome, especially if the regulation is unclear and subject to frequent change, and it can be decisive for the success of the whole operation.

It is then of paramount importance for an investor to ensure the liquidity of the counterpart, which in this case corresponds almost everywhere to the country's government; as a matter of fact, the Government Credit Rating of the different nations was granted the next position in the hierarchy.

Finally, the level of grid development was assigned an important weight, although relatively less relevant compared to the others; this is because it is not possible to exploit a growing energy demand without the proper grid infrastructure development.

Given these considerations, the weights were assigned in the following way:

- 30% Political Risk
- 25% Energy Demand Growth
- 20% Regulatory Framework
- 15% Government Credit Rating
- 10% Grid Development

4. DATA COLLECTION

4.1 Resource availability: PV and Wind

When investing in renewables (PV and Wind power), the first point to address is the availability of the energetic resource, respectively solar radiation and wind availability and speed.

As what concerns Sub-Saharan Africa, solar radiation is not a big deal as it is almost completely available throughout all the countries. To account for the availability of solar PV potential and wind potential on the African continent, the report published by IRENA “Estimating the Renewable Energy Potential in Africa” was taken as reference. The solar potential for each country is measured in TWh/year.

Whereas wind availability presents more complexities than solar, exceeding the only one factor of wind speed by including other factors. Indeed, it's possible find countries with high speed wind all over the territory, some other with wind available only in limited areas, typically coasts, and Central African countries with low speed wind. Hence, in the analysis are excluded those countries without wind availability. To account for availability of Wind, the wind power potential in TWh/year was used.

Country Name	Potential (TWh/y)	Country Name	Potential (TWh/y)
South Africa	48830.4	South Africa	48830.4
Kenya	28662	Kenya	28662
Tanzania	21540.4	Tanzania	21540.4
Ethiopia	19821.1	Ethiopia	19821.1
Mauritania	16100.3	Mauritania	16100.3
Niger	15945.8	Niger	15945.8
Namibia	15697.9	Namibia	15697.9
Zambia	14389.6	Zambia	14389.6
Chad	11262.7	Chad	11262.7
Mozambique	11206.1	Mozambique	11206.1
Botswana	10096	Botswana	10096
Senegal	5780.6	Senegal	5780.6
Burkina Faso	4161.5	Burkina Faso	4161.5
Madagascar	2927.9	Madagascar	2927.9
Malawi	2290.5	Malawi	2290.5
Cameroon	994.9	Cameroon	994.9
Ghana	608.4	Ghana	608.4
Swaziland	485.7	Swaziland	485.7
Cote d'Ivoire	430	Cote d'Ivoire	430
Gambia	174.3	Gambia	174.3
Guinea-Bissau	124	Guinea-Bissau	124
Central African Republic	79	Central African Republic	79
Source: IRENA, 2014		Source: IRENA, 2014	

4.2 Energy Demand Growth

In order to account for the increase in electricity demand in the Sub-Saharan countries and due to a lack of appropriate data, the 5-year GDP growth forecast according to the IMF was used as a proxy. In fact, as shown by various studies, there is a strong positive correlation between the level of GDP and the total electricity demand, thus for the purposes of comparison, the GDP growth forecast acts as sound indicator in that respect.

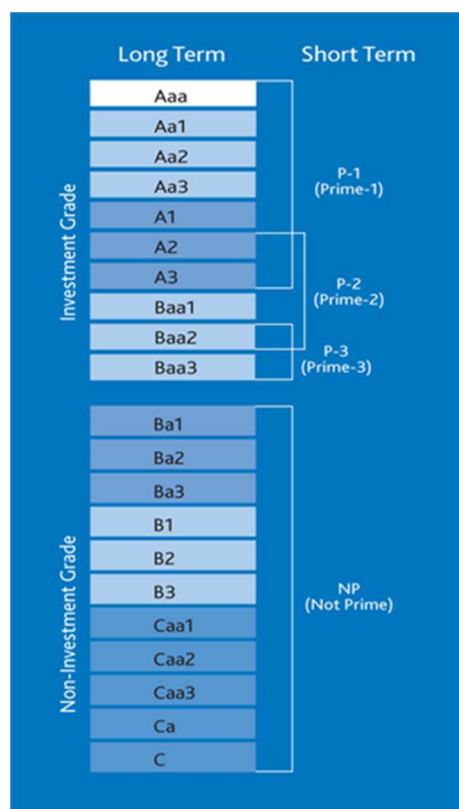
4.3 Political/Country Risk

The political risk of a country is one of the first variables which is taken into consideration by investors in approaching a new country, and particularly in a continent as Africa where the political instability is relevant also for that countries where there are no conflicts. Political instability makes investments difficult to be developed.

To assess the political risk in all the SSA countries, the Worldwide Governance Indicators (WGI) developed by the World Bank was used.

The WGI project reports aggregate and individual governance indicators for over 200 countries and territories over the period 1996–2016, for six dimensions of governance:

- Control of Corruption; captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.
- Government Effectiveness; captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.
- Political Stability and Absence of Violence/Terrorism; measures perceptions of the likelihood of political instability and politically-motivated violence, including terrorism.
- Regulatory Quality; captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.
- Voice and Accountability; captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of associations, and a free media.
- Rule of Law; captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence.



4.4 Government Credit Rating

Another important and fundamental indicator applied was the Government Credit Rating which shows the capacity of the government to face its debts as they come to due. The used score was the one given by Moody's, the international rating agency. The score followed the scale presented in the image, where Aaa is the best rating and C is the worst one.

Source: Moody's, 2018

4.5 Grid Development

The next parameter used for the ranking is the grid development, which has been assumed comparable to the level of access to energy. The main reference source was the World Bank Electrification Database.

4.5 Regulatory Framework for Renewable Energy

To assess the Regulatory Framework for Renewable Energy, the reference source used was the Regulatory Indicators for Sustainable Energy (RISE). RISE project is a collaboration between the Global Energy and Extractives Practice and the Development Economics Global Indicators Group of the World Bank Group.

This indicator captures multi- dimensional aspects of policies and regulations for renewable energy:

- Legal framework for renewable energy; fundamental signal of a government's commitment to make use of its renewable resources.
- Planning for renewable energy expansion; indicates if the government communicated how to meet the target, for example through a strategy or action plan, if it defined the required

investment to meet the target and if the Government implemented a monitoring system to assess the progress toward the target

- Incentives & regulatory support; captures all the financial and regulatory incentives for renewable energy set by the Government such as feed-in tariff, competitive bidding/auction, mandates, generation premiums, production tax credits, capital subsidies, grants or rebates, investment tax credits and tax reductions
- Attributes of financial and regulatory incentives; indicates if policies are clear, predictable, and financially sustainable in the long term.
- Network connection and use; assesses whether the connection cost allocation are defined
- Counterparty risk; assesses the transparency and creditworthiness of the selected utility, and whether the government provides mechanisms to reduce the risk of non- or delayed payment.
- Carbon pricing and monitoring; assesses the status and extent of a carbon pricing and monitoring regime.

5 RESULTS

After selecting the 15 best countries for source availability, the value for the other parameters were found, and each of them was considered according to the weight decided.

This provided a ranking for the wind source of energy:

Country Name	Political Score 30%	5y GDP Score 25%	RE S Regulatory Score 20%	Gov Credit Score 15%	Grid development 10%	Final Score Wind
South Africa	77.94	35.19	100.00	69.23	82.90	70.85
Senegal	67.55	87.86	77.37	46.15	61.58	70.79
Botswana	94.28	60.91	26.24	100.00	57.46	69.50
Kenya	51.74	81.07	91.45	38.46	52.39	65.09
Tanzania	57.66	85.39	84.98	38.46	27.28	64.14
Namibia	83.80	53.09	35.94	61.54	47.82	59.61
Ethiopia	40.03	100.00	63.51	38.46	38.21	59.30
Malawi	56.20	73.46	93.76	30.77	3.69	58.96
Zambia	60.55	63.17	65.13	23.08	21.24	52.57
Burkina Faso	57.92	77.37	43.42	23.08	12.53	50.12
Niger	49.16	78.19	7.39	69.23	32.42	49.40
Madagascar	48.09	70.99	45.96	0.00	16.57	43.02
Mauritania	45.19	79.42	7.39	0.00	36.86	38.58
Mozambique	44.01	56.58	39.96	0.00	17.97	37.14
Chad	25.79	64.61	22.41	0.00	1.34	28.50

And the same for the solar:

Country Name	Political Score 30%	5yGDP growth Score 25%	RES Regulatory Score 20%	Gov Credit Score 15%	Grid Development Score 10%	Final Score Solar
South Africa	77.94	35.19	100.00	69.23	82.90	70.85
Botswana	94.28	60.91	26.24	100.00	57.46	69.50
Cote d'Ivoire	52.23	86.01	78.98	69.23	61.37	69.49
Ghana	70.91	71.40	86.15	23.08	77.60	67.57
Kenya	51.74	81.07	91.45	38.46	52.39	65.09
Tanzania	57.66	85.39	84.98	38.46	27.28	64.14
Namibia	83.80	53.09	35.94	61.54	47.82	59.61
Ethiopia	40.03	100.00	63.51	38.46	38.21	59.30
Zambia	60.55	63.17	65.13	23.08	21.24	52.57
Cameroon	39.50	69.14	54.74	30.77	56.80	50.38
Burkina Faso	57.92	77.37	43.42	23.08	12.53	50.12
Niger	49.16	78.19	7.39	69.23	32.42	49.40
Mauritania	45.19	79.42	7.39	0.00	36.86	38.58
Mozambique	44.01	56.58	39.96	0.00	9.34	36.28
Chad	25.79	64.61	22.41	0.00	1.34	28.50

After having assigned weights, the final ranking obtained for the countries was the following one:

Top 10 Wind	Top 10 Solar
South Africa	South Africa
Senegal	Botswana
Botswana	Cote d'Ivoire
Kenya	Ghana
Tanzania	Kenya
Namibia	Tanzania
Ethiopia	Namibia
Malawi	Ethiopia
Zambia	Zambia
Burkina Faso	Cameroon

6. FOCUS COUNTRIES

The countries selected for a further analysis are Senegal and Cote d'Ivoire. Even if these countries are not in the first positions, they present interesting characteristics and new opportunities from the point of view of investments in the energy sector and particularly for renewable power generation. On the contrary, countries with a better final score, as South Africa and Kenya, already have a relatively stable situation regarding renewables since many projects have already been implemented and considerable knowledge already exists about them. It was also decided to exclude countries like Botswana, which had a higher final score, because the size of their populations was deemed insufficient to generate interesting opportunities for large-scale investments.

6.1 Country Focus for Wind Power - Senegal

GDP	14.79\$BN
FIVE-YEAR ECONOMIC GROWTH RATE	4%
POPULATION	15.41 M
INSTALLED POWER CAPACITY	0.76 GW
RENEWABLE SHARE	6%
TOTAL CLEAN ENERGY GENERATION	7.00 GWH

Political and Economic Situation

Senegal is a country located in the north west part of Africa, on the Atlantic coast. It also completely contains the state of Gambia. Senegal is a country 15.3 millions of inhabitants, located both in big cities both in rural area. Over 23% of the total population lives in only 0.3% of the



territory: the Dakar region, where there is the capital city, due mainly to the inflow of people from the countryside attracted by job opportunities. This raised the demand for socio-economic infrastructure and the issue of sustainable urban management, to guarantee acceptable life condition for the population.

Senegal is one of the most politically stable countries in Africa and has considerably strengthened its democratic institutions since its pacific independence from France in 1960. In March 2016, the country further reinforced its political system by a referendum.

In the past few years Senegal's economic performances were steady above the average, making the country the second fastest growing economy in West Africa, behind Côte d'Ivoire. Growth remained strong in 2016 with a rate of 6.4%. The main industries include food processing, mining, cement, artificial fertilizer, chemicals, textiles, refining imported petroleum, and tourism. Exports include fish, chemicals, cotton, fabrics, groundnuts, and calcium phosphate.

Inequality in Senegal is moderate, and slightly lower than the Sub-Saharan African average. However, poverty remains high, affecting 46.7% and with very pronounced geographic disparities, especially in rural areas where almost two thirds of the population is poor. GINI index has a value of 40,67 (2011 data).

Energy Sector

Senegal is relatively poor of natural resources so that it has to import, mainly crude oil and gas. To meet the steady increasing demand, the government built some diesel and coal generation plants (581.4 MW of installed capacity) and it's launching a program to exploit recent discovered offshore gas reserves. The government also set a target for the production from renewables: 15% by 2020. The emphasis on renewable energy can be inferred from the adoption of two laws aiming at increasing the share of renewables and biofuels. The legislation provides for a feed-in tariff, although this has not yet been implemented.

The electrification of the country is carried out by the State with positive results: 61% of the electricity access has been reached considering both the main grid and mini grid projects, although

there is still a considerable difference between urban areas (88%) and rural ones (40%). (Financial Times, 2018)

The energy sector was reformed in 1998, creating three entities:

1. Senelec, the national utility with monopoly on transmission and distribution;
2. The National Rural Electrification Agency which carries out the electrification of the country;
3. The Electricity Regulatory Board, aimed to guarantee equal treatment both to public and private producers.

Half of the electricity need is produced by Senelec, while the other half is distributed between IPPs, in fact Senegal was the first country in Africa to allow private generation of electricity.

The energy market is shifting towards privatization as Senelec presence becomes less and less dominant; this combined with a partially unbundled power sector as well as an improved environment for project development, has led to an outstanding growth of investments in power generation in the last two years. It is also the willingness of the government to boost power production, as in the past five years a 25% increase in generation capacity has been observed; the objective is to reach universal electricity access by 2025, while also reducing the prices, which have been kept high until now due to the reliance on imported oil. Given these targets, it is evident that renewable energy sources can play a critical role in their fulfilment; as a matter of fact, the government has developed clean energy policies and targets to attract foreign investment, also relying on the dwindling costs of renewable generation.

Recent developments in renewables

New projects of both wind and solar are being developed right now in Senegal, and they will contribute for 350 MW to the national power generation. The most important of them, is probably the wind farm planned to be built at Taiba n'daye (80km north-east of Dakar) by Lekela Power, which, as it happens in many other projects of alike features, consists in a combination of private equity capital and development finance. The project is receiving a funding support of \$250mln from the American investing programme "Power Africa" and it is about to reach its financial closure. The plant, with its 158 MW of capacity, will represent the 15% of the national generation capacity, being the first utility-scale wind farm in Senegal as well as the largest in West Africa. Finally, the project is being implemented following a sustainable model, trying to develop local

skills and bring benefit to the local community; this is done through the hiring of local workers and managers as well as by building roads and providing drainage for the farmers' well-being.

Although this research has highlighted wind power as the most promising renewable energy source in Senegal, solar is growing alongside it, even if it is still at an early stage of development; the Scaling Solar programme is present in this country and, as part of it, an auction has recently been won to build a 60MW of capacity.

With the purpose of promoting rural electrification, the government is assigning 10 concession areas for the generation, retail and distribution of energy, guaranteeing a 25 years monopoly on these activities; as of 2017, already 6 areas had been assigned.

This impressive growth in renewable generation capacity (from zero to 20% by the end of the next year) generates also some problems and risks. The main concern regards the grid's development and management; it is true that Senegal has improved the latter, reducing the frequency of blackouts, but it is obvious that more investment will be strictly necessary in order to absorb the surging amounts of renewable power. To make things worse, the intermittency and volatility of renewable energy supply will make the management of the grid even more challenging. For this reason, there is a possibility, that the technical limits will be reached while the generation capacity is still growing, thus making further investments riskier in view of a possible stagnation period, that would be generated by the misalignment of grid and generation development. Another important risk is represented by the recent discovery of gas reserves off the coast of Senegal, in that it could divert the public investment from the development of the grid, to the building of pipelines and other infrastructure needed to exploit them; moreover, natural gas in many markets takes the role of a direct competitor to renewables and in Senegal, new thermal power stations, recently built or under construction, are designed to run both on oil and gas, in order to be ready when the latter will be available (likely starting from 2022).

However, with the energy demand growing at a fast pace (40-50MW per year), it is true that different sources will be equally necessary to satisfy it, as well as large inflows of investment with the decisive cooperation of the public and private sector.

Relations with neighbouring countries

Senegal is not energetically isolated by the rest of the other countries, while it is connected with its neighbours. The country is part of the West Africa Power Pool; an organisation with the aim to integrate the national power systems into a unified regional electricity market with the ultimate goal of providing in the medium and long term, a regular and reliable energy at competitive cost. Members States are: Gambia, Mauritania, Mali, Benin, Burkina Faso, Côte d'Ivoire, Guinea, Guinea-Bissau, Liberia, Togo, Niger, Sierra Leone, Nigeria, Ghana, Sierra Leone. According to the WAPP, many initiatives were taken in the area to improve the energy exchanges between the different States.

The majority of Senegal's electricity imports are from the Manantali hydro power plant in Mali, which counts for a 10% of the total installed capacity. Between Senegal and Mauritania has been built transmission lines to encourage energy exchanges between the two countries, which are mainly from Mauritania to Senegal. In 2017 Senelec and the National Water and Electricity Company of Gambia (NAWEC) signed a power purchase agreement with the deal of supply Gambia with electricity from Senegal: from 3 MW to 10 MW immediately, with future expansion as the capacity of the network grows.

Senegal also borders with Guinea and Guinea-Bissau. Guinea-Bissau is almost completely dependent from Senegal for electricity as a result of long conflicts.

The situation with Guinea is different and it is changing. Guinea has traditionally imported electricity from the neighbouring countries, mainly Senegal. Since the country started being able to exploit the potential of its hydro resources thanks to WAPP program, Guinea is becoming an exporter of electricity to Senegal. This transmission already existing can boost the role of net exporter of electricity of Senegal if it decides to implement all the projects in renewables.

6.2 Country Focus for PV - Cote D'Ivoire

GDP	35.49 \$BN
FIVE-YEAR ECONOMIC GROWTH RATE	31%
POPULATION	23.70 M
INSTALLED POWER CAPACITY	1.85 GW
RENEWABLE SHARE	3%
TOTAL CLEAN ENERGY GENERATION	170.00 GWH

Political and economic situation

Côte d'Ivoire is the largest economy in Francophone West Africa and has rapidly recovered after a decade of conflict and stagnation that ended with a civil war in 2011. The civil war was caused by ethnic and religious divergences as well as land scarcity issues. After the elections held in 2010 the winner, Alassane Ouattara, took steps to calm the political climate by releasing pro-opposition prisoners, allowing the return of high-level political refugees and unfreezing their bank accounts. Consequently, the October 2015 presidential election was also very significant in the consolidation of political peace, with incumbent President Alassane Ouattara re-elected



with 83.7% of the vote. The main challenges of his new five-year term are to ensure social cohesion, strengthen civil peace and improve the justice system. The current growth expansion, which started in 2012, is still going on—with an average annual growth of about 9 percent. Côte d'Ivoire's economic growth can be attributed to its thriving agriculture, services, industry, and the

influx of foreign direct investment attracted by the improved business climate, structural reform and fiscal policies. The country has many obvious advantages, including a denser road network than in most African countries and several kinds of farmland and climate that enable the development of a range of agro-industrial and food products in big demand worldwide. It also has an expanding gold mining industry and 51 oil blocks. Côte d'Ivoire is the world's largest producer and exporter of cocoa beans and a significant producer and exporter of coffee, cotton, cashew and palm oil. It is heavily dependent on agriculture and related activities, which employ roughly two-thirds of the population. Because of the success of the National Development Plan (PND 2012 – 2015) in reforming the economy, the government decided to create and adopt a new plan (PND 2016-2020), which is aimed at making Côte d'Ivoire a solid industrial base by 2020. It will therefore focus on processing more extensively local agricultural raw materials and diversifying the industrial apparatus by promoting manufacturing. It will also focus on improving living conditions for Ivorians, especially by developing quality economic infrastructure while embracing the concerns relating to land development and environmental conservation.

Energy Sector

The growing economy of Côte d'Ivoire puts the current power supply under pressure. The government thus set goals to increase its power production capacity by 2020 to about 4,000 MW and 6,000 MW by 2030 to meet the rising demand. In addition, the country aims to play a central role as a net exporter in the West African Power Pool. Côte d'Ivoire relies to a large extent on Independent Power Producers (IPPs) to generate and supply electricity to meet the growing energy demand. There are currently 3 IPPs in Côte d'Ivoire; they are Azito Energie, Ciprel and Aggreko. The country has a total installed capacity of 1,886 MW (2016) and produced a total of 8,618 GWh in 2015. As of 2017, 81% of the electricity is produced by thermal power stations while 19% is generated by hydropower plants. In its Strategic Plan for the Development of the Electricity Sector by 2030, the government identified 66 projects that will require significant investment from the private sector, including through public private partnerships with Independent Power Producers, to expand power capacity production and to modernize the transport and distribution of electricity throughout the country. Efforts are underway to increase hydroelectric and thermal electricity generation with construction of new dams and thermal power plants as well as expansion projects at existing thermal power plants. The government is also increasing its focus on rural electrification and encouraging the production of new and renewable energy sources. Renewable energy is

planned to constitute 15% of the supply mix by 2020 and 20% by 2030. Ministry of Petroleum, Energy and Renewable Energy Development is responsible for national energy policy and coordination of the activities in the sector. The Ministry sets the sector’s framework. It monitors electricity production, distribution transmission equipment, social electrification and the promotion and management of renewable energies.

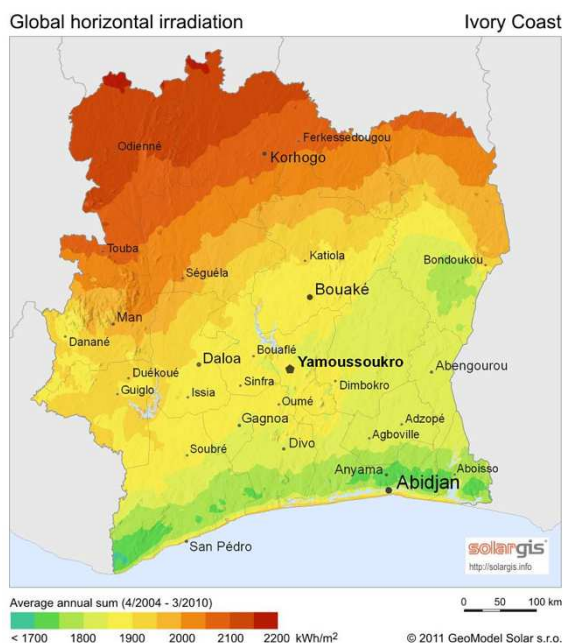
Renewable Energy Potential

Cote d’Ivoire is beginning to recognize the potential of renewable energy, especially after Thierry Tanoh was elected as Minister of Petroleum, Energy and Renewable Energy Development in January 2017. Tanoh has publicly stated that clean energy is an “important” sector, which can contribute to economic development and electricity access. No utility-scale renewable energy projects, aside from large hydro, have yet been installed.

Information and data on renewable energy resource and market potential in Côte d’Ivoire are limited. The remaining large hydropower potential has been roughly estimated in the past. Solar irradiation levels indicate good potential for PV installations and biomass power potential is thought to be considerable. According to existing data, wind and geothermal energy have a comparably low potential for electricity production.

Solar Potential

Côte d’Ivoire receives abundant solar energy. The solar potential in the country ranges from 2.0-6.0 kWh/m²/day, with an average of six hours of sunshine a day. The solar energy resource is generally greater in the north of the country. The annual potential for photovoltaic installations is 10,325 TWh. In terms of solar projects, a 20 MW solar power plant in Korhogo and a 50 MW power plant in the Poro region are due to be commissioned in 2017. In addition, public lighting projects using solar street-lamps are ongoing. The Strategic Action Plan for the Electricity Sector by 2030 has plans to retrofit existing rural diesel grids with PV. Furthermore, household applications and isolated



PV grids will play a major role in rural electrification. The Plan foresees the completion of at least 12 pilot projects in rural areas.

Côte d’Ivoire to install 25MW PV plant

Cote d’Ivoire’s first utility-scale solar plant is expected to be connected to the grid in 2018 – 2019. Korhogo Solaire, a subsidiary of Morocco’s Nova Power, will build a 25MW facility in the Northern Province of Korhogo. The plant will cost 240 million to construct and is intended to start the country on the path toward a more balanced energy mix. The additional facilities would help Cote d’Ivoire meet its goal to generate 11% of its final energy consumption from renewables by 2020, and 16% by 2030.

7. CONCLUSIONS

Investing in Sub Saharan African countries presents unique characteristics compared to other geographical areas, and the situation might also change considerably from country to country.

Since these are developing countries, they present a higher risk. This is due to the political situation which, despite experiencing a general improvement towards stability, still presents situations of high instability because of conflicts, terrorism, revolutions and crisis.

The risk profile also considers the different economic situations of the countries. Within a general growth of the Sub Saharan Africa, it is possible to find at the same time developed economies, fast-growing economies and situations of deep economic crisis. This affects the country's rating and its capacity to pay debts when they come due.

Investing in the energy sector is even more complicated since investors should consider the regulation of each country, which may be substantially different. However, analysing the legislation it is generally possible to find some common issues among them: African countries, for instance, are planning on average to increase the level of the electrification and consequently the power generation. This is made first of all to assure a decent standard of life to the population; secondly, to support the economic growth and to meet an increasing energy demand. In order to reach these targets, the Sub Saharan African countries are adopting some common measures that aim at scheduling the energy growth as: the liberalisation of the energy sector with the entrance of independent power producers; the creation of standardised power purchase agreement to facilitate new businesses; the involving of international institutional bodies as the World Bank of the International Monetary Fund. All these aspects can make investments in the energy sector in Sub Saharan African countries both easier and more profitable.

And even more profitable can be considered investing in renewables since the world is moving everyday towards more sustainable sources of energy, as also showed by the commitments taken in the Paris Agreement; the technology is getting less expensive quite fast and for sure another important advantage, peculiar to this case, is the generally high availability of natural resources over the continent, mainly in the forms of wind and solar, which pushed the different governments to set objectives regarding the share of energy coming from renewable sources.

Considering all these factors, this report provided a general ranking of the Sub Saharan countries. However, it is important to underline the limits of the final list. As mentioned, this geographical

area is undergoing continuous changes, trying to improve under several aspects, thus regulations are being modified, international companies sign new projects, governments allocate capital for the development of the grid. This implies that the final ranking has only a temporary validity and should be periodically reviewed as single indicators may change their score.

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