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ENSURING SUSTAINABLE ELECTRICITY FOR ALL IN WEST AFRICA THROUGH INNOVATIVE DECENTRALIZED RENEWABLE ENERGY SOLUTIONS:

An Analysis of Ivorian Context

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Date:

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Declaration

I am Moro Aimé Apollinaire Bosson; hereby declare that this thesis represents my personal work, realized to the best of my knowledge. I also declare that all information, material and results from other works presented here, have been fully cited and referenced in accordance with the academic rules and ethics.

……... …….

MORO AIME APOLLINAIRE BOSSON **DATE**

…….. …….

Supervisor **DATE**

YACOB MULUGETTA

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Contents

List of abbreviations

CIE :	Compagnie Ivoirienne d'Electricité
DESCO:	Distributed Energy service company
DMP:	Distribution Master plan
DRE:	Decentralized renewable energy
DS:	Decentralized system
ECOWAS:	Economic Community of West Africans States
ECOWREX:	Ecowas observatory for renewable energy and energy efficiency
EFAP:	Energy for All Program
ESCO:	Energy services Company
ESMAP:	Energy Sector Management Assistance Program
FR CFA:	Franc Cfa (Ivorian currency) 1 USD: 570 CFA
GSM:	Global System for Mobile Communications
GIZ:	Gesellschaft Fur Internationale Zusammenarbeit
GOGLA:	Global Association for Off-grid Solar Industry
GOVCI:	Government of Cote d'Ivoire
IDRES:	Innovative Decentralized Renewable Energy Solution
IEA:	International Energy Agency
IRENA:	International Renewable Energy Agency
Kw:	Kilowatt
LED:	Light Emitting Diode
LIFI:	Light Fidelity
MDG:	Millennium Development Goal

Mw:	Megawatt
NDP:	National Development Plan
NIPAES:	National Investment Program for Access to Energy Services
NPRORE:	National Program for Rural Electrification
PAYGO:	Pay as you go
PV:	Photovoltaic
REMP:	Rural Electrification Master Plan
RISE:	Regulatory Indicator for Sustainable Energy
SGD:	Sustainable Development Goal
SHS:	Solar Home System
UEMOA:	West Africa monetary and economic union
UN:	United Nations
UNSE4ALL:	United Nation Sustainable Energy for all Program

List of Tables

List of Figures

Abstract

The purpose of this study is twofold. On the one hand, remind African and international policymakers that access to energy is a basic right needed for the realization of other rights. On the other hand, it seeks to find the appropriate means to ensure access to this important right for the poorest people in West Africa and Côte d'Ivoire in particular, in a sustainable way. Our hypothesis is that; the energy policies in place do not allow in the current path and will not allow, following the current paradigm, to achieve the objective 7 of the SDGs in 2030. Innovation at all levels is the key that can enable populations to have access to a modern, sustainable electricity at a lower cost and promote sustainable local development.

However, this requires a paradigm shift in African countries' electrification conceptions and better energy access policies geared towards sustainability goals. In other words, by promoting innovative decentralized renewable energy solutions and better planning for rural electrification. To conduct our study, we proceeded to an evaluation of the energy access and rural electrification policy in Côte d'Ivoire as well as the real case study scenario. We focused our investigations on the project of productive use of energy of the village of donvagne, Lifi led project implemented in the village of Drongouine and a case study of the pay as you go market in Ivory Coast and in Senegal. At the end of our research, the results collected from Rise 2017 showed that access to energy suffers from its average planning and the weak accent marked by proactive policies in rural electrification and decentralized systems. In addition, the study reveals that the presence of the network in a locality does not automatically mean that households have access to electricity. This presence of the grid in rural areas does not contributes ex nihilo to local development even less to the sustainable development of communities. Finally, technological and financial innovation (Lifi led and pay as you go) can be powerful means to accelerate access to energy and its impacts in rural areas.

Indeed, the decentralized approach to planning; Coupled with the nature of decentralized renewable systems and solutions can have more sustainable impacts on urban and rural peri-urban communities if they target the productive use of energy and the innovative and adapted diversification of electricity uses and services. A combination of solutions (network extension and decentralized systems depending on the realities involved), and the promotion of innovation at all levels: political, technological and financial; ensure sustainable access to electricity in West Africa more quickly and efficiently.

Key words: Ensuring, Sustainable electricity access, Basic right, west Africa, Innovative, decentralized renewable energy solutions, Poor’s, SDG’s, local development, Cote d’ivoire.

Résumé

Le but de cette étude est double. D'un côté, rappeler aux décideurs Africains et internationaux, que l'accès à l'énergie est un droit basic nécessaire pour la réalisation d'autres droits. D'un autre côté, elle vise à rechercher les moyens adéquats pour assurer l'accès à ce droit important aux populations les plus pauvres en Afrique de l'ouest et en Côte d'ivoire particulièrement, et ce de façon durable. Notre hypothèse est que ; les politiques énergétiques en place ne permettent pas en l'état actuel et ne permettront pas en suivant le paradigme actuel, de réaliser l'objectif 7 des ODD en 2030. L'innovation à tous niveaux est la clé qui peut permettre aux populations d'avoir accès à une source d'électricité durable, moderne à moindre cout et favoriser le développement local durable. Cependant ceci passe par un changement de paradigme dans les conceptions d'électrification des pays africains et par de meilleures politiques d'accès à l'énergie axées sur des objectifs de durabilité. En d'autres termes, en faisant une plus grande place aux solutions innovantes décentralisées basées sur les énergies renouvelables et une meilleure planification de l'électrification rurale. Pour conduire notre étude, nous avons procédé à une évaluation de la politique d'accès à l'énergie et de l'électrification rurale en Côte d'ivoire ainsi que la mise en situation réelle à l'aide de cas d'études. Nous avons axé nos investigations sur le projet d'usage productif de l'énergie du village de Donvagne, le projet Lifi led mis en œuvre dans le village de Drongouine et une étude de cas du marché du pay as you go en côte d'ivoire et au Sénégal. Au terme de notre recherche, les résultats collectés à partir de Rise 2017 ont montré que l'accès à l'énergie souffre de sa planification moyenne et du faible accent marqué par des politiques volontaristes en matière d'électrification rurale et systèmes décentralisées. De plus, l'étude révèle que la présence du réseau dans une localité ne signifie pas automatiquement accès des ménages à l'électricité. Cette présence du réseau en milieu rural n'apporte ex nihilo, le développement local encore moins le développement durable des communautés. Enfin l'innovation technologique et financière (Lifi led et pay as you go) peuvent être des moyens puissants pour accélérer l'accès à l'énergie et ses impacts en milieu rural. En effet, l'approche décentralisée menée pour la planification ; couplée à la nature des systèmes et solutions renouvelables décentralisées permettent d'avoir plus d'impacts durables sur les communautés péries urbaines et rurales si celles -ci visent l'usage productif de l'énergie et la diversification innovante et adaptée des usages et services électriques. Une combinaison de solutions (extension du réseau et systèmes décentralisées en fonction des réalités en présence), et la promotion de l'innovation à tous les niveaux : politiques, technologiques et financier ; permettraient d'assurer l'accès durable à l'électricité en Afrique de l'ouest plus rapidement et efficacement.

Chapter 1: General Introduction

In his vision statement for the launch of the United Nations Sustainable Energy for All (UNSE4ALL) initiative, Secretary General Ban Ki-Moon stresses the need for a shift in perspective as he asserts that:

"Building out a national electricity grid has historically been a successful strategy for achieving high rates of energy access in many countries, but it is not as well suited to serving sparsely populated or remote areas. Such solutions require business models that are commercially viable, entrepreneurial supply chains that can reach remote areas, increased consumer acceptance, community-based service delivery models and innovative financing mechanisms (Nique.M, 2013)

The UNSE4ALL initiative was borne out of the 2015 Sustainable Development Goals SDG's Many African countries, including all the West African countries gathered on September 25th 2015 in New York to set up 17 sustainable developments Goals agenda. His aim is to lead and guide worldwide policies (International; regional; governmental and local policies) in order to eliminate poverty, reduce inequality, fight against climate change and social injustice.

They are a bold commitment to finish what our generation has started with MDG in 2000 and tackle some of the most pressing challenges facing the world today

Among these goals, SDG7 calls for us to "secure access to accessible, reliable,

Sustainable, modern energy for all by 2030" (UN, 2017). Translating this will into measurable goals gives rise to the pillars of the UNSE4ALL initiative:

1) Ensure universal access to modern energy services by 2030,
2) Double the global rate of improvement in energy efficiency, and
3) Double the share of renewable energy in the global mix (UNSE4ALL, 2017). Throughout my thesis, the emphasis is on the goal of u (Singh, 2001) universal energy access. To be concise and more efficient, we have chosen to analyze electricity access for rural and peri urban communities because it's the most challenging part of the iceberg when it comes to problems related to energy in developing countries

In this thesis; clean cooking and energy for transportation which are also important areas of energy access will not be covered. We will focus our research on electricity access for all in the Ivorian context regarding his importance on development and energy plan.

At the background of this research, there is this picture:

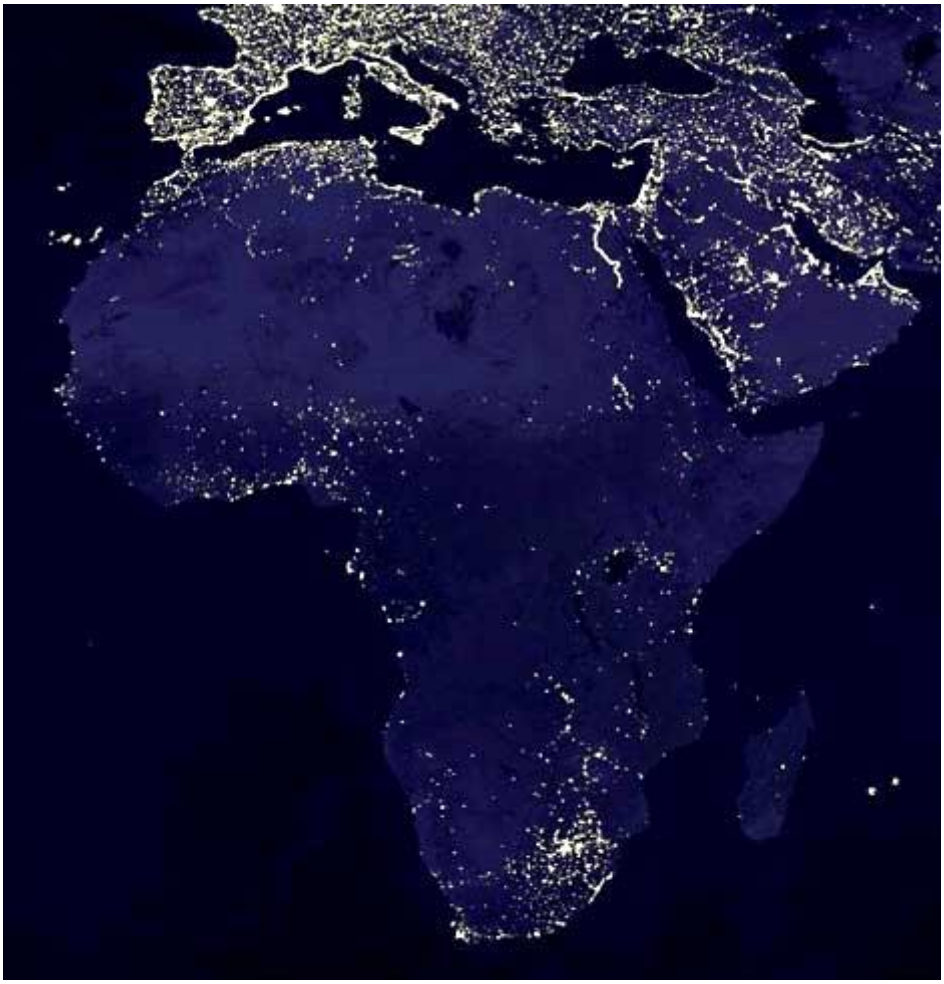

Figure 1: Africa at night

This map with Africa in dark at night is a drama, when we know the renewable potential of the continent. Despite the efforts, programs, funds and finances flowing and emerging, electricity access remains a critical issue for sub-Saharan communities principally for those living in rural and peri-urban areas.

This research turns around one curiosity. What are the causes of that situation despite the fact that several countries like Nigeria, Cote d'Ivoire and many others African countries have invested a lot of billion in electricity sector?

Many reasons are behind that for sure but what are the most relevant that need to be addressed?

We have only 12 years to reach the SDG's deadline. And at this stage (3 years) after SDG's agenda adoption, a midterm analysis of countries actions in line with their international and national commitment toward SDG's agenda objectives is needed.

This research will permit to assess the ongoing policies regarding Goal 7 and suggest some methods and solutions in order to achieve 100 per cent electricity access for all by 2030.

Achieving this target contribute in the same time to realize the SDG's agenda objectives

To reach that goal, various solutions exist, but we have chosen to bring some examples and cases studies of innovative decentralized renewable energy solutions (IDRES) as complementary and viable tools for ensuring sustainable electricity for all in West Africa and in Cote d'Ivoire particularly

1.1 Justification and context of the research

- **International energy access achievements**

Population without access to electricity by region

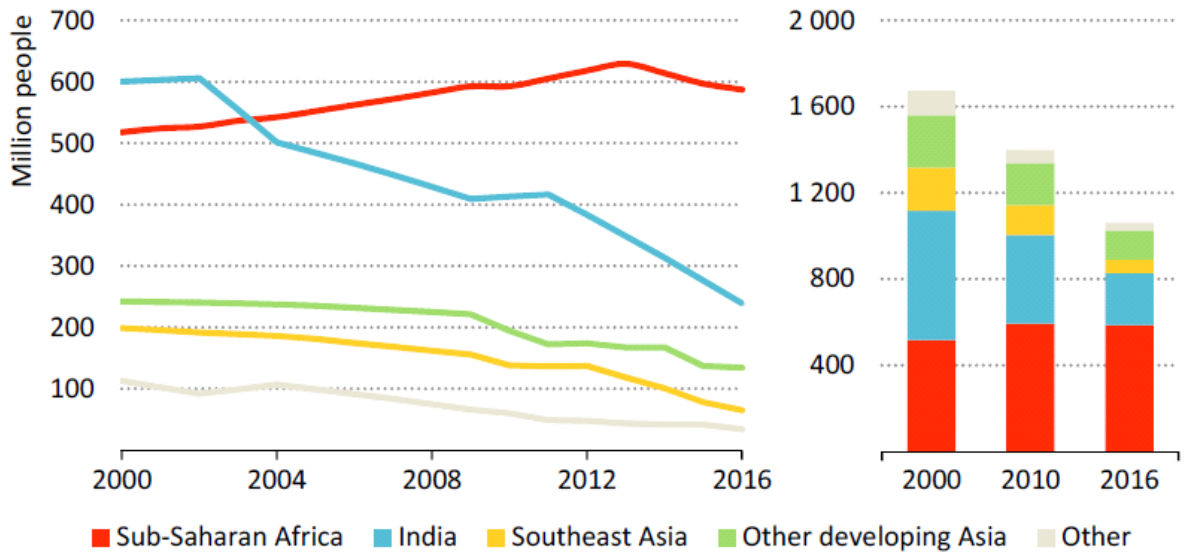

Figure 2: Population gaining access to electricity per region

(Source IEA)

- Since 2000, nearly 1.2 billion people have gained access

- In 2016 1.1 billion people without access
- By 2030, there will be 674 million people without access (on business as usual)

We notice easily notice with these graphs that worldwide people living without electricity rate is going down in all the regions of the world excepted sub-Saharan Africa since 2016. its means that the efforts done at international level to increase energy access are led by India which is the country with the high performances followed by other developing Asian countries like China and Bangladesh but also south east Asia performance.

The reason behind that can be explain by the constant political will of these countries to increase electricity access principally in places where the need where very high (rural and peri urban areas). Electricity access has been placed since the end of 1990's in India and South East Asia as core priority of policies and development plans (reference)

In the same time, an importance notice of the performances of these countries need to be done. Three remarks need to be done:

- They have invested a lot in renewable energies principally solar and mini hydro
- They are leading the market of off grid and mini grids
- Rural electrification is the key priority of electrification and energy access policies

In the other hand, it appears clearly that the sub-Saharan African countries are the bad students in energy access worldwide. Both graphs show it. All the regions have done significant performances excepted those countries. but since 2014 the curve is decreasing slowly. This situation can be explained by the performances of eastern countries like (Tanzania, Ethiopia, Kenya leading the way) and the efforts in rural access done by countries like Senegal, Ghana, South Africa. In the same time 2014 means the boom of shs pay as you go in East Africa. figures today can permit to make some links between this boom of solar off grid solutions and increase in energy access in East Africa

One remark can be done. Sub-Saharan Africa is the region where investments in renewables and decentralized solutions are the lowest expected East Africa

- **Evolution of population without access to electricity (Highest share in west Africa)**

These 2 graphs highlight the share of population lacking electricity per country and a scenario of people without access to electricity from 2000 to 2030 per region.

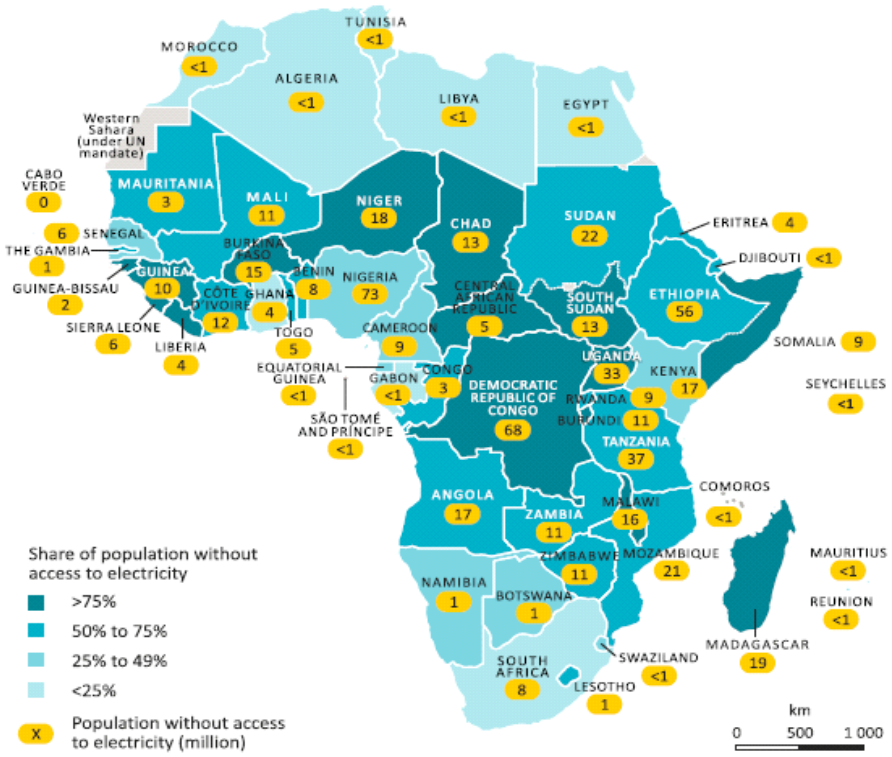

Figure 3: Population without access to electricity per country Africa

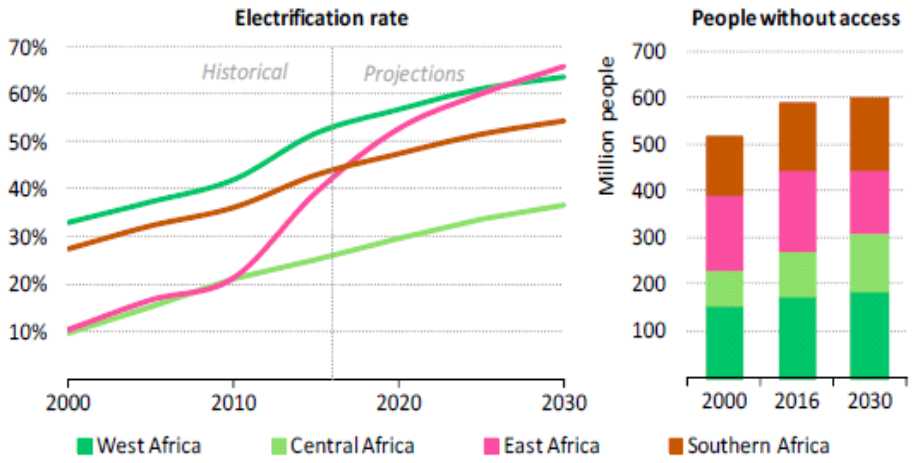

Figure 4: Electrification rate forecast 2030 by region

- **Rising of innovative electrification models worldwide**

The general notice is that decentralized solutions are recognized as reliable systems of electrification due to the improvement of renewable technologies and storage, decrease of cost on solar equipment, emergence of business models, improvements of equipment efficiency and finances flowing in renewable and these systems in general. Local generation

is becoming a serious tendency worldwide and principally in developed and emerging countries

In many parts of the world, Europe, North America, decentralized solutions (Mini grid essentially) are imposing themselves as viable way of electrification.

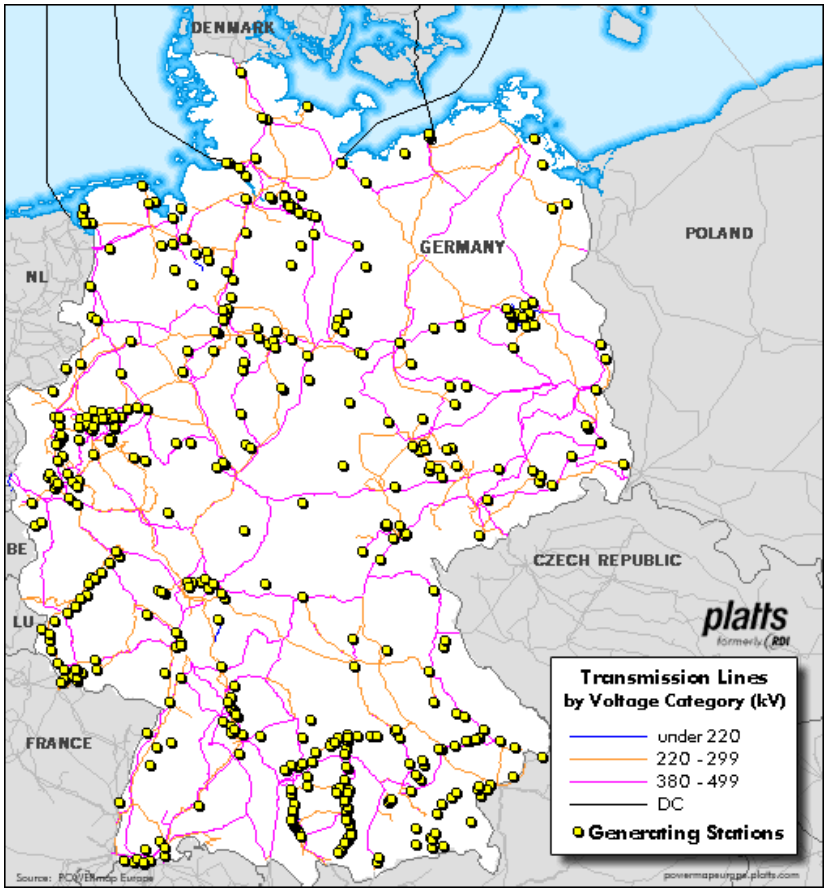

Figure 5: Germany power grid

Integrated way of electrification combining grid extension (fossil and speed increase of share of renewable: solar pv farms), solar off grid, and solar and mini hydro mini grids are emerging worldwide as viable model of electrification principally even in developed countries.

The reasons are diverse: to meet efficiency target, reduce Co2 emissions, security issues, guarantee energy access to increasing off grid communities, achieve their target in increasing the share of renewable in the energy mix.

In other hand decentralized solutions are being proved as viable systems of to reach last mile and electrify off grid communities in India, southeast Asia, Latin America, East and southern Africa (South Africa) Mini grid and stand-alone systems are becoming cost effective with innovation in storage, more efficient hybrid systems and appliances drop in panels prices, batteries.

In other hand decentralized systems are driving so many innovations from policy to technology, financing and business models)

For example, innovative business models like pay as you go; solar local entrepreneurship models, Microfinancing institution implication are breaking finances barriers that electricity sector faces

A pro poor approach more holistic, systemic giving priority to basic needs, productive use of energy and oriented to reduce poverty is emerging in Asia and Latin America as viable model

Finally, we observe implication of local governments and a shift of paradigm in energy policies now placing energy access as focus point of rural and local development.

This remark is very interesting. Now energy and electricity accesses are no more only to increase figures in these countries but a serious tool to tackle poverty and leapfrog innovation, and local development

Decentralized solutions are fully integrated as key electrification solutions for poor and off grid communities in India and south eastern Asia countries and rural electrification are established as principal topic in energy sector and electrification plans

1.2 Research questions and hypothesis

The main questions raised by this research are: does west Africa and cote d'ivoire following this current trend painted ahead? If not, why?

How can decentralized renewable solutions contribute in ensuring sustainable energy for all in West Africa and in Cote d'Ivoire particularly?

What are the linkages between SDG 7 and development in general and how relevant this interrelation is improvement of electricity access in Cote d'ivoire and west Africa?

Is the existing policy permitting to Cote d'Ivoire to achieve sustainable energy for all by 2030 and why?

What are the Idres and in which way they can to achieve electricity for all in West Africa ad Cote d'ivoire particularly?

What are the barriers and challenges for decentralized energy solutions development in Cote d'Ivoire? Which recommendations can be done through this research in order to permit them to play their role in electricity access, sustainable development and local development?

Our hypothesis can find his ground by paraphrasing the former Secretary General of United Nations Ban KI Moon: grid extension cannot alone permit to achieve sustainable electricity access for all. We have to support them through innovative solutions driven by renewable energy. This can be possible with innovation and strategy, strong political will and investments

In other terms, decentralized systems are complementary to the grid extension solution and they can contribute to achieve sustainable electricity for all. Examples for that exist in Cote d'Ivoire

The hypothesis is that the DRES can permit to faster energy access for all, increase local economy and local sustainable development if they are led by innovation, fully integrated in electrification and development policies and oriented for productive use

1.3 Research Significance and Objectives

The significance of this research lies in the opportunity to "flip the paradigm" on the current energy access planning approach in Cote d'Ivoire. Despite the fact that some projects, programs and companies exist in decentralized systems sector, these seem not to be clearly supported and set in an integrated plan approach. This research objective is to remind the commitment of our governments in West Africa to ensure sustainable, clean and affordable energy for all by 2030. For this region a pro poor approach which give priority to rural and pro poor electrification plans is needed.

The general purpose of this research is to promote innovation in decentralized renewable energy systems as key solutions to achieve sustainable development goal 7 in Africa and West Africa in general and in Cote d'Ivoire particularly.

To achieve that, our objectives will focus on:

- Assessing the current electrification plans in Cote d'Ivoire and identify the limits of centralized grid system in achieving universal access by 2030;
- Analyzing the impact and role of decentralized systems on sustainable energy access for all and in substance on sustainable development (This will be based on case studies, and DRES market analysis);
- Providing some policy recommendations to develop decentralized renewable solutions in order to faster achievements of SDG7.

1.4 Methodology

The methodology used in this research is a combination of different methods. Qualitative and quantitative. We conducted Market survey of SHS pay go sector in Cote d'ivoire.

A descriptive approach of case studies and examples of DRES have been conducted

Some informal interviews with populations living in rural and peri urban communities, interviews with pay as you go companies, mini grid developers, and rural electrification organizations have been realized. We have also collected information's through on site travels in Cote d'ivoire and Senegal, projects developments and implementation used as case studies in this research, attendance to workshops on energy access and off grid solutions in Cote d'Ivoire.

I gathered data from Schneider electric online box and website, also through participation in regional programs in decentralized systems: Rogep, forum climate chance.

We have also used internet to gather data, find projects and policies of countries about DRES

We were limited in data collection by some Pay go companies which found information needed too much confidential. It's was also difficult to get data and information on ongoing and future electrification plans. The last difficulty was the lack of existing mature projects to assess in mini grid sector for economic and cost analysis comparisons

1.5 Scope and limitation

This study is a research for validation of my Master degree in energy policy. The general theme of this research is innovation in sustainable energy access with a focus on rural electrification. For more efficiency, we have chosen to talk about electricity access for pro poor communities. It means our target areas are rural and peri urban areas. The beneficiaries are poor communities in general, off grid communities. The topic mentions West Africa as study area but we have focused the research on Cote d'ivoire to be more specific and because it's one of the countries very hostile (opposed) to these solutions despite the fact that many companies and actors find the country very attractive.

The situation of Cote d'ivoire is almost similar to others west Africa countries in term of rural electrification access rate and poor level in energy access policy planning.

As an economic leader and energy hub 40 per cent of share in Uemoa and one of economic and political leader with Nigeria and Ghana in Ecowas, change of his position toward decentralized solutions can drive adoption and opportunities for many others

For these reasons, we will not talk about clean cooking and energy for transportation. The resource used is mainly solar (it's the most abundant and available in the region) despite the fact that pico hydro, biomass and hybrid solutions potential are very high in the country.

1.6 Structure of the research

This study is structured in seven chapters.

The first part of the research is dedicated to Introductory part. This in order to fix the subject in context and know the orientation of the analysis

Then, follows the literature review. We started with a more general one which covers the topic of rural electrification and one more specific which are linked to the thesis topic subjects

After that, chapter 3 is an assessment of existing energy policy in Cote d'ivoire. This part is very important to understand ongoing policies and try to analyze their efficiency according to national and international standards

After assessing energy policy in cote d'ivoire, we reaffirmed in chapter 4, energy access as a basic need internationally recognized with Sdg's Agenda 2030. We have tried to demonstrate the link between SDG 7 and other Sdg's in other to highlight his importance for sustainable development

The following chapter which is 5, will permit to give our contribution. For us, energy access can be ensuring in west Africa and Cote d'ivoire through Innovation that we named: Innovative decentralized renewable energy solutions. Better energy access can drive local development.

But these solutions face a lot of obstacles, challenges and barriers in their deployment in the country. that is what we have demonstrated with Chapter 6.

To overcome these challenges, some recommendations based on challenges revealed ahead have been done in chapter 7 in other to guarantee energy access for all in west Africa and in cote d'Ivoire particularly.

Chapter 2: Literature Review

Few literatures on energy access and rural electrification in francophone West Africa and in Cote d'ivoire is available. This research was inspired by reading of articles and guidance documents:

In Ivorian context, we have not found a research exclusively focused on rural electrification sector. This research seems to be the first or one of the rare thesis to focus on this topic in Cote d'ivoire.

We have mostly used reports of international energy organizations like IEA, Gogla; articles and master thesis of others regions like east Africa and India; specialized organizations publication and website like Energypedia; Odi.

Esmap rise tracking the SDG 7 pdf document on Cote d'Ivoire reveals the score of country and stressed on poor planning in policy for sustainable energy for all; the score of 41 combining energy access; efficiency and renewable share ranked the country as low medium performer (less good than Senegal)

Odi report on accelerating energy access with solar off grid reveals Empirical evidence of the impact that the use of solar household systems is increasing as more research is undertaken. The market for these products is quite young, and innovations in products and business models are occurring all the time. Despite this rapid change of the environment, it seems clear that low-income households who acquire even the smallest solar light can benefit through financial savings and the availability of better quality light. Impacts on health and education are established, though more difficult to measure

2.1 General literature

The need for increased investments in rural infrastructure and other key public service that are necessary for achieving growth and reducing poverty in rural areas has been underscored by various stakeholders. Singh and Ali (2001) have reiterated that government expenditure on rural telecommunications, electricity and roads can have substantial impact on rural poverty reduction. It is estimated that more than two billion people live today in energy poverty, without the benefits of electricity. Rural electrification has gained prominence in recent years with the heightened interest in infrastructure in relation to the core part it can play in improving welfare and reducing poverty (Fishbein ,M, 2003); Singh and Ali, 2001;

World Bank, 2008 In the last two decades, poverty reduction has been a major policy focus in the 12 development circles.

Consequently, the international development agencies have officially recognized poverty as a core issue and this is evidenced by putting poverty as one of the millennium development goals. This is a sure recognition that infrastructure has a close relationship to the level or stage of development of a particular country. The role of modern energy in poverty reduction has been documented by various studies. (Ondari , J, 2013) asserts that no country in the developing world has ever achieved 8 – 10 percent annual growth that is required to reduce poverty without modern energy. The highest poverty levels in rural areas of Kenya highlight the importance of investing in basic infrastructure such as electricity, as part of the national development agenda (Otieno, H and Awange .J.L, 2006). Electricity as consumption and an intermediate good has been linked to income growth and therefore a causal relationship exists between income and infrastructure (Cook .P , 2012). Rural electrification promises a brighter future for many rural communities and in the long term, the benefits of providing electricity to poor households can be high. Research study outcomes have given evidence indicating the positive relationship between electricity consumption and gross domestic production and this correlation has been reflected by the relationship existing between the electrification rate in a country and the percent of households who are living above the poverty line of two dollars per day (Kirubi, 2006; Tuntivate, 2011). Whereas demand for energy in urban areas is high due to large commercial enterprises, the energy demands of commercial sector, small industry and communities in the rural areas follow similar evolutions to those of households as economic activity increases (World Bank, 1996). Electricity is an important condition for the development of rural businesses and that under the right circumstances it can result in significant economic growth. As evidenced by the existence of numerous research studies, the social and economic benefits of electrification have been researched over the last two decades. (Barnes ,D.F, 2012)established in his review that 13 in households with electricity, people have enhanced chances of undertaking activities that require higher levels of lighting as opposed to households with no electricity. Consequently, a research study conducted by (Singh ,K, 2009)found that businesses in rural areas of developing countries with access to electricity such as home businesses, small commercial shops, grain mills, saw mills, coffee and tea processing, brick kilns and other small-scale enterprises can benefit from rural electrification programs.

In his book "Rural Electrification and Rural Development" (Cook .P , 2012) points out that the effect of rural electrification on small businesses should be determined by the nature of the local community, the complimentary programs and the ability of rural entrepreneurs. He further emphasizes that although electricity is an important and essential input that can spur and help in the development of small industries, the other complementary conditions such as access to good rural markets and adequate credit should also be considered. The sentiments are further buttressed by (Otieno, H and Awange .J.L, 2006) who opines that since the above complimentary conditions are not uniformly distributed in all rural areas, the anticipated growth of enterprises in rural areas provided with electricity can be slow. Rural areas without electricity have worse record of business development when compared to rural areas provided with electricity. A study conducted by World Bank in Philippines revealed that small home businesses were more active in areas with electricity (World Bank, 2008). Rural electrification has the potential of improving the quality of life of rural life in various ways. The energy demand is rapidly growing throughout the developing world where there is increased need for energy to support various services like domestic and small-scale services (Abdullah and Markandyab, 2012; Barnes, 2012). In order to enhance electricity access to rural areas, several of the developing countries have undertaken a number of policy and 14 institutional initiatives. However, Rural electrification programs in developing countries have faced major obstacles that are associated low population destinies in rural areas that has resulted in high capital and operating costs for electricity companies, low electricity consumption as a result of poor consumers (Singh and Ali, 2001), interferences on the orderly planning and running of the electricity by politicians always insisting on favoring constituents and interference by local communities and individual farmers in providing way for the construction and maintenance of electricity lines (Barnes, 2012). Consequently, the quality of electricity services proposed for rural areas in developing countries often fall short of those provided to urban areas. This is evidence in the form and number of brownouts and blackouts, power interruption and fluctuating power quality (World Bank, 2003).

Although developing countries are still lagging far behind in relation to the provision of electricity to its rural population, several of the emerging economies have successfully provided electricity to their rural populations. For instance, over 90 percent of rural people have access to electricity supply while in Costa Rica, more than 95 percent of the rural population receives electricity supply from cooperative and government energy agencies

(United Nations, 2005). Similarly, more than 95 percent of the rural households in Tunisia have access to electricity supply (World Bank, 2008).

In Kenya, the government has fostered rural electrification in the country using grid and off grid supply through diesel stations or renewable energy sources such as the solar, wind and biogas. The Rural Electrification Authority (REA) that was established in 2003 has been on the fore front in the provision of the electricity to rural populations (Abdullah , S and Markandyab.A, 2012). The government continues to connect electricity to most public institutions in the rural areas such as trading centers, public secondary schools and health centers due to their significant role in achieving rapid growth (Ondari , J, 2013).

2.2 PV systems competitiveness in rural Cote d'Ivoire

Today rural electricity remains the most challenging issue in electricity access. Then electricity choices are not really based on in depth economic comparisons' researches: it's the research done by (K.M. Sako, Y. N'Guessan, A.K. Diango, K.M. Sangaré , 2011)

Their key finding turns around the fact that the supply of electricity to the rural communities of Côte d'Ivoire continue to be major problem. The study presents an economic comparison between Photovoltaic (PV), Diesel Generator and Grid Extension. The purpose of the study was to analyze which technology is more cost effective suitable to use in remote areas in Cote d'Ivoire by using life cycle cost techniques. The parameters used for simulation were load energy demand and grid extension distance. The results have shown that Diesel Generator could be considerably more expensive than PV system in long term (up to 6 years). Compared to Grid, PV cost effectiveness would both daily load demand and distance to Grid dependent. Over 5 kWh days $^{-}$load demand the distance to Grid should be at least 1 km. Over 50 kWh day^{-} load demand the grid extension distance should be up to 6 km. The results show that PV is the cost-effective option for low power energy demand in rural areas and also when the locality is very far from grid

2.3 Ensuring sustainable electricity access for all

Recognition of energy and electricity access as vital human right can find origins in many international texts. The most known is: SDG agenda 2030 goal 7:

Ensure access to affordable, reliable, sustainable and modern energy for all

- 7.1 By 2030, ensure universal access to affordable, reliable and modern energy services
    - Indicator 7.1.1 Percentage of the population with access to electricity

Many organizations like Schneider electric; sustainable energy for all, work for the international recognition of this right as a human right; Schneider electric recognize that Energy is a human right in the article politico.

One out of every five people on earth has no access to electricity. African and European governments, along with businesses, can team together to tackle this problem.

Electricity is something most of us in Europe take for granted. When we flick on the light switch, we expect the room to be illuminated. But this is not a reality everywhere in the world. https://www.politico.eu/sponsored-content/energy-is-a-basic-human-right/

2.4 Energy access and innovation

The link between decentralized energy solutions as serious option to drive both innovation and energy access for poor is established. Author like David Gibson in his master thesis titled taming *a* Wicked Problem: Energy Access planning from an Energy-Poor Perspective

In his research he expressed the fact that only an existing market driven and long-term relationship between client and planner can permit to solve issue as a result, formulation of the best approach to a particular problem has often relied on "fruitful collaboration between the planner and the client"

Following this logic, if we accept that "business as usual" for energy access planning has taken a top-down, grid-centric approach, then expanding the range of options to pursue a more bottom-up, energy-poor perspective may reveal new opportunities. In practice, his research proposed that addressing this challenge might take the form of layering new geospatial indicators on top of the established LCOE foundation in an effort to prioritize the results from an SHS PAYG service provider's perspective. In addition, this line of thinking may help to foster the integration of socioeconomic, political, and regulatory factors into the energy planning process he highlighted in his research the great impact that these solutions can drives on rural electrification if they are well planned using technology and decision-making tool like GIS.

2.5 Increasing Energy Access in Developing Countries: The Role of Distributed Generation

The Business Council for Sustainable Energy, US Agency for International Development May 2004.

In an attempt of reduce energy costs, and attract private capital and improve service, many developing countries are gradually opening their electricity market. But many of them are struggling to make utilities economically sustainable and force the governments re-evaluate their energy strategies. Distributed Generation (DG) is provided as a solution. The pre-condition of DG is an open electricity market. This report examines the role played by DG in increasing energy access in developing countries. It discusses five issues: (1) distributed generation technologies; (2) the fit and unfit of distribution generation and developing countries' contexts; (3) regulatory and policy considerations; (4) the implications of economic and financial incentives for DG; and (5) indirect investment on DG via investing in human capital, education and outreach.

Distributed energy technologies covered by this paper are Fossil Fuel, Renewable (solar, wind, biomass and biofuel etc.). Each technology has its side effects, and their diffusion have to be tailored according to the variance of national contexts, such as consumption behavior, utility system features, cost types, environmental impacts. There are also some regulatory and policy issues that needs to be taken into consideration, where economic and financial incentives are key matters.

2.6 Energy Access Theme Results: Energy Services for the Poor in West Africa

Sub regional technical report by ENDA-TM Energy Program, Senegal, 2004.

This study examines the role of macro-economic reform and its impact upon the poor people's access to electricity in two Western African countries: Senegal and Mali. In attempt to alleviate the poverty that suffocates the West African countries, the Structure Adjustment Program (SAPs) is used as a leverage to promote economic reform. As the prerequisite of getting funding from multilateral co-operation donors, these SAPs were designed to be implemented in tandem with sector reforms.

This study specifically focuses on assessing the implementation of SAPs in these two countries, and evaluating the changes in service quality in term of electricity access for the

poor. Despite the limitations of the data collected, this study shows that the Governments of both countries appears have no explicit polices for the poor, and no indication that the poor have been specifically considered. Government control over the electricity sector seems to concern more with profitability of their activities. The study also reveals that the poor could have been negatively impacted by reforms

2.7 Energy Access: Assessment of Energy Reforms – Case Studies in Latin America and the Caribbean

Roberto Kozulj, Nicolás Di Sbroiavacca and Daniel Bouille, Global Network on Energy for Sustainable Development (GNESD), April 2004. (Roberto Kozulj, Nicolás Di Sbroiavacca and Daniel Bouille, April 2004)

This article explores the relationship between poverty and energy sector reforms in Latin America and the Caribbean (LAC). The article is based on the results from Phase 1 of a broader project, Energy Access: Assessment of Energy Reform – Case Studies for Latin America and the Caribbean, which explores two broad aspects of the impact of energy sector reforms: access and affordability. Access to energy was evaluated in terms of three indicators: national electrification levels, national electrification rates, and electricity consumption per capita. Affordability was measured in terms of two variables: electricity tariffs and household electricity expenditures as a percentage of household income. The article is structured around case studies of three countries: Argentina, Peru and El Salvador.

The authors explore both the direct and indirect impact of power sector reforms on the poor and emphasize the significance of the latter. The concern for the indirect effects of reform grew following the realization of problems associated with the indicators intended to measure access to the poor. Thus, the authors argue that, while it is difficult to measure the direct impact of energy reforms (notable with respect to access) on the poor, the indirect effect on the poor – through the association of electricity sector reforms and macroeconomic policies – are clearly evident. They argue that the reforms have affected the capacity for generating employment, increased foreign indebtedness, and resulted in corrective policies that have worsened the problem of poverty.

2.8 Regulatory Approaches to Rural Electrification and Renewable Energy: Case Studies from Six Developing Countries

Eric Martinot and Kilian Reiche, Working Paper, World Bank, June 2000. (Martinot , E and Kilian Reiche, 2000)

This paper describes a range of regulatory approaches to stimulating the provision of electricity services among rural off-grid populations in developing countries. The paper explores that concession approach to rural off-grid electrification, using both conventional and renewable energy resources. The author notes that the concession approach is a relatively recent rural development practice, and that implementation lessons are consequently not yet available. The study's findings are therefore based on project designs and expected results in six case studies.

The six case studies that form the basis of the findings presented in this paper are: the PAEPRA Program and the World Bank/GEF "Renewable Energy in the Rural Market" project in Argentina; decentralized rural energy projects in Benin and Togo; the Cape Verde Energy and Water Sector Reform and Development Project; the Photovoltaic-Based Rural Electrification Project in Peru; and Renewable Energy Based Rural

Electrification under the population participation law in Bolivia. After describing the cases the paper explores issues related to tariffs and subsidies, and service quality. The authors argue that, while concessions are an attractive solution in countries with no existing energy service providers or very small markets, the regulatory, institutional and financial challenges are large. There is therefore some way to go in the evolution of best practices for contracting, operating and regulating rural energy service concessions.

2.9 Decentralized renewable energy solutions

Eps article **"*Decentralized renewable energy solutions to foster economic development*"** prepared by Giuseppe Artizzu, EPS - Ilaria Rosso, EPS - Anna Paola Minervini, EGP - Edoardo Patriarca, EGP – Emi Bertoli, EGP - Antonio Bonanni, Enertronica - Giovanni Pediconi, Enertronica - Tunde Morakinyo, ERM - Rachel Cochran, ERM - Alberto Berizzi, Politecnico di Milano

This article establishes the existing links between decentralized renewable solutions and economic development. article Authors revealed that electricity supply and socio-economic

development are closely linked. The papers emphasis on the fact that: (Eps, 2015)Innovative, sustainable decentralized energy solutions represent indeed the most efficient instrument to promote electricity access in remote and low load density areas. Within this framework efficient generation technologies are crucial for the provision of electricity access and, in turn, to foster local development although not yet sufficient to directly spur sustained growth. Inclusive business models able to foster productive uses of energy are necessary, although the cycle jump-start requires many different inputs. The paper has therefore analyzed the existing nexus between electrification and development, further highlighting the important role of having a holistic point of view and building strong partnerships to achieve the most efficient and sustainable business model. Finally, systematic know-how dissemination and a consistent regulatory framework for decentralized energy systems will represent key elements for an effective energy policy within emerging economies.

Chapter 3: Assessment of existing energy policy in Cote d'Ivoire

3.1 Overview of historical context of electricity sector in Cote d'Ivoire

Ivorian electricity sector is one of the most dynamic in sub-Saharan Africa. Like many African countries, the country's electrification policy will focus on the development of hydroelectric dams. However, the great droughts of the beginning of the 80's will mark a big stop in the dynamism of the electric sector with the recording of great load-shedding throughout the country. With the end of the 1980s marked by the economic crisis, a wave of reforms led by the Breton Wood institutions with their head the World Bank will launch in the early 90s (years of reforms and structural adjustment). Privatization of the electrical sector, which was formerly the domain of the State. The ex EECI (Ivory Coast electric power will be stripped of its mission of public company of supply of electricity .the sector will be reorganized and one will attend the birth of the Ivory Coast Company of electricity CIE with mission to provide electricity distribution in Ivory Coast) in 1990 through a public service concession granting it the monopoly of electricity distribution in Cote d'Ivoire In the same order, the production sector will be privatized with the implementation of the Power purchase agreement. The Ivory Coast will therefore be one of the first countries in sub-Saharan Africa to democratize and diversify electricity generation with introduction of private actors. The first PPIs will see the light of day (CIPREL, AZITO, AGREKO) with the aim of producing natural gas-based electricity essentially. From only two hydroelectric dams in (60's), the Ivory Coast will reach 5 dams mainly located in the South and South West of the country as well as 6 production plants based on natural gas or oil all located in the South of the country (Abidjan). Despite this healthy improvement due to the good organization of its energy sector in general, Ivory Coast like many countries will be no exception to the trap of development policy mainly cities to the detriment of rural areas. The axis of the privileged development is the city towards the village. No sustainable and comprehensive local and rural development policies are being implemented, even less driven by the electricity sector. Indeed, the development of the rural world entrusted to ANADER will focus the main part of its policy on the development of agricultural activities. The priority of the country being this one. However, we note with regret that the rural areas being the locomotive of the economic success of the country could not benefit for the majority of the fall-out of the economic embellishment of the country during more than 20 years (1960-980: economic miracle Ivorian). The driving role of electricity as a factor of local development has not been put forward. Worse, municipalities and regions responsible for planning local development do

not have the financial means or the technical capacities. Their ability to influence energy and electrification policies will be limited until today. The large energy sector and electricity sub-sector will not escape this trend. From now on energy and electricity will be provided to those who have the financial capacity to receive it, ie to pay the subscription to the network and made available in priority companies. The provision of sufficient energy and driving economic and industrial development will become the primary concern of the Ivorian authorities until today. Guided by the supply and demand adequacy (market economy) with a particularity in the Ivorian case: distribution monopoly and strong regulation towards the end of the 90s. Trade concerns and the financial viability of the utility and the sector will become prime concerns for energy policies since the early 1990s This situation will have three major consequences -An electrical policy planning under the supervision of the institutions of Breton woods since 1990 to date, coupled with a monopoly of electricity distribution provided by the CIE. A disparity of development and electricity supply between the sparsely populated north and the south of the country (economic lung) with also a commercial preference of dense urban areas in the electrification plans to the detriment of rural areas. Trade and economic concerns take over the natural role of public service attached to the electricity sector. We will gradually forget access to electricity as a key factor in local and national development to highlight the financial capacity of users. From then on, electricity will become a luxury for most poor people (peri-urban an- it will generate a wave of exodus of rural populations to the urban world and also urban sprawl and the birth of many townships in large urban areas such as Abidjan, San Pedro, Bouake. In addition to these aforementioned problems, which are not exhaustive in the electricity sector, the socio-political crises of 1999 will weaken this sector. The absence of investment from 2002 - 2010 due to the civil war and the migration of the vast majority of populations from north to south (mainly Abidjan) will further degrade this sector. As witnessed, the major load shedding of 2009 after the 2010 election and the return of peace in 2011, many efforts are being made by the government of the day. Numerous investments in the energy sector are recorded, increasing from 1900 MW to 2000 MW in 2018 with a target of 4000 MW in 2020 and 6000 MW in 2030 (conferred Cote d'Ivoire Energy) However, bitter findings deserve to be made. The electricity sector is still experiencing a disparity between rural and urban electrification. Access rates attest to this: 30 per cent access in rural areas and 88 per cent in urban areas (Rise esmap) mostly rural

3.2 Overview of current situation and target of electricity sector

The energy and electricity sector are major hubs of the 2016-2020 NDP. A large wave of structuring projects and sector reforms are included. These numerous projects (in appendix) are the testimony of the will of the State to revitalize this sector. The creation of a Ministry of Petroleum and Renewable Energy Development in 2016 and the development of projects in the renewable energy sector are beneficial.

However, the penetration rate remains low despite numerous investments (55 to 60 percent). The number of CIE subscribers remains very low and the frauds therefore losses on electricity are very high (report Cie) source The main principles of French law equal access to public service dominated by the principle of equalization, the lack of real planning in the access to electricity especially for the poor (peri-urban and rural), the minimal place of the centralized rural electrification in Department of energy (sub sector electrification), planned today by CI-energie. (power distribution) and the business as usual marked by the dominant pole and arch-government vision and the World Bank in favor of the policy of extension of the network, and the share of major electricity projects dominated by PPPs seem to be obstacles to access to electricity for all in Cote d'Ivoire.

We will check in another chapter if these problems listed above are also obstacles to the development of innovative solutions and models of electrification in Cote d'ivoire The energy policy objectives highlighted are the increase in installed capacity and the per cent energy mix with a low share of renewable energies except for large hydro (16 percent 2020, 42 percent 2030). But also the electrification rate about 88 percent. Essence of the energy policy is summarized in these big figures. However, a question proves necessary this policy of increase of the installed power and the production will allow it to satisfy the right of access of each citizen to a source of energy. Affordable, reliable, modern that we have dedicated by signing the 17 Sustainable Development Goals on September 25, 2015 in its SDG 7?

3.3 International agreement and commitments

Cote d'ivoire is part of many international agreements in line with environment, human rights, climate change and sustainable development.

The country is also member of many regional and international organization in charge of energy and climate a and participate to many initiatives and programs for energy access

The following international set of agreement is not exhaustive but permits to capture the country's commitment for energy access.

Here we will enumerate some of these international agreements.

First, we have the general assembly for SDG's agenda 2030 ratification on September 25th 2015 at UN headquarter in New York. With seventeen goal and 169 targets, the SDG's agenda main objectives are poverty reduction, climate change effects reduction, reduce inequalities and guarantee social justice in the world by 2030.

SDG 7 has been recognized as very important for realization of others goals. A special initiative: Sustainable energy for all has been created by United Nations to ensure a good tracking and implementation of this crucial goal

Second relevant international agreement is the COP 21 of Paris. The general resolution taken by the country through his NDC (National Determined Contributions) submitted on September 22nd 2015. The main objective is to reduce GHG by 28 per cent and increase the share of renewable of 42 per cent by 2030 (large hydro included) http://www4.unfccc.int/submissions/INDC/Published%20Documents/C%C3%B4te%20d'Ivoire/1/Document_INDC_CI_22092015.pdf

The country ratified the Kyoto protocol of 1998 for (GHG) reductions. Then, Cote d'Ivoire recognized the pacts of 1966 on social and economic human rights (second generation of human rights).

At regional level we have the agenda Africa 2063 of African union.

At National level, the constitution of the country state that international agreements are superior on national law (article 123 of 2016 Ivorian Constitution).

So, it means these international agreements should be integrated in national legal framework. In the other hands, all national policies should be in line principally with Sdgs because it's the universal policy guide ore period (2015-2030)

3.4 Legal and regulatory framework

At the national level, there is an important legal arsenal framing the electricity and sustainable development sector

For the electrical sector, we can mention: Electricity Law 1985 The Electricity Law of 1985 opened up electricity production to private operators, but the transmission, distribution, import and export activities of a monopoly. The state granted a private operator, the Ivorian Electricity Company, has concession over the production, transmission, distribution, import and export of electricity. The CIE replaced the national training company National energy policy of 2013 Electricity Code 2014 In 2014 the sector was reformed with a new Electricity Code, a comprehensive framework for production, transport, dispatch, distribution, commercialization, import and export of electricity. The Code reinforces the powers and competencies of the regulatory authority for the electricity sector, and considers the fact that it is a source of revenue. The document further liberalizes the power sector by formally ending the monopoly state on transportation, distribution, commercialization, and import and export activities of electricity. All those activities can be done by one or more private operators. Investment Code Ordinance No. 2012-487 was established in June 2012. It is the guiding investment framework of the Ivory Coast. It covers in detail topics like the obligations of investors, incentive schemes for investments and guarantees given to investors. This Code aims to encourage and promote green and socially-responsible investment in the country. It also supports activities such as processing indigenous raw materials, enhancing the quality of life, protecting the environment and promoting a green economy Fiscal annex of 2012 by 9 per cent http://www.droit-afrique.com/upload/doc/cote-divoire/RCI-Annexe-fiscale-2012.pdf For the environment. The right to live in a healthy environment is a constitutional principle contained in the preamble Law No. 96-766 of 3 October 1996 on the Environment Code reinforces this vision. With regard to decentralization and the capacity of local authorities to conduct local policies and participate in their development, a legal arsenal confirms this These are the following laws: Law on Decentralization, Law No. 80-1180 of 17 October 1980 on the municipal organization amended by Laws No. 85-578 of 29 July 1985 and 95-608 and 95-611 of 03 August 1995. Law n ° 2003-208 of July 07, 2003 on transfer and distribution of competences of the State to the territorial collectivities. Law No. 2012-1128 of 13 December 2012 on the organization of territorial communities Law No. 2014-451 of 05 August 2014 on the orientation of the general organization of the Territorial Administration On the basis of these laws, will be built the whole of the regulation with decrees, orders or orders which are texts of application or orientation of the political decisions to regulate the sector of the energies in Ivory Coast.

3.5 Institutional framework

The Ivorian institutional framework is as follows:

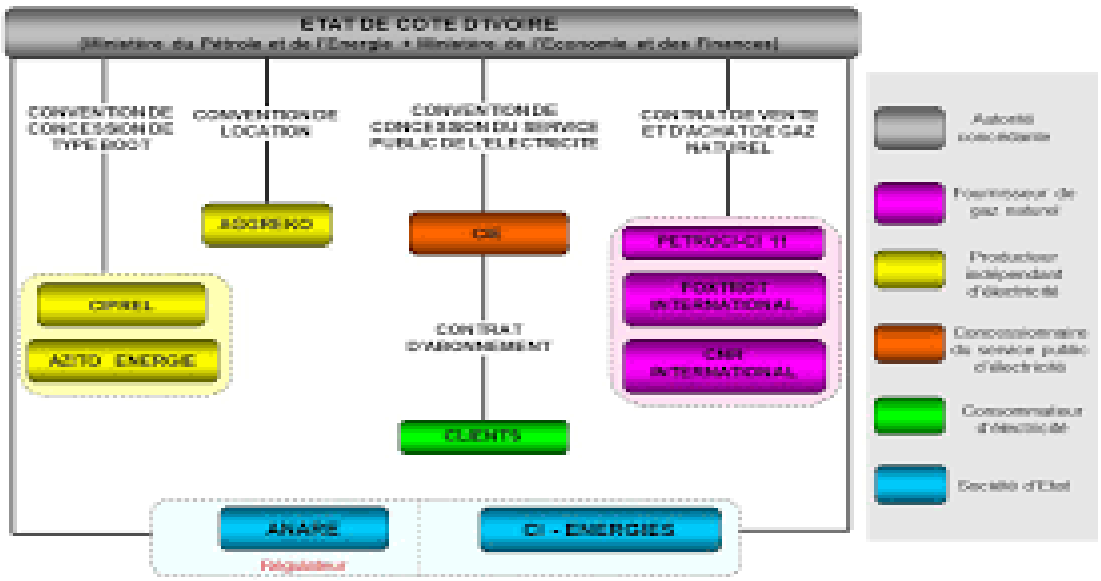

Figure 6: Ivoirian energy sector structure

(Source Ci-Energies)

Table 1: Ivorian Electricity institutional framework

Category	Operator	Role
Tutorship	**-Ministry of finance** **-Ministry of budget** **-Ministry of petroleum; energy and development of renewable energies**	The Ministère du Pétrole, de l'Énergie et du Développement des Énergies Renouvelables (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. The General Directorate of Energy comprises three Central Directorates and two related departments. The central directorates are the Directorate for Energy Monitoring and Regulation, the Directorate of New and Renewable Energies, and the Directorate of Rural Electrification while the related departments are the Bureau of Energy Saving (BEE); and the Department of Administration and Materials (SAM).

Table 1 (contd): Ivorian Electricity institutional framework

Category	Operator	Role
Regulator	**ANARE**	It is in charge of overseeing the compliance with the laws, regulations and obligations under authorizations and conventions in force in the electricity sector. It proposes the electricity tariffs to the state as well as the tariffs to access the national grid. ANARE ensures protection of consumers and their rights and arbitrates disputes between operators or between operators and the state. Finally, it advises and assists the state in regulating the electricity sector. The Electricity Code of 2014 gives greater independence and authority to the body by specifically providing that it is an independent legal entity with financial autonomy.
Public companies	**CI-Energies**	In December 1998, the state undertook a reform of its institutional framework, limited the mandate of the CIE and created two new national companies: The Société de Gestion du Patrimoine du Secteur de l'Electricité (SOGEPE) was set up to manage the assets of the state and the financial flows of the sector on its behalf. The Société d'Opération Ivoirienne l'Électricité (SOPIE) was created to ensure long term planning of the sector. In 2010, Côte d'Ivoire undertook another reform, which led to the merger of SOGEPE and SOPIE under the new national electricity company Société des Énergies de Côte d'Ivoire (CI-ENERGIES). CI-ENERGIES continues to carry out the tasks of both companies and thus manages on behalf of the state the electricity supply as well as new projects as grantor of concession agreements.
Private operators	**CIPREL** **AZITO** **AGGREKO**	Independent power producer Buyer-seller relationship with CI-energies

Table 1 (contd): Ivorian Electricity institutional framework

Category	Operator	Role
Private operators	**Petroci** **Foxtrot** **Canadian natural ressources**	Natural gas supplier
Utility	**CIE**	Producer, transport and distribute electricity Exploit CI-Energies infrastructures
Cusumers	**Custermors**	Pay electricity bills each 2 months to CIE

3.6 Policies and program

Various programs and policies have been set up to guide general development policy, foster the dynamism of the electricity sector and promote access to energy in Côte d'Ivoire. We do not pretend in this memoir to highlight all development policies and energy even less all programs and projects in the electricity sector and access to energy. However, the choice of these easily allows having a synthetic vision to understand the plans and projects of electrification in force in the country

3.6.1 National Development Plan

Since December 9, 2015, the Council of Ministers has adopted a communication and a draft law on the National Development Plan for 2016-2020 (PND 2016-2020). This plan aims at consolidating the trajectory taken by Côte d'Ivoire since the end of the post-electoral crisis towards emergence and industrialization. For the longer-term vision, a National Prospective Study entitled "Côte d'Ivoire 2040" is also being finalized. The energy sector contributes significantly to this economic recovery through a strategic vision and specific objectives well framed.

3.6.2 Electricity Sector Master Plans

3.6.2.1 REMP

The Rural Electrification Master Plan aims to organize Ivoirian rural electrification sector

In order to materialize this ambition, the energy company of Côte d'Ivoire (CI-ENERGIES) has developed a Master Plan for Rural Electrification (PDER) of Côte d'Ivoire, which aims

to propose a development plan for the electricity distribution system in line with the fixed objectives of access to electricity services throughout the country. Decentralized solutions are perceived as an accompanying solution for remote communities. The technical solution chosen by the electricity sector is the solar-diesel hybrid mini-grid system with storage (the Diesel acting as a backup source). 96 localities are eligible for rural electrification from the hybrid diesel - solar PV option: 70 localities for which voltage drops are greater than 10%. 26 localities with less than 250 inhabitants whose isolated supply is economically profitable compared to the connection to the electricity grid. Existing Generator Build Ivory Coast Electric the localities supplied with ERD are mainly by generator. As of December 31, 2016, there are 49 localities that are powered by a single generator, of which 39 will be connected to the national grid in 2017. Improvement of the electricity distribution quality of 480 localities with voltage drops of more than 10% in areas with a high concentration of localities, by the construction of 4 source stations and 3 renewable power plants (small hydropower and biomass) injected into the electricity distribution network.

3.6.2.2 DMP

The extension of the electricity distribution network through the Distribution Master Plan (PDD in French) over the period 2015 - 2030

3.6.3 Programs

3.6.3.1 National agenda for sustainable energy for all

Adopted in 2016; the agenda contains all the objectives and agenda of the country to achieve sustainable energy access for all by 2030. Designed by ECREEE; Govci and sustainable energy access for all in Africa; his aim is to frame the policy and programs toward objective of sustainable energy access; renewable energy mix and energy efficiency

By 2030 and even before 2020, the year of an emergent Côte d 'Ivoire, the objectives of the successful SE4ALL initiative are: ⎪ Increase the share of renewable energies in the energy mix to meet electricity consumption needs, from 20% in 2014 to 34% (including large hydropower) in 2020 and 42% (including large hydropower). by 2030; ⎪ Electrify all 8,523 localities in Côte d'Ivoire by 2020; ⎪ Doubling the number of connections to the electricity grid by 2020; ⎪ Earn around 50 MW per year through the combination of energy efficiency measures and reduce the level of peak load losses estimated at 4.75% in 2013 to 3.23% by

2030 ; ⁞ Introduce energy efficiency standards and requirements for electrical equipment; ⁞ Approving labeling; ⁞ Control and sanction energy efficiency; ⁞ compulsory and periodic energy audit; ⁞ Train and technically improve national actors in efficiency Energetics; ⁞ Raise awareness of users of electrical equipment; Manage and maintain energy efficiency data; ⁞ Financing energy control activities; ⁞ Establish financial, tax and customs benefits to encourage the implementation of energy efficiency measures; ⁞ To meet household demand for LPG estimated by 2030 at 1,200,000 metric tons; ⁞ Increase by as much as 10% the amount of charcoal produced by efficient carbonization methods by 2030; ⁞ Facilitate and popularize the use of improved stoves in rural areas

3.6.3.2 NPRORE

To date, there are more than 4,537 electrified localities thanks to the national program for rural electrification (PRONER in French) initiated by the State of Côte d'Ivoire. An action that fits with the ambition of the Ivorian government to put under stress all localities of at least 500 inhabitants in Côte d'Ivoire. Launched in 2013 by the State of Côte d'Ivoire for a total cost of about 600 billion FCFA. It aims to electrify all villages with at least 500 inhabitants and all other localities below 500 by 2020. This target was set for 2018. However, it is clear that we are very far from this. Ambitious goal of the government this program is implemented by CI-Energies, the company in charge of "planning and ensuring the electrical development of Côte-d'Ivoire". To date, about 1000 villages remain to be electrified under the PRONER according to CI ENERGIE. But of the 8513 localities in the country, there are still 5666 non-electrified localities, according to figures from the research office Innovation Energy Development (IED). CI-Energies estimates to 2,847 the number of localities electrified in 2011 and 4,537 at the end of December 2016, a growth of 59%.

3.6.3.3 PRODERE

The purpose of the Regional Renewable Energy and Energy Efficiency Development Program is to supply, install and power up mini photovoltaic solar hybrid solar power plants, low voltage distribution networks and solar photovoltaic street lamps in seven (07) localities in Ivory Coast financed by Saber Uemoa

3.6.3.4 EFAP

Based on the finding of the gap between the electricity access rate of 77% in 2014 and the electricity service rate to 32% of the population, the government adopted a cabinet meeting in May 2014. "Electricity for All Programs (EFAP)". This program aims to connect 200 000 households per year over the period 2014-2020, associated with the 50 000 households connected per year by the conventional system so as to double the number of connections to the networks by 2020: the cost of subscription is $ 2 USD over 3 years. The aim of the Electricity for All Program (PEPT in French) is to facilitate people's access to electricity by easing access formalities and facilitating the payment of the cost of connection to electricity. And this over a period of three (3) years for the better-off households to ten (10) years for low-income populations.

Figure 7: PEPT metering card

Conditions

- Reside in an electrified locality,
- To own or rent a house and this regardless of the type of house. Traditional houses in banco, straw, wood plaster or not are eligible.

- Living in an area covered by the electricity grid

This program will make it possible to connect 1 million households by 2020, or 200,000 households per year.

PEPT funding

PEPT funding will require significant financial support from government, technical partners and the private sector.

The financing requirement for 200,000 connections each year has been estimated at about CFAF 22 billion.

The overall estimated cost of the PEPT is FCFA 272 billion, of which CFAF 12 billion is an initial household contribution, CFAF 110 billion of resources to be mobilized and CFAF 150 billion for the refinancing of the program.

3.6.3.5 NIPAES

The National Investment Program for Access to Energy Services (PNIASE in french) has been implemented over the 2013-2015 period. This program is subdivided into three main components in accordance with the three pillars of the ECOWAS and UEMOA White Paper on Access to Energy Services: (i) access to electricity, (ii) access to modern energy from cooking and (iii) access to the motive force.

Three indicators have been identified to measure the level of access to energy in Côte d'Ivoire:

- Proportion of electrified localities;
- Proportion of households with access to electricity;
- Proportion of households with access to the modern cooking system.

3.6.4 Electrical projects in Cote d'ivoire

PRODERCI

The project of development and reinforcement of the electricity network in Ivory Coast (Proderci) is a project of 460 billion cfa financed to 95 percent by the Chinese bank Eximbank and 5 percent Ivory Coast state it aims the rehabilitation of 26 transformer stations and the extension of the network of 1600 km of transport; it will supply villages and peri-urban areas

in the north-east; north center; west and west center where the network is failing or little existent

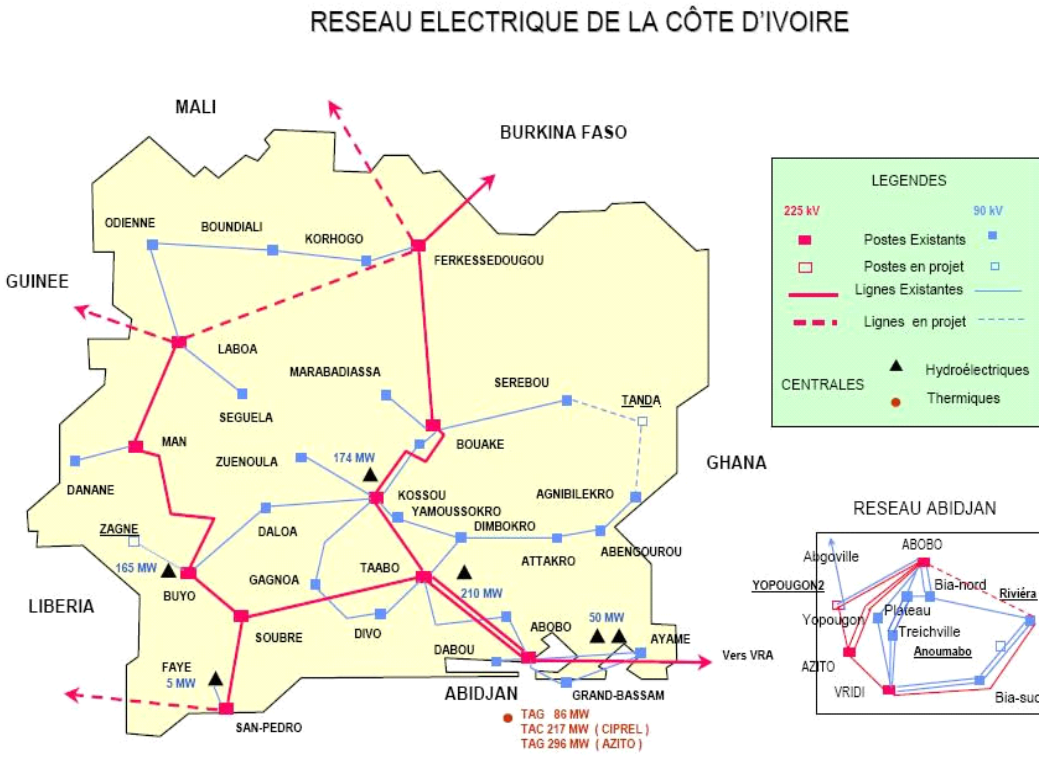

Figure 8: Ivorian electrical grid

The project aims to fill the gaps presented by the electricity network visible on this map. This is a 43-month project that started in July 2018

3.7 Funds and financing

Ivory Coast is a very attractive country because of its economic appeal and the strength of its economic sector recognized in the region. For access to energy many private investors are essentially jostling at the door of the country. The country knows investments of all kinds. As well domestic investments (State, Utility, local private sector) as external investments: world bank, IMF, foreign banks, foreign companies in particular in the sector of the renewable energies (big projects solar pv , biomass, mini grid and off grid) figures However, it should be remembered that in view of the current orientation, making the first step in the development of major projects (extension rehabilitation and reinforcement of the network, major projects natural gas production sector (increased production capacity of ciprel, azito, agreko) and the development of large hydro, the financing of the Ivorian electricity sector requires very large means that can only be provided almost exclusively by the major

multilateral financial institutions (IMF, World Bank, ADB) and large private companies (Eximbank) More and more PPPs are emerging in the sector, as witnessed by the Soubré dam. In addition to these classic players in the financing of electric projects in the Ivory Coast, it is clear that more and more companies with financing are knocking on the door of the Cote d'Ivoire. Essentially in the energy sector renewable and especially the solar off grid and mini grid. Two countries pay as you go in 2015 (Zeci, peg), the country counts today 6 pay go companies with arrival of Baobab +, Lumos, Schneider Electric and the newest orange energy.

Some companies such as Schneider Electric have investment funds that are: Schneider Electric Energy Access and Energy Access venture, however, it should be noted that there is little, if any, presence of local entrepreneurs or national companies in the SHS sector, pay as you go. The sector is dominated by large foreign multinationals with large capacity to raise funds on the international market or with equity. This situation extroverted this sector and subject it to the vagaries of the availability of international financing. The competitive local businesses and the ability to create national champions of solar off grid are greatly limited In spite of these numerous investments that is able to mobilize the sectors of the solar shs pay as you go, it is appropriate is less glittering for the sector of the mini grid in spite of the will of investment of groups such as Schneider Electric, Engie and of ONG international as the Geres already present and very active in the sub-region and in Africa Nigeria-Senegal for Schneider; Mali, Benin for Geres; Tanzania; Congo for Engie Given the rigidity of the policy in place prioritizing the extension and consolidation of the network ..., the slow pace of government to quickly establish a favorable framework for decentralized networks, the country loses its funding to countries more attractive in the region, such as (Nigeria, Senegal, Burkina Faso, Mali, Benin, Togo), which are making major changes in favor of decentralized networks and solar shs. Witness the signing in March 2018 of an agreement between BBOXX and the Togolese government to distribute more than 1 million solar kits in the country. Nevertheless, the off-grid sector (mini grid and shs) could see in the near future the influx of major international, multilateral and national investments, driven by the banking sector, local authorities and private companies. This would have the effect of diversifying the sources of financing for access to electricity and local development in the country while promoting the involvement of decentralized actors in the process of electrification of the country

3.8 General analysis of Ivorian electrification policy

Before our analysis we will show the policy, analysis done by Esmap and rise

After that and in line with the presentation of the policy, program and projects, we can affirm that the political will exist for electricity access in Cote d'ivoire at governmental level. The main issue is the to frame this will in line with sustainable and local development

We can conclude at this level that problems are questions of vision, methods, and strategy. This can be translated by these factors. The general energy policy of the country is not well structured, and not structured around energy access, for example there is no specific policy act for electricity access. Only several punctual or emergency plans or programs without structured exist. For example, the actors are very different from the utility; EFAP to the government (PRODER), to regional organizations: ROGEP (Regional Off Grid Electrification project)

The general observation that we can do from that there is no rural electrification agency, lack of permanent consultation Framework and clear policy for pro poor electrification plan

The impacts of all these projects are not assessed and consolidated in a unique data base of electricity access policy impacts. This makes impacts analysis of actions very difficult. This situation could explain difficulties that we faced to assess the impacts of existing electricity access plans and actions in Cote d'ivoire.

We have punctual programs and projects which are not well coordinated for clear global target achievements. In the plans, we don't see or feel clearly energy and development policies designed in a systemic thinking way. In other way, it's not framed in line with the SDG agenda 2030 principally SDG7, Africa union agenda 2063 and Cop 21 resolutions which means create the nexus (energy, development and climate)

Despite the existing political will of GOVCI to tackle energy access issue confirmed by existence of many actions and plans , we can affirm that the lack of systemic and holistic organization oriented toward sustainable access for all, absence of an integrated existing electricity access policy , lack of a coordinated strategy for energy access in general and for rural electrification particularly seem to be the prior sources of lack of efficiency of existing policy to tackle electricity access for all

3.8.1 Assessment of current policies regarding SDG7

The assessment is based on Rise: Regulatory indicator for sustainable energy

The regulatory framework performance for energy access in west Africa is the following:

Table 2: RISE energy access scores – ECOWAS (RISE, 2017b)

Countries	Rise energy access Score	Indicator
BENIN	49	Medium
BURKINA FASO	40	Medium
COTE D'IVOIRE	46	Medium
GHANA	63	Medium
GUINEE	57	Medium
LIBERIA	20	Low
MALI	39	Medium
NIGER	29	Low
NIGERIA	22	Low
SIERRA LEONE	17	Low
SENEGAL	69	Strong
TOGO	32	Low

Table 3: Rise Cote d'Ivoire result energy access

Indicator	Score
Existence and monitoring of officially approved electrification plan	40
Scope of officially approved electrification plan	0
Framework for grid electrification	50
Framework for mini grids	22.5
Framework for stand-alone systems	35.56
Consumer affordability of electricity	100
Utility Transparency and Monitoring	87.49
Utility Creditworthiness	33.83
Total	**46.17**

As the table is showing the country is a low medium performer with a result below 50 out of 100. For electrification planning many efforts need to be done. The country must have an approved official scope for electrification plan and for rural electrification urgently. The frameworks for mini grid and stand-alone also are very low. Improvements in this sector will permit to increase the score of the country in his effort to achieve sustainable energy access

A detailed report of the country performances can be found in annex 1.

3.8.2 Assessment in line with local economy and local development

The vision is driven by: increasing in installed capacity, security of supply, principle of equal pricing and geostrategic aspect of electricity access is driving the Ivorian electrical sector (CI energy's director presentation, Institut Francais Abidjan ….)

The current paradigm is dominated by the grid extension and reinforcement, large fossil projects (coal power plants of San Pedro), big renewable projects to feed the grid (Pv, biomass, large and medium hydro). This vision shows that local production for local use is not yet the main priority of the Govci at this stage

Many actions have been implemented as we can see ahead but it's very difficult to see their impacts (socio economic and environmental). Few studies are dedicated to assess impacts of projects and programs implemented in transformation of communities and citizen. This situation expresses a lack of orientation of the result in a sustainable way. Local development trough energy access is not clearly a vision

Issues like job creation, skill development, basic socio-economic infrastructures like schools and hospital development and lighting

It's also important to remind that there is no specialized organization in charge of rural development. Ministry of interior and regional council in charge of planning and executing local development policies don't have enough power (electricity code), they are not associated in the institutional framework, and they lack finance

Excepted EFAP, and Zanzan mini grid projects, serious projects oriented on socio economic and environmental impacts don't exist in the country

At institutional level, absence of local collectivities in electricity institutional framework can explain that situation. Government and the utility are not the rights organizations to bring on

board local issues and try to tackle them through electricity access. Investing banks, Ngos and off grid and mini grid operators are also missing.

At this level it's important to mention the non-existence of rural electrification policy act and specialized agency (example of rural electrification agency). Rural electrification in Cote d'ivoire is shared between Cote d'ivoire energy, the direction of rural electrification, the utility and the government.

This situation can explain the lack of good planning and difficulties of flexibility in the vision.

At regulatory level, monopoly in distribution is an obstacle for mini grid ***Esco's*** development. Many taxes still exist on importation of solar equipment; the level of 9 per cent of reduction seems to be very low if the country wants to develop renewable share and efficiency in energy mix

As we have seen most of the programs and projects in the policy are focused on large projects financed through foreign investments (World Bank and now Chinese banks).

Most of the projects are not renewable based excepted large and medium hydro, coal plants, increase in thermal plant capacities, big renewable projects, grid extension and some punctual off grid, (pv and diesel projects)

3.8.2.1 Example of local projects impacts PEPT

In view of the trends recorded, we note that for the customers of the target localities, effective access to electricity is above all, synonymous with development and security. Although new activities have not yet been undertaken by the majority of the new customers we met, it is important to note that subscribers will be willing to engage in revenue-generating activities within a few months, thanks to the electricity. In addition, the impact of the program on the day-to-day education of children and on school results seems to satisfy the heads of families who hope that this trend will be confirmed with the results of the end of the year

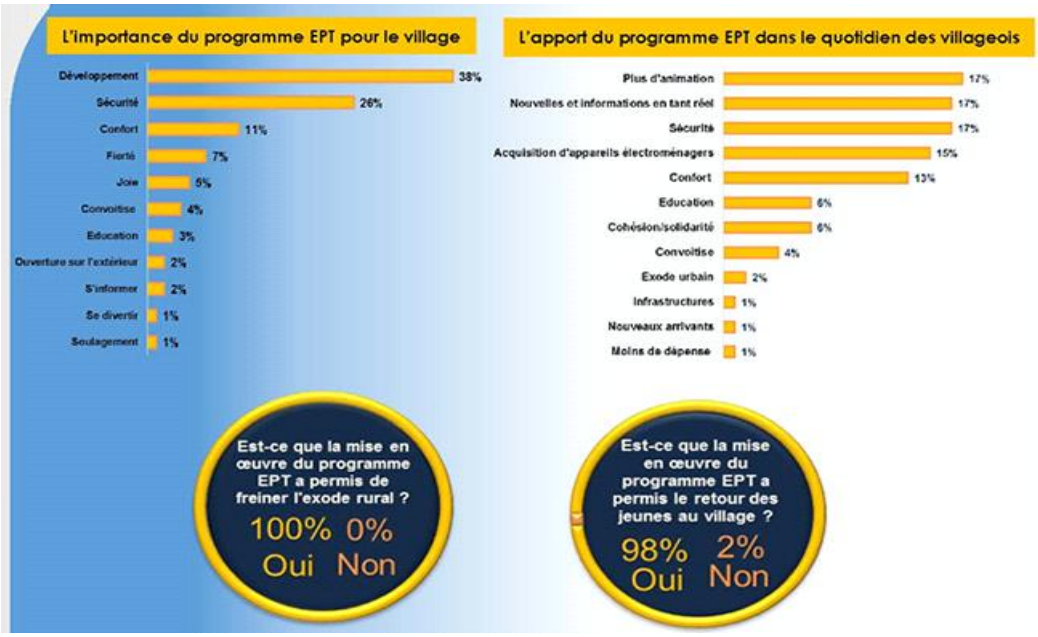

Figure 9: Social impact of PEPT

Source CIE website

3.8.2.2 Example of a local impact projects: Zanzan projects

- ***Project Location***

The project has been implemented (from 2012 to 2017) in 7 villages of the Zanzan region, province of Nassian, in the North East of Ivory Coast

- ***Project details***

The project consists in the installation of seven (7) PV Hybrids Mini-Grids (Solar /Diesel-Fuel Generators) and the required power distribution lines, connections, meters and indoor electrical installation, supplying renewable and reliable energy

In order to increase the standard of living with the necessary electricity to satisfy the members of the communities involved. The project aims also promote value-added services (e.g.consumer goods and productive-use equipment) promoting local economic activity and improving public services (health assistance, education, public lighting, etc.). In contrast to classic Solar Home Systems (SHS) those Mini-

Grid allows users to satisfy the whole community energy needs (homes, public lighting) including strategic consumers as schools, hospitals and religious buildings. A different design configuration and system concept was required in each Mini- Grid based on the demand surveys, project context and user's requirements.

Market survey of shs pay as you go (private sector –scalable) socio economic impacts: job creation, 4 companies, attractive market

- ***Management and business model***

The community is responsible for the operation and management of the system through federated local associations in every micro-grid. Several prepaid monthly fees were calculated, within the user's willingness to pay and energy needs in order to be sufficient to cover the ongoing costs and put money aside for replacement of equipment in the future. The specialized maintenance is assumed by a specially created local electrician association, which members having received training sessions and being part of the installation team.

- ***Results***

The project succeeded in the electrification of seven villages with about 10.000 inhabitants. Those beneficiaries increased their quality of life through a 24/7 quality electricity service. The income of these populations increased through economical

Activities developed thanks of assured electricity supply. (Report of the company)

Chapter 4: SDG 7 as basic condition for others goals realization –relations between sdg 7, development and climate

4.1 Link between energy and development consecrated by MDGS

At the beginning of the 1990s, the international community considered energy essentially as a means of action for the protection of the environment and the fight against climate change. At the United Nations Conference on Environment and Development (UNCED), held in Rio de Janeiro in 1992 (better known as the Rio Earth Summit), which highlighted the importance of linkages between environment and economic development, the energy problems mentioned were mainly oriented towards climate change. For example, the Action Plan adopted following this Conference (Agenda 21) focuses on renewable energies and energy efficiency, which are seen as a means of protecting the atmosphere (Cecelski, 2000a). However, the document does not focus on access to energy. As Clancy (1999) points out, energy has never been seen as a basic need such as water or food. According to the Larousse definition, energy "is manifested by the production of heat, work or radiation. Since he has domesticated fire, man uses raw materials (wood, coal, oil, uranium, etc.) and natural phenomena (wind, solar radiation, tides, etc.) to derive energy". The role of energy in development issues began to evolve in the late 1990s and more precisely in 1997 at the 19th Special Session of the United Nations General Assembly, organized to draw up a 5-year review After the Earth Summit in Rio. At this conference, the relationship between energy and development was clearly presented (UNDP, 1997), and a specific chapter on energy was Program for the continuation of Agenda 21. Awareness of the preponderant role of energy in poverty reduction is reinforced at the World Summit on Sustainable Development, held in Johannesburg in 2002. One of the commitments of the Report of the World Summit on Sustainable Development (2002) states: " To act jointly and redouble efforts to work together at all levels to increase access to reliable and affordable energy services to facilitate the achievement of the Millennium Development Goals, Half the proportion of people living in poverty by 2015, because access to energy facilitates the elimination of poverty, enabling the production of other important services ". While there is no Energy Millennium Development Goal (MDG), access to energy is now seen by the international community as a necessary condition for achieving the Millennium Development Goals Poverty and hunger, health, gender equality and education (UN-Energy, 2005). Jeffrey Sachs goes so far as to say in 2005 that: "In the absence of increased investment in the energy sector, the MDGs will not be reached in the poorest countries" (Foreword in Modi et al., 2005). The British Agency for

International Development (DFID) presented in a matrix the relationship between energy and the MDGs (DFID, 2002).

These 2 matrices, included in the White Paper for a Regional Policy, on access to energy services for rural and peri-urban populations to achieve the MDGs of ECOWAS and UEMOA in 2006, can be summarized as follows

Table 4: Summary of links between energy and MDGs Objective Importance of energy to achieve these goals

1 Eradicate extreme poverty and hunger
Access to reliable and affordable energy services enables business development.
Lighting can extend commercial activity beyond the hours of the day.
The use of machines improves productivity.
Clean and efficient fuels reduce the Households spent on cooking, lighting and heating.
Post-harvest losses are reduced by better conservation
Energy for irrigation improves food production and access to better nutrition.
2 Achieve universal primary education
Energy provides access to water, hygiene, lighting and heated / temperate areas, contributing to the reduction of absenteeism and abandonment rates by creating a better environment for children.
Electricity provides access to schools and homes for the media for communication and education.
Electricity provides access to schools and homes for the media for communication and education.
Quality lighting helps study at home as well as attendance at evening classes.
3 Promote gender equality and empower women
The availability of modern energy services frees girls and young women from the time allotted to survival activities (collection of firewood, water, inefficient cooking, manual harvesting, etc.).
Affordable, high-quality energy services pave the way for business female

Table 4(Contd): Summary of links between energy and MDGs Objective Importance of energy to achieve these goals

4 Reduce child mortality
Clean cooking equipment reduces exposure to air pollution in homes and improves health.
Modern energy is safer, and can reduce accidents (burns, fires, etc.).
Electricity can pump clean, pure water.
Refrigeration allows vaccination of young children. Energy services are required to provide access to better services medicines for mothers (refrigeration of medicines, sterilization of equipment and operating theaters)
5 Improve maternal health
Excessive workloads and heavy manual work can damage the overall health of a pregnant woman.
6 Combat HIV / AIDS, malaria and other diseases
The electricity in the dispensaries allows the opening at night, to retain the personnel qualified, and the use of special equipment.
Access to energy services, through its multiple aspects (lighting, communication, driving force, pumping, cooking, etc.), makes a great contribution to achieving the MDGs

4.2 SDG s

Figure 10:Sustainable development goals

Faced with the new challenge and challenge facing the world today, UN has drafted the Agenda 2030 and approved 17 Sustainable Development Goals (SDGs) listed below with the figure 1. In these Goals and targets, UN are setting out a supremely ambitious and transformational vision and envisages a world free from poverty, hunger, disease and will, where all life can prosper. Each goal has specific targets to be achieved over the next 15 years. The UN is considering a world free of fear and violence. A world with universal literacy. A world with equitable and universal access to quality education at all levels, health care and social protection, where physical, mental and social well-being is ensured. A world in which we reaffirm our human rights commitments to safe drinking water and sanitation and to improving hygiene; And where food is sufficient, safe, affordable and nutritious. A world where human habitats are safe, resilient and sustainable, and where universal access to affordable, reliable and sustainable energy.

Table 5: Seventeen sustainable development goals

Goal 1. End poverty in all its forms everywhere
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3. Ensure healthy lives and promote well-being for all at all ages
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5. Achieve gender equality and empower all women and girls
Goal 6. Ensure availability and sustainable management of water and sanitation for all
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all.
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
Goal 10. Reduce inequality within and among countries
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable 5 Goal 12. Ensure sustainable consumption and production patterns
Goal 13. Take urgent action to combat climate change and its impacts
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Table 5 (Contd): Seventeen sustainable development goals

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development.

4.3 SDG 7 and others SDGS

Figure 11: SDG 7 impact on others SDG's

The main result of this analysis is that energy is a cross-cutting agent for tackling the economic, social and environmental dimensions underlined by the SDGs. Energy is a key driver for social inclusion, economic development and environmental protection. From a social point of view, the lack of access to energy is one of the biggest constraints to the main scope of Agenda 2030 that lies in the eradication of extreme poverty (SDG 1). Energy access contributes to improve the quality of life since it provides better health-care services and a

greater life expectancy (SDG 3), and the possibility to have access to quality education (SDG 4). Moreover, the use of electricity allows replacing or facilitating time consuming rural activities, especially for women and children (SDG 5), allowing them to develop their human and social potential empowering their role within their households and society. In addition, energy provides access to electricity, the use of less polluting systems for cooking and heating (SDG 2), it promotes industrialization (SDG 9), telecommunication services (SDG 9), and it is critical for the supply of safe and drinking water (SDG 6) as well as for the development of inclusive human settlements (SDG 11). In relation to the economic dimension, it is difficult to imagine an economic development without access to modern energy that is a key factor for the majority of products and services enabling the development of companies which, in turn, allows the creation of jobs (SDG 8). Lastly, from the environmental perspective, if produced in a sustainable way and/or from sustainable sources, energy is crucial to mitigate the risk of climate change (SDG 13) and limit the use of unsustainable firewood reducing deforestation and soil degradation (SDG 15).

At an aggregate level (Figure 7), SDG 7 can be considered as an enabling factor for sustainable development since for eleven SDGs out of fifteen, the value of correlation is between 0.5 and 1.5. In terms of intensity value of interactions, SDG 7 shows the strongest correlation with respect to SDG 13, followed by SDG 1, SDG 9, SDG 6 and SDG 2. The lowest interactions are found with SDG 14, SDG 15 and SDG 16. Results also highlight the strong correlation existing between energy, water and food that is analyzed by the water-food-energy nexus approach.

4.4 Energy and development in West Africa

Some researchers (e.g. Pirlogea, 2012; Yakunina and Bychkov, 2015) have provided evidence on the role of energy in human development. Energy access has positive effects on socio-economic development; this is reflected in the improvement of certain such as education, health, gender, shelter and food security, access to information, Improvement of the living environment. These dimensions of development are directly connected to one another (Kanagawa , Makoto and Nakata T, 2006). The Energy and Mining Group of the World Bank established the connection between economic prosperity, sustainable income, health, education, women and children (Kanagawa. M. and Nakata, 2006). The study is framed on four key indicators that are linked to energy access. The indicators refer to the following dimensions: Health Education Income Environment: Linking energy with the key

indicators (V Kanagawa and Nakata, 2006) The main focus of this framework is that there is a direct link between access to energy and economic development as the inadequacy of modern fuels and electricity in most developing countries creates poverty and limits the delivery of social services as well as the opportunities for women. This paper aims to use the framework to analyses the situation in the ECOWAS region and provides inputs to policy makers to make informed decisions with regards to energy access-poverty indicators. Electricity access in West Africa 2013 Country Population without electricity (millions) National electrification rate % Urban electrification rate % Rural electrification rate % GDP per capita Estimated at 2013 (USD/PPP) HDI rank 2013 ranking Benin 7 29% 57% 9% 1600 166 Burkina Faso 14 17% 56% 1% 1500 183 Cabo Verde 0 94% 100% 84% 4400 122 Cote d'Ivoire 15 26% 42% 8% 1800 172 Gambia 1 36% 60% 2% 2000 175 Ghana 7 72% 92% 50% 3500 140 Guinea 9 26% 53% 11% 1100 182 Guinea Bissau 1 21% 37% 6% 1200 178 Liberia 4 10% 17% 3% 700 177 Mali 11 26% 53% 9% 1100 179 Niger 15 15% 62% 4% 800 188 Nigeria 96 45% 55% 37% 2800 152 Senegal 6 55% 90% 28% 2100 170 Sierra Leone 6 5% 11% 1% 1400 181 Togo 5 27% 35% 21% 1100 162 Source: Kanagawa and Nakata,2006 2.2 Energy Access and Heath According to the United Nations, SDG 3 indicates reduction in child mortality, improvement in maternal health and fight against HIV/AIDS, malaria and other diseases. Many foods need cooking and the application of modern cooking facilities reduces significantly in-door air pollution, therefore limiting respiratory and other lung diseases. Access to modern energy services enables households to heat water, thus reducing waterborne infections. Sustainable energy access supports the running of medical facilities such as hospitals and clinics (IEA, UNDP and UNIDO, 2010). In addition, access to energy enables medical facilities to serve the people after dark, to power the communications gadgets and retrieve clients' information. Energy access crises therefore has caused public health alarms, due mainly to inhaling of pollutants during indoor cooking, injury during fuel wood gathering, lack of safe storage of medication (refrigeration) and electricity access for medical facilities (Sovacool, 2012a). Improved energy access will thus improve health delivery and medication storage. The ECOWAS region has recognized that insufficient access to energy has an impact on the social development. Women in particular bear the hardship of collecting fuel and water on a daily basis, leaving less time to access health or 19 education services. According to estimates, more than 257.8 million people (nearly three fourths of the region's population) in the ECOWAS region are affected by air pollution from indoor smoke, small particle pollution, carbon monoxide, and nitrogen oxides, predominantly as a result of cooking and heating with solid fuels. Energy services are vital for providing safe, affordable

and effective health services. The challenges in the ECOWAS region are how to improve maternal and children's health, expand the number of doctors and health facilities, which can be achieved if access to energy is considered as part of the solutions. 2.3 Energy Access and Education Limited access to energy has adverse effects on educational chances to humanity, both for adults and children. These effects include irregular school attendance due to sickness. Many medical researchers have established links between air pollution mainly due to ineffective indoor cooking stoves and severe respiratory problems amongst children. Achieving universal primary education is the SDG 2 of the United Nations. Children in poor rural areas spend the majority of their time fetching firewood and water. Access to modern energy services will facilitate cooking and allow time for school. Electricity is crucial for education since it improves communication and information sharing. It also enables lighting thereby allowing students study during the night. It also allows communities to organize literacy lessons for adults, thereby improving their reading skills. It is also worth noticing that household electricity is important to education, by expanding total hours available for work, chores and study - enabled by electric light compared to fuel-based lighting. Also, it is much easier to recruit and retain teachers in the rural areas if the schools are well-equipped and well-maintained and have access to electricity, clean water, and sanitation facilities. For example, the non-formal education system in Ghana where those without formal education are trained to read through evening classes can be improved with access to electricity. In Guinea only 2% of schools are electrified (UNESCO,2012), and education explains the gender inequality in Burkina Faso. Ninety percent of children in sub-Saharan Africa go to primary schools that do not have access to electricity or any form of energy services, hampering their chances of receiving adequate and quality education. There is a clear linkage between energy poverty and education 2.4 Energy Access and the Environment the environmental effects of limited energy access include destroying forest zones, changing the landscape and greenhouse pollutants. The World Health Organization (WHO, 2014) projected that about 2 billion people are dependent upon the traditional biomass for space heating and cooking, and burn about 2 million tons of biomass daily. Whereas the wood is in limited supply, the population grow is high and the rate of replenishing the trees is slow, thereby resulting in the deforestation and affecting the environment (Sovacool, 2012a). The connection between firewood fetching and deforestation is not true for all nations. A study revealed that many times, people fetch firewood not from the forest reserves but from the “invisible trees” (Sovacool , B.K and Pasqualetti, 2012). (Sovacool , B.K and Pasqualetti, 2012) further suggested that only in Africa - including the ECOWAS - region fetching

firewood significantly results into deforestation. Firewood is one of the main sources of cooking in the ECOWAS region. With regards to access to modern cooking facilities, the access situation is worse than that of electricity access. In the ECOWAS region, Nigeria only has over 100 million people without access to clean cooking facilities. Within fifteen ECOWAS member countries, where more than 60% of the population relies on traditional fuels for cooking, it is estimated that in 2015 more than 200 million people were without modern cooking facilities 2.5. Energy access and economic growth (Income) Modern energy services help to increase income earning activities and can significantly support poverty alleviating methods. A world-wide assessment showed that between 20% and 30% of the yearly incomes of poor people is used on energy band an additional 20–40% is remotely used on the use of the energy (Sovacool, 2012a). A reliable supply of efficient heating, lighting, cooking and transportation is vital and modern energy sources are the key to that need. Researchers, academics and practitioners have accepted the strong bidirectional relations between access to energy and income levels. It is evident that nations with poor population also have less access to modern energy sources (Practical Action, 2013). An increased income is mostly accompanied by increased access to modern energy services. However, electricity access is not only the outcome of economic development; it contributes significantly to the economic development (Practical Action, 2013). According to Jones (1989) and Lee (2005) urbanization leads to increased energy consumption and energy use also increases GDP growth. Rural electricity consumption equally increases agricultural growth (Fan , S, Nyange . Rao , N, 2005). It is therefore important that for countries to 21 develop, every effort must be made to increase access to not only electricity but modern energy facilities. In trying to increase access to electricity and modern energy, attention must be given to the quality, reliability, quantity and sustainability of modern energy sources. GDP per capita in the ECOWAS countries ranges from USD 800 in Niger to USD 4400 in Cape Verde. Most ECOWAS countries rank among the poorest in the world, with 13 Member States classified as having “Low Human Development” by the United Nations

Chapter 5: Introduction to Innovative decentralized renewable solutions and their contribution in achievement of SDG 7

5.1 Definition of IDRES

IDRES are all the innovations driven by decentralized renewable energy systems. These systems are not just decentralized systems their main characteristic being in the fact that they are renewable based or driven.

DS can be powered by fossil fuel like diesel Genset.

Their second characteristic is that they drive innovation:

- These can be innovation in technology or innovative electrification models like nano grid, lifi led, lateral electricity or Microsol by (Schneider electric);
- They can be innovation in business models, like pay as you go, build own operate for mini grid, lease to own, microfinances for energy access, community-based models, pico or shs entrepreneurship;
- They can also be innovation in energy supply (Energy access) following a ladder: energy for basic needs, energy for productive use and energy for modern life. Or distribution through more disintegrated tiers instead of bipolarity centralized and decentralized systems;
- Policy innovation which design rural electricity access in holistic way considering externalities and SDG's;
- The main aim of IDRES is innovation for sustainable local development which create jobs, specific problem solving oriented, are adapted to local context, local participation, associate electricity access with others sectors like Ict's, drive social change, give priority to digitalization and productive use of energy. All these solutions support DRE and permit them to deliver the full potential and target new and infinite domains, create more nexus in order to fight poverty, climate change and reduce injustice.

We can define IDRES as all innovation based on decentralized renewable systems which contribute to deliver basic energy services and development to poor populations.

According to Irena technological break roughs are needed to reduce carbon emissions in the energy sector. Even with economically viable and scalable renewable based solutions

available for around two-thirds of the world's energy supply, population growth and rising energy demand could outpace energy decarbonization without urgent investments in Research and development (R and D). Successful innovation should encompass the innovation, similarly, must provide balanced support, addressing both technologies, including system operations, markets design, regulations, and the enabling infrastructure to scale up renewable (Irena, 2017)

For example, we can mention:

- Micro finance for energy access
- Lateral electrification
- Productive use of electricity
- Innovative decision-making tools for market penetration (Gis for pay go penetration)
- Metering
- Innovative business models for mini grid
- Innovative companies Escos,
- More disintegrated actors
- Systemic and integrated electrification approach
- Energy access based on energy ladder and community needs (not kw/hr.) new paradigms (community approach, basic infrastructure; household approach and individual approach)

5.2 Decentralized renewable energy development in West Africa

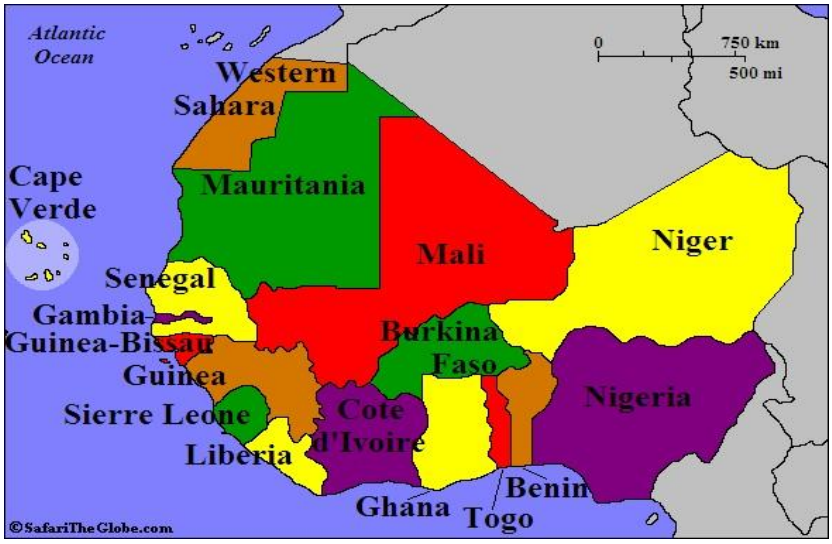

Figure 12: West African Map

West Africa is composed by 15 countries with a population of 382 million people (world meters 2018)

The principal regional organization is ***Ecowas***. For energy, ***Ecreee***; is Ecowas organization working to support countries in their renewable and energy efficiency policies. The organization provides also technical analysis, develop projects, host programs.

It's also the focal point of initiatives like ***Rogep***, Sustainable energy 4 all in west Africa. Ecreee has established ***Ecowrex*** which is Gis based map for renewable energy projects in West Africa.

The West African power pool is working and interconnects most of the countries. It's a specialized organization of Ecowas with the main objective to create a unique electricity market and offer more competitive and more reliable energy to West Africans across the region. It covers 14 out of 15 countries.

Despite these established institutions the region very weak when it comes to security West African region is one of the most unstable at political level in the continent. Two out of 15 countries face serious crisis with constants attacks and part of territory controlled by terrorist group on their territories in 2018 (Northern Mali, Northern Nigeria).

One of the principal threats to stability in this region is terrorism (all the countries in the regions are exposed to terrorist attacks. (Burkina, Niger, Cote d'ivoire, Mali, Nigeria) have been victim of terrorist attacks. In Senegal, Burkina and Cote d'ivoire; the risk of attack remains high.

AQIM and Boko haram are the most active in the region

The common problem of all these countries is weakness of rural electrification rate.

Excepted, Cape Verde regarding the figure ahead, all the others countries present serious inequalities between urban and rural electrifications. Also, political will for renewable energy development remains weak or focused on developments of big projects in Solar Pv. Only Senegal is doing good in rural electrification followed by Ghana.

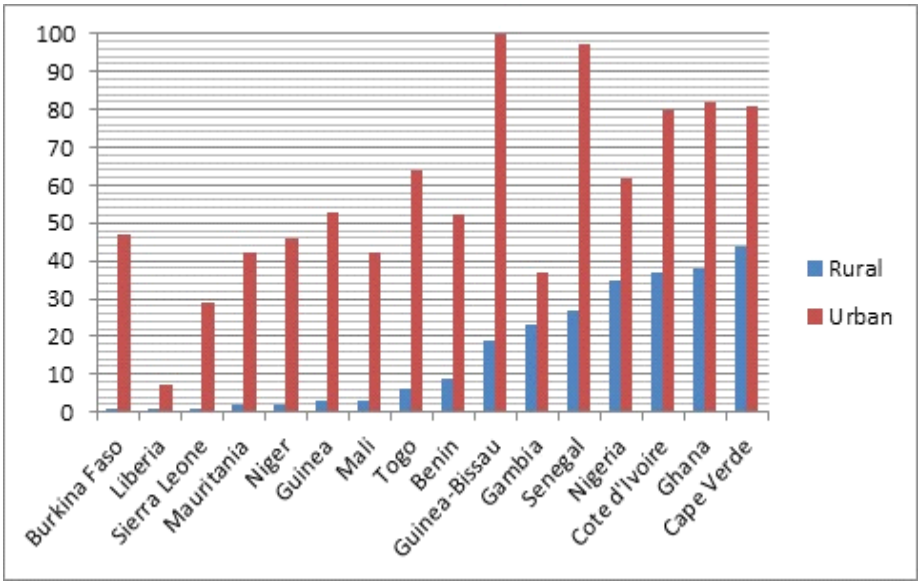

Figure 13: Urban and rural electrification rates in west Africa 2010 energypedia

These years; many countries, companies, and donors are showing great interest for off grid solar solutions and mini grid developments (Nigeria, Mali, Senegal, Burkina Faso, Benin, Ghana, Togo and Cote d'ivoire). Many of these companies are already trying to penetrate this great market and duplicate performances in eastern Africa where competition is becoming more difficult, interest for pay as you go is becoming low or (stabilizing) and interest for higher electrifications solutions like mini grid are taking the lead.

Cote d'ivoire, Nigeria, Burkina Faso, Ghana, Benin and Togo are very attractive markets for solar off grid and pay as you go companies. Strong political will is emerging in countries like Benin, Togo, Liberia for pay as you go development

For mini grid, Nigeria, Senegal, Mali, Cote d'ivoire is leading the way in term of number installed

Poverty and conflict have put West Africa behind the rest of the world in the deployment of solar. But the implementation of sweeping renewable energy goals means solar has a big chance to gain a foothold in the region, says Ben Willis

As the deployment of solar energy continues its onward march around the globe, one region that is quietly eyeing up the opportunities the technology presents is West Africa.

Addition, electricity demand is on the increase as income and socio-economic conditions improve across the region. Solar energy can diversify the current energy mix and help to meet this demand." Theoretically all West African countries have the potential for solar development.

In terms of an abundance of resources, Ecreee identifies great potential of development for renewable energies sources principally Solar pv; in Mali, north-east Senegal, the Cape Verde Islands, Niger, Burkina Faso, northern Nigeria and northern Côte d'Ivoire.

5.2.1 Micro and mini grids are emerging as an electrification model of choice to achieve Sdg

Figure 14: Ecowrex Gis mini grid map, West Africa 2017

The table ahead shows the map of existing mini grid in the west African region. Mali, Senegal, Nigeria and cote d'ivoire are leading the way. many organization (ngos, associations like Geres in Benin and Mali, private actors like Engie and Schneider electric (with microsol and villaya micro grid) and local companies in Nzegria like Gve are deploying these solutions in the region with innovative business model.

This sector is driving a lot of innovation.

For example, Schneider electric villaya micro grid is a plug and play containerized system which can be managed remotely with a digital tool.

In Mali, Geres has developed a very interesting business model for his mini grid in konseguela. An eco-building electrified activity zone built to host a mini grid and activities which need power to be delivered. The small companies pay for their installation on the site

and for energy used. Centralization offers great benefits for populations who have access to product locally, and very interesting in term of quality of energy delivered on site. One person is responsible of the maintenance and exploitation of the site. He is a permanent employee.

Businesses are generating local jobs, reducing time of villagers in their daily activities, and are growth income, investments .and in their activities.

It's an example of productive use of energy and an innovative business model for local development

Mini grid innovations appear as the right way to go to accelerate sustainable energy access by 2030. It means providing electricity to 640 million of people mainly in sub-Saharan Africa.

IEA developed two scenarios to achieve this target. The figures below present them.

Both of them permits to achieve universal access but with significant differences. with the figure in left side which gives priority is given to mini grid the share in term of option of electrification (48 per cent mini grid), 29 per cent grid extension, 23 per cent for off grid. The main advantage with this scenario is that it will permit to increase renewable (essentially solar) and reduces the share of fossil. This scenario will need investment of 391 billion Usd to reach universal access.

With the second scenario the share is more equilibrated with (This scenario can permit to achieve more efficiently. energy mix the share is dominated by grid (37 per cent) followed by mini grid 34 per cent, and off grid 29 per cent. In this scenario fossil fuels dominate the energy mix with a small share of renewable.

This scenario is cheaper than the previous scenario (334 billion Usd).

In the both scenarios, we notice that mini grid is an important option to achieve universal energy access by 2030.

Its means that the gap for more sustainable energy access is 57 Usd. It the cost of SDG 7

According to Iea the ideal scenarios to achieve universal energy access by 2030 will.

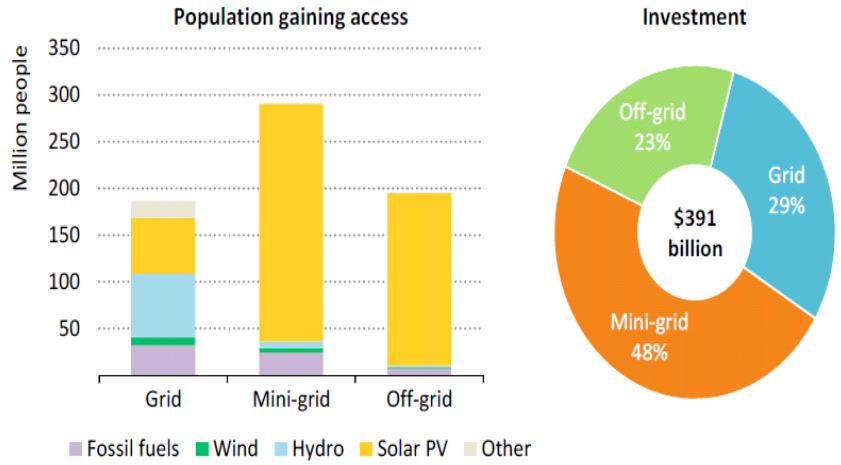

Figure 15: Access to energy investment forecast decentralized system, IEA

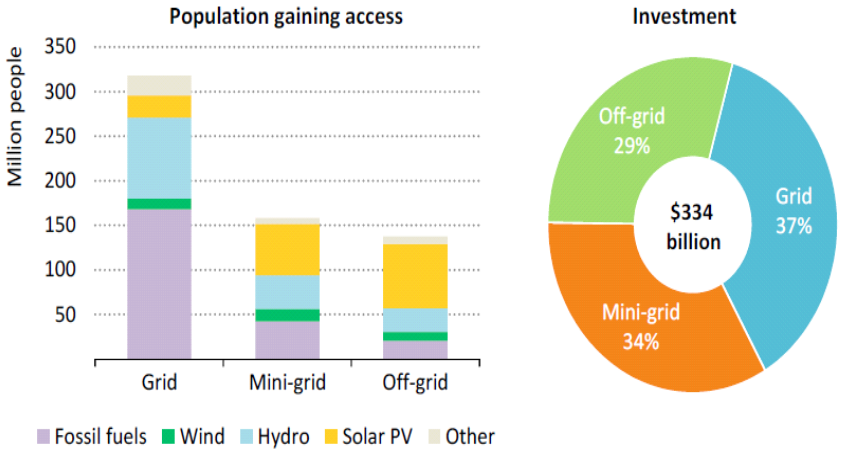

Figure 16: Access to energy investment forecast grid based, IEA

West Africans countries need to develop mini grids if they want to achieve sustainable universal access of electricity by 2030. One more reason based on examples ahead are the externalities and positive impacts that they can bring to local communities.

5.2.2 Stand -alone systems

A stand-alone system is a system that operates independently of is not connected to, an electric transmission and distribution network

Major balances of system equipment for a stand-alone system include:

Solar home systems and pico systems

5.2.2.1 shs stand -alone system

A shs stand - alone system is a system which is composed of a battery, bulbs, wire

Figure 17: Shs, Mpoka product

5.2.2.2 pico systems

Pico systems are generally for basic needs in energy access. Their principal usage is lighting, phone charge. But new models include radios.

Powered by solar generally with a solar panel they are eco-efficient using Led bulbs.

They can permit to replace candles, flash light, kerosene lamps, fire lights and are better for health and education.

In Africa many families spend (around 10 Usd / month according to energypedia) in kerosene phone charging, flashlight batteries which can be harmful for their heath, WHO recognizes that fossil fuel lighting products present many risks for health (eyes, lungs). Also, they can cause accidents (body or house burning).

They can permit to develop businesses like pico and shs entrepreneurship in Kenya (Mkopa) through direct sales, many people buy and sell this equipment and generate a lot of income while providing reliable source of energy.

Pico systems are suitable both in off grid communities and on grid communities (shortage and dark areas).

In off grid areas they can be very important for students to read at night, people to charge their phone and women to feel secured. Some clinics use it for lighting at night and in this case, they can be very useful to increase quality of service.

Figure 18: MobiyaT170 lantern by Schneider electric

Figure 19: Homaya S02 by Schneider Electric

5.3 DRE development driver of IDRES in West Africa and cote d'ivoire

Many shs companies exist in the region. At least one per country

5.3.1 Nano grid

As his names say it Nano grid are small micro grids typically serving a small building or a single load (quora.com what's a nano grid).

It a combination of both innovations: technology and approach.

Nano grid is an innovation driven by the lateral electrification developed by Nanoé and in pilot project in north western Madagascar (less than 5 per cent access to electricity). According to Nanoé, Nano grid are collective solar systems which power 4 to 6 households who buy prepaid electricity through mobile money according to their needs. Nano grid can

be connected among them and have these characteristics: Ecologic, Affordable, Flexible, Scalable, Smart.

The business model of Nanoé is based on the objective to develop a structured network of local decentralized electrification constituted by Nano entrepreneurs who build, operate and exploit the nano grid.

Nanoe (www.nanoe.net) provides support to these entrepreneurs in 5 domains:

- Access to finances
- Access to equipment
- Training
- Access to tools and methods
- Market penetration

In Senegal (village Niomoune in Casamance) is benefiting to nano-grids .138 household use this technology. The payment of energy is done through pay as you go system in the sunna box (can be managed remotely). A local company south solar system has been trained for sunna box and equipments use. Real sign of transfer of competencies between North and south.

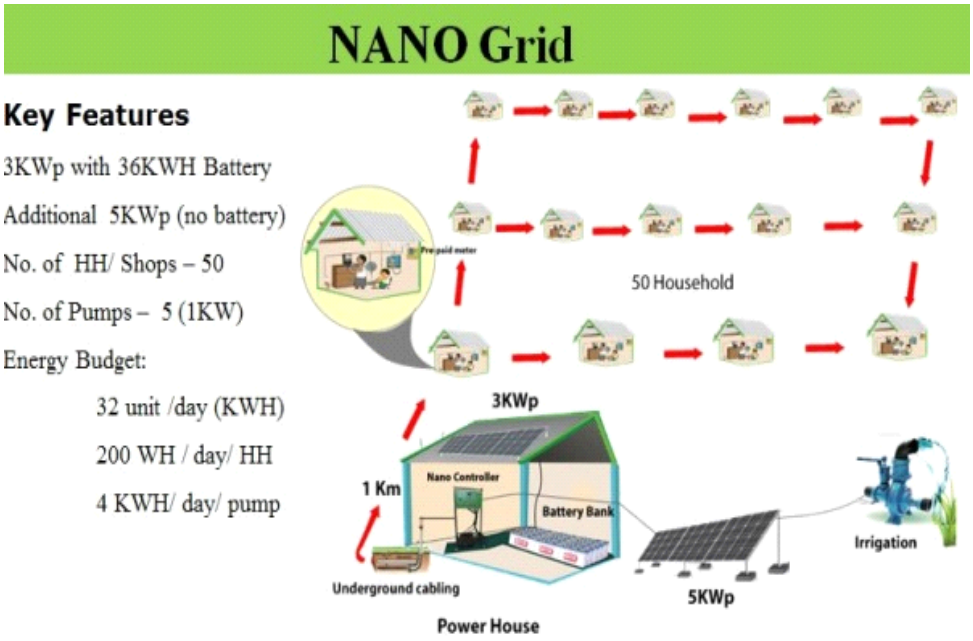

Figure 20: Nano grid synthetic figure 'source Nanoe'

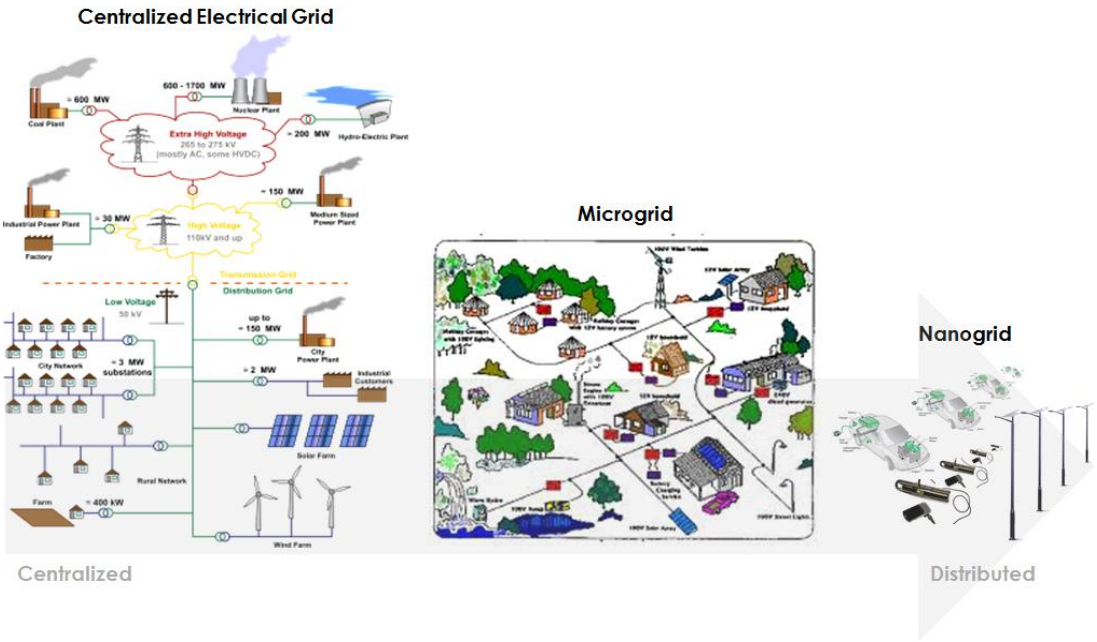

Figure 21: Comparison figure Nano grid and others electrifications systems

5.4 Impact of IDRES on Sustainable electrification in West African and Ivorian context

5.4.1 Methodology

The role of these solutions in west Africa and in Cote d'ivoire will be analyzed through selected case studies and markets analysis that, i have participated in. The best example that we will focus more on is Donvagne projects, West African market survey of pay as you go and lifi led observer. During my research internship, I was fully engaged in Donvagne project as program manager. In lifi led as external analyst (for Brahimakro project) and in market survey as researcher with my colleague from Schneider India business development team

For the others cases, I learnt more about them inside Schneider electric West Africa in Abidjan from march 21st to August 31st.

5.4.2 Case studies

5.4.2.1 Case study 1: Donvagne

Project title: electrification project of the economic activities center of the kabiato cooperative of the women of donvagne

Budget: 90,000 Euros

Presentation of Donvagne

Figure 22: Donvagne satellite view Map

Located in north of the Ivory Coast in the sub-prefecture of Bondo and Tanda, Donvagne is a town of 6000 souls recently connected to the network CIE. The locality is located 60 km from Bondoukou. From Abidjan to Donvagne, it will take about 6 hours and 30 minutes by road with more than 400 km of paved road between Abidjan and Tanda and 50 km of Tanda in Germany on the track. The village has modern housing, two non-electrified primary schools and a dispensary with a solar system and a gas-fired refrigerator.

Figure 23: Donvagne primary school whithout electricity

Figure 24: A fridge of Donvagne clinic powered with butane gas

The main economic activity is agriculture (cashew, yams, maize, cassava, plantain are the main crops).

The relief consists mainly of plateaus but also slopes and terrain in places. The mobile connection is very limited. No Orange network (just in places). Mtn is more stable

The village is electrified, electric poles are present in large numbers, however, they are not all energized.

Fourteen households have electricity meters at the moment and the current quality is not very good (weakness of the brightness in places, obligation to turn on the switch 2 hours before having the illumination of the bulbs by moment)

Main economic activities: The main economic activity in the locality is agriculture. The main crops in the locality are: coffee, cocoa, cashew nuts, yam, cassava and shea. The women of this village are grouped in agricultural cooperatives (Society of Cooperatives simplified Kabiato of the women of donkey), they also devote themselves to the folding and the marketing of the shea butter Problems Despite the development of agricultural activities in the above-mentioned localities and the presence of the electricity network (in the case of Denmark), the general population and women in particular are still experiencing enormous

difficulties in exercising and developing economic activities. Interviews and meetings led by Ong Kartieca in these villages, it appears that poverty and lack of access to energy appear as major obstacles to the development of these rural areas

Figure 25: Old damaged mills in Donvagne

In general, these women organized into cooperatives live below the poverty line (1 Dollar USD / day). Their ability to connect to the power grid is limited or impossible for many of them. They suffer even more from the lack of equipment (mills, kneaders, cold rooms) for the exercise of their economic activities. It is in order to meet the challenges of gender inequality through training and emancipation through economic activities that the NGO Kartieca will send these seven (7) ladies to India. After six months of training, these women trained in basic electricity and solar energy continue to face enormous difficulties in implementing the knowledge acquired because of their precarious socio-economic situation. lack of support from organizations It is strong of this and believing in the power of energy to favor sustainable and inclusive development that the Schneider Electric Foundation has decided to support these women through its program access to energy and for the purpose of productive use and clean energy

Equipment provided

Table 6: Budget of mini grid project in Donvagne

Budget for village:	**DONVAGNE**
Electrical Equipements	**Item**
	Mobiya TS170S 100Units
	Homaya SHS02 100Units
	Villaya M25 (Solution comp)
Transforming equipments	Mill
	kneader
	Cold room

VILLAGE	MULTIFUNCTION MILLS	COLD CHAINS CONSERVATION-COLD ROOMS	Kneading BUTTER BUTTER SHEA
DONVAGNE	1	1	2

Business model and ownership transfert

The terms of transfer of ownership of the equipment to the village of Donvagne are defined asfollow:

An agreement between Schneider Electric and an association that will provide the order, define the terms of the equipment transfer and the sustainable management of the project

Management

The selection of beneficiary homes for solar lamps and Shs kits will be done by the Ong kartieca and following a participatory process involving the villagers. The opening of a cash register or a local account is to be expected. The lump sum paid for the acquisition of Mobiya or Homaya will be used for equipment maintenance. This amount will be housed in a local fund or local account managed by the community. The NGO will provide the collection procedures and supervision in close collaboration with the villagers. The daily management of the mini-network will be done by the women's cooperative. They will ensure recovery. The daily management of mills, kneaders and cold rooms will be done by the cooperative of the women who will use it. The fees paid by the customers will be used for their maintenance

NB: solar panels can be serviced by the Mami Solar and the management cooperative. In the course of the meeting we will discuss in more detail the levels of involvement and responsibility of each actor (Schneider Electric, Ngo Kartieca, local cooperative, village community). The flat rate fees payable by households for mobiya and homaya were discussed and fixed villagers themselves.

Figure 26: Ivoirian Mami solar training in India (Barefoot training)

Project planning

The project at this stage has been planned in three steps

For the first step, many (4) meetings with Schneider electric, the Ngo, mami solar and a representative of the village of Donvagne has been organized. The aim consisted in

understanding the context, assess the problems and explain the vision of productive use. its permitted also to evaluate the level of the Ngo in managing the project and the level of implications of villagers. This step permitted to identify and adapt the needs of the populations to our vision of productive use promotion in a participative way.

Result: this step permitted us to understand difficulties and the context. it's also permitted to adapt the offer with the demand in a participatory way to avoid misunderstanding or create new demands out of the scope. it reveals that population know their needs but it necessary to guide them. Also, it permitted to understand the gap between existence of the grid and low rate of connection. That was the sign that presence of the grid in an area doesn't means capacity to have electricity in homes or create by the only presence local development.

The second step was preparation of the budget and the project development. At this stage cooperation of the Ngo, local communities and partners were crucial. It's permitted to prepare the business model and think about partnerships in order to develop a holistic project with impact on local communities. It's very important to mention that working with a Ngo or actor who is passionate about local development and project development can permit to solve many obstacles.

The third step, at this stage was the visit to the village

The objective of the visit was to assess really adaptation between the needs and the development of the project. it was also a prospection and meeting with populations

During 2 days from May 23rd to 24 th I went to the village

Figure 27: Photo with village representative for inclusive decision making

Results of visit trip

This trip has permitted to understand the need s and real problems of development of populations. They are able to define their needs and be part of local problem solving. local development association can contribute in financing of economic activities (Donvagne development association will give a loan of 2000 euros to launch activities of the women of the cooperative

It's reinforced our vision and ambition, to adapt access to electricity to local issues and local development with an emphasis on productive use. The trip permitted to highlight the importance of electricity access for rural communities whatever the source of energy and their willingness to pay and sustain the project

The links between local issues and energy access can be understood by communities. They are very implicated and motivated when they understand the capacity of energy access to create impacts on revenues

Energy access projects should be framed in a participatory way with many stakeholders (private sector, local population, community leaders, Development Ngos and local associations). Also, it commends to take care of social, economic and environmental impacts of the projects.

A productive use of energy project should be based on a strategy (develop productive use of energy to fight poverty), must be flexible, participative, based on adaptation, focused on training and skills development, market analysis and constant follow up. It's a development project, so its sustainability is the key when you plan to scale up. The socio economic and human capacity development of the project are very key to frame a productive use project in an efficient and sustainable way

Figure 28: Meeting with villagers for project explanation

In conclusion the trip permitted to adapt the project to the new inputs and challenges like human skills development (financial literacy, technics of sales, telecommunication using). We have brought new actors like lifi led in order to bring internet, training in internet, bring in digital content and IECD will develop activities for skills and economic development. We are thinking for new way to tackle challenges for school and dispensary of the village which are on powered. As you can see this project is an example of Innovative decentralized renewable energy solution.

It's bringing constant adaptation, innovation everywhere from business model, to energy supply (productive use for development), and innovation in technology (Micro grid in container and lifi led). At the end of the project we expect:

- An economic activities center for the village and in a long term an (economic activities zone for many villages around) **(SDG8 and 11)**

- 200 women of the cooperative will work in the EAC, increase their revenues and develop new **(SDG5 and 1)**
- Agriculture products of the cooperative will be transformed locally and sold with added value **(SGD 11)**
- provide fresh product and develop activities like fresh drinking **(SDG 8 and 12)**
- 200 women will be trained in finances, office, basics of marketing **(SDG10)**
- 1 permanent job will be created for equipment safety **(SDG8)**
- 200 beneficiaries of solar kits and lantern (poorest of the community) **(SDG7.1)**
- Digital content and capacity to communicate through internet for the village **(SDG9)**

5.4.2.2 Case study 2 Lifi led Drongouine

How LED lights are bringing internet to a remote Ivorian village?

An Ivorian entrepreneur is using LED technology to bring not just light but also internet and television to about 5,000 people living in a remote region in the Ivory Coast.

In April 2017, Drongouiné an Ivorian village located near the border with Liberia was equipped with solar panels that provide its residents with light when darkness falls. But that's not all: this light also gives them access to the internet and television without any wire or wifi connection, thanks to a new technology called Li-Fi.

Figure 29: LIFI LED TEAM at Drongouine primary school

This school in Drongouiné now has free internet thanks to solar-powered LED light bulbs installed around town.

So, what's Li-Fi?

Li-Fi (Short for "Light Fidelity") uses LED lighting to transmit data (including text, photos and videos) to computers, smart phones or tablets.

It differs from Wi-Fi in that, instead of using radio waves to transmit data, Li-Fi uses the light spectrum. An LED light can share data by blinking on and off several thousands of times per second think Morse code.

Researchers believe that Li-Fi could have the capacity to transmit data 100 times more quickly than Wi-Fi. Li-Fi is already used in some offices, especially in France, but researchers are hoping to roll it out for large-scale use by 2020.

Drongouiné residents who have a smartphone or a tablet can now connect to the internet or watch television. There are some limits, though – for example, the light spectrum can't

This device uses the light spectrum produced by LED bulbs to broadcast television channels. Once darkness falls, project chief Ange Frédérick Balma demonstrates how it works.

Figure 30: Drongouine light bulb Led

"By providing free internet, we want to encourage young people who have left their village to come back and participate in its economic development"

The company now has 12 employees.

Drongouiné was chosen because it has suffered a lot over the past 20 years from the conflict that has spilled over from Liberia

Mobile phone signals don’t reach this region. People have to walk about two hours to their nearest town to recharge their phones or connect to 3G.

Li-Fi project is elf funded, paying for the solar panels, the LED lights, the electric cables and a Li-Fi receptor. Altogether, it cost us 5 million CFA francs around €7,600. We tried to be creative to keep costs low: for example, the team called on local people to give us their plastic waste and we used it to make light poles. They set up these light poles in different places – like outside of the school, the dispensary and the local youth club – and mounted LED lights on them. The lights are powered by solar panels.

Figure 31: Light pole supports electric cables made out of 100 percent recycled plastic

Impacts of Lifi led in Drongouine

Thanks to the internet connection, now it possible to set up distance-learning programs to train local farmers. We have Ivorian agronomists host video conferences on Skype or they send videos by WhatsApp to local farmers to show them how to increase their yield.

Many young people have left the village as part of the rural exodus. Now, they live in Abidjan or other big cities but don’t have real jobs or careers and are just waiting around. Lifi led CEO wants to inspire these young people to come back to Drongouiné to participate in the economic development of their village, with the help of the free internet that this technology provides.

"This device has changed the lives of doctors and teachers”

What do local residents have to say after five months of this new technology?

We asked André Ba, who coordinated the Li-Fi installation. He lives in Danané, a town about 10 kilometers from Drongouiné.

The device works within a radius of 300 meters. Now, doctors have permanent lighting thanks to solar panels. They can deliver babies at night. In case of an emergency, they are also able to use the internet to connect in real time with doctors and specialists in Abidjan. Teachers can also use internet in the classroom.

Many people in the region are curious about Drongouiné. Some people have even come from Liberia or Guinea to see the light that provides internet! People in the neighboring villages are jealous, but no one has ever tried to steal it because everybody understands that it can benefit the whole region.

What are the next steps for the project?

The project which is supported by the National Federation of Professional Organizations for Youth in Rural Ivory Coast (FENOPJERCI) isn't stopping after bringing power to Drongouiné.

By the end of 2017, about 2,000 other similar Li-Fi systems are supposed to be set up in other rural Ivorian villages (with funding from the African Development Bank, the US Agency for International Development, and the Ivorian Ministry of Digital Economy).

The project has even piqued the interest of Ivorian President Alassane Ouattara, who met with the Lifi-Led Côte d'Ivoire team on August 4. The Ivorian presidency also awarded the company the 2017 prize in digital innovation.

With 5,000 lighting kits, he should be able to cover the needs of all 8,000 Ivorian villages across the country. That means the team just have to get funding for an additional 3,000 to reach his goal. He also received a lot of requests from countries like Madagascar, Guinea, Mali and Burkina Faso. He wants to show the world that all we have to do is install lights to bring technology to remote regions.

Figure 32: Lifi led light on experiment in Drongouine at night

5.4.2.3 Case study 3: Market survey of Pay as you go SHS in West Africa and Cote d'ivoire

Methodology

The market survey main objective is to analyze the market evolution the general objective is: understand development of pay as you go shs in West Africa, existing business models, understand the challenges and adaptation of offers to the market and population needs

The research has been conducted in Senegal and Cote d'ivoire. The methods used are interview with actors (yelen, lumos, peg, baobab +), visit of off grid villages and local renewable equipments, interviews with SHS owners

12th April 2018

Yeelen (Cheikh Fall)-Dakar, Senegal

Yeelen sells own SHS without PAYG. Has PAYG trial version with GSM module.

- Presently selling about 3000-4000 units in 2017 of 2 systems:
    - 9 lights + 1 mobile charging point + radio system with output for 12W/12V DC fan. Runs on lead acid battery and powered by 18Wp solar panel. Priced at 120 euros. Sold about 1000 units. Battery capacity not known

        - 5 lights + 1 mobile charging point with 12Wp solar panel, backed by lead acid battery. Priced at 100 euros. Sold about 3000 units. Battery capacity not known

- Lead acid batteries are imported from Morocco. Rest of the supply coming from China. Supplier not disclosed.
- Installations start from 120km away from Dakar.
- Insights on customer requirements:
    - Only the head of the family (earning member) gets to enjoy the TV or fan
    - Each compound is about 300-500 sq.m in area
    - Atleast 7 members are there in a family. The entire family is based in a compound, not surely a house
    - Every village has about 250 compounds
    - Polygamy is practiced, and all the wives stay in harmony in the same compound
    - Present expenses for pain points:
        - Mobile charging: 0.15 Euros per day for small Nokia or Techno mobile. Charging station from local assembly used.
        - Kerosene lamps: 1.5 Euros per day
- PAYG is right now being tested. Facilitated by Orange money. PAYG is not a requirement to enforce payment, but is merely looked as an option to automate. Payment is ensured by giving freebies to the head of the village. And connections are given to people who only come through the head of the village. Localized employment is provided, so the community tends to payback, considering that they are here to help the community.
- DC TVs are managed by the local dealer or distributor. The signal to the TV comes via an antenna, and not by a satellite connection in most of the customers.
- Lengthy cables are required as house locations are complicated. Length of cable provided to each light point in some cases is 15m.

- Sell more bulbs as optional. Radio is nice to have, and not must-to-have. Users substitute mobile phone with the radio application
- Head of the village given a 250Wp system for 2200 Euros to power TV & fan

16th April 2018

Tauba Rama-Senegal (Dakar)

Mr.Sheikh: Sells PAYG SHS with Fosera (Lumeter)

Right now distribute SHS with PAYG, but you are looking partnership to setup microgrids

- Micro-grids for local institutions, SMEs (shops, productive units-women trying to food processing->processing sheep butter for incense, baobab fruit to powder conversion)
- Distributing PAYG with Fosera. PAYG enhances affordability.
- Agents on the ground collect money and pay with mobile money at a centralized location
- Right now Orange money has no fee for online payment. Wari and expresso have charges.
- Right now no mobile money integration
- Sales: 200 systems of Fosera LSHS (2 lights, 3 Lights + DC TV systems). The TV one is most popular. 80% comes from sales of the LSHS 10500.
- Upfront money: 3% of the total amount. Pay every month.
- TNT connection is inbuilt into the DC TV.
- Additional satellite dish is 30W(AC) but is 18W(DC), and is plugged into another port of the powerbox.
- Code is sent by back end to the customer's mobile phone. Customer enters the code on a remote that is provided with the product
- Payment plans are for 24 months. Prefer the keypad to be on the product itself. That's why sunKing Pro adoption is going on.

- Product warranty for 3 years, TV is for 2 years. Spare PCB available
- 185000 CFA is end price with PAYG for LSHS 10500 system without the TV. TV is paid in 1 or 2 months. TV is for 80000 CFA.
- Lumeter:
    - Basic, gold plans. Deposit for any number of units, and then some per unit
    - $3000 for 2 years for 200 products. Approx $15 per product
- Termination code: Customer receives a code free of cost every single month
- Customer needs more loads.
    - Needs 2 or 3 more lamps. Recommended to sell lamps as stand-alone.
    - Mostly TV is sold
    - Sometimes 1 fan is sold. Right now, no fans sold. But demand exists on the fan
- Less than 2% default rate. Meet villages and ask local leaders support.
- SPLs sold without PAYG is about 100s in Senegal
- Expansion in Burkina faso, Mauritiana

April 14th Dakar + visit to village

Serge Malhan from Kama (operates in Senegal & Mali)

- Into electrical lines business since 2013. Ex-Schneider electric employee. Does microgrids from 130kWp to 230kWp
- Inverters used: SMA, SE
- Cheap labour in Mali. Doesn't need payment collection or in-a-box solution. Small roads in Mali, so plu n play kits are expensive to use
- Hybrid systems with DG & Solar
- SAT connection is inbuilt with the TV

- Urgent demand in Mali for 5000 units of SHS
    - Lights to be powered by S02
    - TV to be powered by separate CCU, battery & SPV. TV is 35W (32 inches with SAT) or 51W (42 inches with SAT). 5000 units of the TV alone were given free from the govt before the elections. Want to power it with SHS, and be ready before football world cup in June 2018
    - DC TV is locally available in Senegal, Mali. Guinea might not have DC TV
    - Systems supplied in Mali so far:
        - 5 lights of 7W each LED + 5 switches. 230Wp + charge controller at $9 + lead acid battery (200Ah/12V) Costs at 280000 CFA. Sold at 360000 CFA
    - No PAYG. In case customer doesn't pay, the local SAT operator cuts the SAT connection.
    - Limited GSM connectivity with GSM in Mali & Guinea
    - Recommended size of SHS he suggested:
        - S03: Power a 34W or a 53W DC TV + 2 mobile charging points + 5 lights (reading enough). Priced at Euros 200 to him
        - S04: AC & DC output. Comfort system for powering a AC TV, and more than 7 lights
        - Sell lights as additional add-ins

17th April 2018

Sandrine Marmalejo

Distributor for GLP. Located in Thies

- Sold around 500 units of PAYG for SHS
    - Distribute through micro-credit products
- Sell pico to SHS

- Provide charging device for intermediary ones
- Pay license fee to angaza. Use Keypad system rather than GSM, because the network bandwidth is limited.
- Set up pricing plan with Angaza. Final code is also given by Angaza
- Affordability: 300/400 CFA per day, for mobile charging & light and sometimes 1000 CFA per day for higher needs
- Home 60 sold out. About 1000 units sold. No Home 120
- 18 months' tariff plan. 7500 per month
- Default rates about 15%. Mainly due to payment options. Away from Wari & Orange money.
- Warranty is for 2 years. GLP gives them 3 years' warranty.
- Feedback for S01 & S02:
    - Dimming option needs to be on the overhanging switch
    - Nice product. Considering distribution with SE, waiting for PAYG as they want to build pipeline
- Needs an open platform like Angaza. No tie-ups with mobile money is required
- Need DC TV. Right now taking the TV also from Home 120 GLP. It has antenna port
- Everybody is asking for TV. Fan is also needed
- Per system paid to Angaza for $8

18th April 2018, Abidjan

Solar Access

Yves Cedric Sokro

- Buy SHS kits from China and sell. Sold 10k USD of SHS near Yopougon. 18 SPV panels are installed for a house, each of 50Wp
- Have powered a pharmacy

- 3 lamps + 1 projectors + 1 fan is powered by a 10Wp solar panel
- Solar power bank is sold at $30
- Products are sold around village festivals time
- Market insight:
    - Limited knowledge at the village level on the availability of solar energy
    - 45W DC TV is commonly available
    - Most of the TVs powered by the antenna for the signal.

      So no separate power consumption
        - Unit wise bulb/light could be available
- For promotion, the NGO displayed about the uses of solar energy & it's possible outcomes for the village while being in village(Akeikoi) at the night

April 18th 2018, Baobab energy

Ange Lewis Ndri (Commercial responsible)

- Baobab is a MFI also venturing into distribution of SHS (sunKing) and clean water
- Presence: Ivory Coast, Madagascar, Mali & Senegal
- Tie up with Microcred in Ghana
- Products sold:
    - Home 60 & Home 120 of GLP
    - PAYG just started but less adaptive as the system is yet to be mature & is a bit heavy to deploy. Doesn't exactly supplement their classical MFI model of selling the products with consumer financing & payment collection being done manually
    - Has samples of Home400, no sales plan or forecast available as of now
    - Reason for GLP: Fosera doesn't have the after sales support like GLP. Keypad version is better as limited GSM connectivity throughout Ivory coast

- Home 400: 1 SPV panel + 4 LED bulbs + 1 22" DC TV + radio + 1 flashlight+ 1 charger
    - Optional Canal+ dish is offered to the customer
    - Pricing:
        - 644000 FCFA (1200 USD) for the kit in total. 5000F CFA ($10) per week paid over 24 months. The remaining is upfront money.
        - Price difference between PAYG & non-PAYG is $200 over the lifetime of the product
- Also sells a Chinese (SunBell) solar lantern at $72 using a micro loan system

- Business model
    - Sell through their local MFI setup with Microcred (21 locations in Ivory Coast). Consumer takes loans to buy the product from Baobab+ using the loans given to them
    - Leasing is for 1 or 2 years. Customer pays close to 25%-30% as upfront deposit
    - PAYG sales started 8 months' back
    - Payment is done through mobile banking account of MTN & Orange
    - PAYG is being tried at San Pedro, Duekoue, Man (Economic activities in the area are Cocoa production)

April 19th 2018, Abidjan

- Green countries is an Ivoirian start up led by Sylvere Kouakou. The company produces bio fertilizer from organic waste collected through some partnership with agro industry companies which give for free around 60 tons of their waste.
- The site of company is located in Bingerville near Abidjan.

- Business is of interest of find the challenges in the last mile distribution of the product to the end customers, that's the farmers in most of the country
- Crops supported: Sugar, cocoa
- Distributes through farm co-operatives: Selected 2 farms per co-operative as pilot. Co-operative doesn't charge more than 5% margin as it's run by the farmers

The advice that we got from him at this moment is to know where are how potential customers, prospect there, give them some incentives and use them as distribution channels. It's very important to penetrate the market reducing at the maximum intermediaries at a launch of the product. the main challenge is to have a small market, establish loyalty it and for expansion you can think about exploring new distribution networks

We ended the meeting by a visit of one of his site and he showed a willingness to partner with Schneider for solar products.

April 19th 2018, Lumos

Visited the MTN agency in Yopougon Keneya where the Lumos kits are being sold

- GSM system for PAYG. After buying the product, the MTN mobile payment account enables the recharging the device. The code can be 1, 5, 10, 20 or 30 days. Payment is based on number of days and not on the energy consumed
- Total price of the product is $570. The 12V DC output socket is same as that the car port. This is different from the Sun King & d-Light systems.
- Lead acid-based battery system, TV and radio are add-ons. A separate 150W inverter was used to power the AC loads. Warranty is for 5 years

Figure 33: Lumos SHS paygo product

April 20th 2018, Abidjan

PEG Ivory Coast Nate Keller

Distributes D.Light PAYG SHS now, distributed M-Kopa earlier

- Sold 25k units in Ghana & 7k units in Ivory coast
- Product:
    - Product 1: $70 upfront payment and remaining $700 recovered in 12 months. Code is a 12-digit generated for manual entry into the keypad. Number of trials allowed for error is 3.
    - D.Light gives them access to their CRM tool named Atlas, and gets connected to their own ERP system
    - Price:
        - X850: With TV is $700
        - D30: Without TV is about $300
- Reasons for moving from M-Kopa to d.Light:
    - Lesser price about $1000 for 500 pieces lesser
    - GSM based:
        - Limited connectivity
        - Monthly recurring expenses
        - Measurement done on energy consumed rather than number of days
- Suggested PAYG solution: to have both GSM & Key-pad system
- Termination code: Once the outstanding payment is cleared, the final code is passed on which ensures that the system doesn't need any more codes after it

April 21st 2018, Divo (Sur les rails)

Visit to Divo (2 villages Air mankono and Sur les rails)

Airmankono

Mr boli Ousmane, resaler of solar panels & battery

We took some information about the solar equipment

-solar panel: 100Wp: 100 USD

-Battery: 150 Ah, 12V lead acid battery

Tv: 15W Samsung

Led 7W

-Solar lantern: Chinese products 6-7 usd (one-time battery powered, not rechargeable)

There is no technician in the village, people do installments themselves or by small electricians

- Canal + decoder and dish: decodeur: 14V-DC

Mr Boli takes his products in Abidjan (Adjame black market)

-Equipment

Battery: 40 Ah+50Wp panel (4 bulbs (3-15 W-DC12V outdoor bulb) + fan (14w) +tv (15 w) +canal+ (15w)

Price

Battery 20usd 40 Ah

Solar panel (90usd) +4bulbs (9 usd) +fan (22 usd)+Tv 17'' 80 usd +charge controller 15A 30 usd -5 A :10 usd

Total price of equipment: 270 usd

Visit to Divo

Village of Sur les rails

Mr Dro salesman of Peg

We went to visit installation of Madame Gnohou (5th customer of the village)

Case study Peg in sur les rails

She was connected to the grid but without own meter. She had hooked up the electricity along with her neighbor and was paying the govt for one household. The current of the grid is not reliable around 1 hour of available electricity per day

Madame Gnolou is a farmer of palm oil, she sells the palm oil nut and her revenue depend on her sales. She generally harvests once per month and she is willing to pay 30 USD even if she earns 50 usd per month.

Peg offer

4 bulbs (each 5 meter of cable and the battery). She wants more bulbs and is not interested now to have more appliances (TV, fan)

Lessons after Discussion with the salesman of peg

The entire key to reach last mile are:

- Constant presence with villagers and creates good relationship for long term collaboration
- Try to understand the particular problems and needs of the customers and trty to emphasis on the advantages of the products for his household
- Focus on leasing aspect
- Rapidity in products delivering in rural areas is very crucial to keep the confidence, build the reputation and for the business

Sunday 22nd April, visit of Brahimakro (Aboisso south eastern Cote d'ivoire)

Brahimakro is an off-grid village situated in the department of Aboisso. There is not grid in this village. Startup lifi led has installed some solar street light (3 in total: the public place, the school and the entrance of the village and some bulbs)

The aim of our visit was to understand the need of these populations and how they welcome solar energy

When reaching the village, we noticed that some houses have solar panels on the roof.

We visited two houses to have more details

Visit of house 1 Brahimakro

It's a household of 13 people with 4 rooms. They rely on farming (cassava and yams for subsistence and selling)

The house is equipped with:

- Battery 40 AH / 1 USD per charge at 6km of Brahimakro. The battery lasts for about 3 days of usage with the TV;
- Usage of battery: Tv phone charge;
- Battery can last 3 days for tv and phone charge when well charged;
- Price of the battery: 100 usd;
- 2 bulbs powered by the battery bought at 2 USD;
- They have also Chinese solar bulb powered by a small panel.

2nd House: Family Traoré

This second family has 9 persons (Father, mother and kids). Family traoré has 4 rooms and 1 guest rooms equipped by a solar panel

The father Mister Traoré is a famer (cassava, maize for subsistence and sells a part of harvest). His wife sells 'Attieke' (Ivorian cassava couscous) during the night. The kids are manly students

Family traoré has a solar panel and 40 AH battery (2nd hand that he bought at 20 USD). He has this equipment since 3 years

The battery doesn't work well

Usage of the solar equipment

- Radio: 8W commonly available from the market

- Phone charge: 4 mobiles
- 3bulbs

Before having the solar panel

Family used some flashlight for lighting with battery (3 flashlight batteries) that are charging each 2 days at 1 USD per complete charge of the battery.

Results of the Market survey

From the market survey we gathered many results.

From discussion with the actors we got that 4 existing pay as you go companies in Cote d'ivoire (Zeci, Peg, Lumos, baobab + and now Orange energie)

Pay as you go systems available are key pad systems and Gsm systems with a prominence of key pad system with a lease to own approach or rent to own for most of them. These innovations in technology and financing systems create integrated link between digital technology, financial technology and electricity access. **(SDG9)**

Most of the companies are developing their activities in the south west; west center and now the center of the country (Cote d'ivoire). These zones are generally populated and a high penetration of mobile phone, mobile money points. They are agricultural areas, and composed of many big villages. These regions are marked by unreliability and weak penetration of the grid

Necessity of the pay as you go for these populations is very high. They don't have regular income and in the same time, spend a lot of money in phone charging (from 100 to 200 Cfa) sometime at several kilometers (4 km for Brahimakro), old batteries (100 Usd) which are charged (in the nearest village 4 km) and kerosene and candle use.

Pay as you go permits to the companies to have a guarantee to recover their money and sustain their business and for customers to resolve finances problems linked to high advance cost of classic utility.

One of the benefits is that the kits is composed of bulb for lighting, generally a Tv or radio for communication and information, a phone charger to charge their mobiles and a key pad or Gsm systems to control the systems and payments and a solar panel +battery which make the system available everywhere in the country

Figure 34: Zeci Shs product (source Zeci website)

The two leaders of the market: Zeci (EDF and off grid electric) have sold more than 10000 kits in 2 years, they are employing 500 persons generally local young men and women and are opening new sale point in others parts of the country.

To know if the pay go solutions can efficiently contribute to sdg7 and sustainable development in general, let discover their impacts and added value

Pay as you go SHS and pico kits are the results of many innovations (technology, business models, finances, strategy). The actors of the sector are continuously working on improvement of these innovations in order to be competitive and overcome different challenges and satisfy customer's needs.

They obey to definitions of innovative decentralized renewable energy solutions. First because they are renewable based (solar), they are a set of innovation (pay as you go technology, digital based, permits to collect precious datas through software), they operate mainly in off grid areas (rural or peri urban communities with no or unreliable electricity) and they are real solutions because solve issues in a ladder way from basics needs to productive use to comfort). Each product targets a specific need and usage which can increase according to the revenue and the increase in the needs (energy usage) of the customers.

Second main observation is that, the kits contribute to increase energy access for poor and off grid communities. In the case of Cote d'ivoire, its more than 20000 kits sold by the

companies in less than 2 years. It's at least 100000 new people impacted after 2 years of activity (RGPH 2014 / around 5 persons per household). They can contribute to bring access to modern, reliable, affordable for people in last miles **(SDG 7.1).**

Third result, the penetration of the Ivorian market has permitted to increase of more efficient bulbs and batteries (lead acid, Led bulbs) and efficient appliances (fan, tv, fridge...) **(SDG7.3).** Also, Paygo kits permit to increase the share of renewable in the mix (reliable data don't exist on the subjects but the link is established worldwide) Gogla market report 2017.

One important innovation of paygo kits is that selling the products in form of the kits permits to overcome the issue of energy service provisions which can be an obstacle for regulation or utility

Also pay go products are different from Pico lanterns (2w) to bigger kits with efficient appliances (150 w).

This strategy permits to create offers based on electricity ladder. This focus energy on the needs and the usage of the customers going from basic needs (modern source of lighting, phone charging which can be powered but solar lanterns and small Shs kits)

Peg who sells Dlight products has sold more than 7000 kits and employs 100 people's generally local people. These results after 2 years of presence expresses the link that exist between paygo system and job creation principally local job creation and skills development for young people **(SDG8)**

As we can see the pay as you go market driven by financial innovation for renewable application is having great impacts. Bringing more efficient appliances increasing the share of efficiency and renewable in the mix. It's permitting to population to have affordable energy access (ratio long term payment and appliances), development of telecommunication and mobile money, reduce health and safety risks linked to kerosene lamps.

Also pay as you go kits contribute to increase in comfort with the fan, and fridge and development of local activities (barber's shops, fresh drinking, charging phones points…)

One of the most important things was that it was permitting to increase education quality**. (SDG4)** For example many parents in 'sur les rails' (village in south western of cote d'ivoire) were grateful to peg, because their children were able to study with safer lights. In some areas the dispensary was powered by a shs kit like in Donvagne.

The nurse confirms the link between existence of the light and increase in patients and quality of his services and keeping of vaccines **(SDG 7 and 3)**

Pay go stand-alone systems is an example of IDRES (innovating business model, innovation in technology, creating social, environmental and economic impacts and affordable)

Providing energy through different tiers with scalable products according to the revenue and the needs of the customer of this system backed by set of innovations and decentralized systems is the key of this system. But some challenges exist:

- First, maintenance of equipment. Its sometime difficult to find trained people who can do the maintenance. To overcome that most of the companies have 24 hours call centers and training plans for local people
- Second, taxes on solar equipment still exist and actors find the reduction of VAT on solar equipment applied by the Govci very low.

Other challenge for local operator is their ability to get finances from local banks

Various business models for standalone development exist and the market in Cote d'ivoire and West Africa is very attractive in rural and peri urban communities. Burkina faso, Nigeria, Ghana, Cote d'ivoire, Mali, Togo and Benin are the top markets according to Gogla market report 2017. Presence of big players like recently, Orange in cote d'ivoire, Burkina and soon in Liberia, Mobisol in Cote d'ivoire, BBOXX in Togo and projects like Rogep (200 billion budget for off grid development in 17 countries of west Africa and Sahel) are signs of great opportunities that these sector can drive in the region.

Chapter 6: Challenges, barriers and opportunities

6.1 Challenges

Many efforts have been done and are ongoing to achieve universal access to electricity in Cote d'Ivoire. For the viability of the utility even if challenges still exist for (financing of the utility to connect rural and peri urban areas) (solution being addressed with the EFAP), reliability and penetration important investments are flowing in the country.

But we must focus on the objectives in a sustainable way. According to Rise, Cote d'Ivoire and many West African countries don't perform very well in term of policy and regulators framework for energy access. The score of the country is 41 out of 100 (behind, Ghana, guinea).

This means that many challenges still exist and need to be overcome in order to achieve the target of 100 per cent of sustainable energy access for all by 2030 and achievement of the agenda SDG2030

The main challenge after analysis in Cote d'Ivoire is policy and regulatory framework in line with SDG 7 target. Mainly for rural electrification.

According to Rise figures concerning energy access in Cote d'Ivoire and most of West African countries. The main challenge in electrification remains the rural area. Their result influences negatively the result of energy access and increases the number of people without access in the country. Ongoing policy contained in Master plan for rural electrification of 2013 can't permit to achieve sustainable energy access for all in the country with the fixed target of the government. It will permit to increase the level of connection, increase in penetration rate but will not permit to deliver the full potential of electricity access in a sustainable way. It means the role of driver of development and growth in a sustainable way.

Two levels of challenges exist:

- The first is strategy of the general electricity plan;
- The second is related to the policy of decentralized renewable energy systems.

For the first challenge, as we can see electricity policy is not very clear and well framed. There are some gaps in the prioritization. For example, one of the top priorities in the country after policy assessment of electrification in Cote d'ivoire is not the rural and peri urban

communities. The project PDA of World Bank and few finances allowed to the component 3 can be used to support that. (57 Billion cfa) and only two programs (EFAP …). At institutional level, we don't have efficient organization which will benefit to rural electrification and sustainable electricity access for all. The utility and CI energy alone can't achieve these targets which are more complex and need more holistic view, a shift in the strategy of electrification combining Mini grid, grid extension and stand alone. Policies and regulatory framework for grid extension are acceptable may be excellent but for the mini grid and stand-alone systems, its remains weak. Mini grid and stand alone can't be solutions at bottom level (compensation solutions) but should be fully integrated with grid extension in integrated bulk for electrification in Cote d'ivoire. The objective being achieve sustainable electricity access for all.

The figure 16 shows us the importance of decentralized systems in achieving SDG7. So, its appears clearly that only a good combination of grid, mini grid and stand alone can permits to achieve SDG7. Of course, the new solutions will generate some additional Cost, but these can be overcome if we have an integrated institutional framework which integrate actors like private sector (developers and off grid companies), multilateral organizations, local communities, Ngos and associations, entrepreneurs, international initiative, financial companies (investment banks and MFI).
Another challenge is availability and few data and researches on electrification and this is worse for rural electrification.

Another challenge is governance. Its means level of participation of local government, populations, Ngos in energy policy making. This level remains very weak and not really governed by good governance and participating principles.

Another challenge is technology. Countries don't invest a lot in research and development for energy access. Few researches exist on the topic. Innovation should be the key and it should be financed and taken as a key part for targets achievement.

Last challenge is productive use. Rise mentioned that energy for productive use is not yet in force in Cote d'ivoire. As Donvagne project and Geres projects has shown, this aspect should be promoted in we want to address local problems and fight poverty.

Fiscal challenges. A lot of subsidiaries exist for fossil fuels but few for renewable. Existence of numerous diesel Genset and low fiscal for solar equipment are serious challenges.

Quality of equipment and maintenance of standalone and mini grid should be tackled.

Policy for off grid development (mini grid) specifically after 2014 is not clear conflict. Distribution is not yet liberalized in cote d'ivoire. The utility Cie has the monopoly of distribution in the country.

For standalone systems, finances remain a problem for companies which need more investments and guarantee to sustain their business and investments. Also, local companies need some support (technically, financing) in other to be competitive and create local revenues

6.2 Barriers

After painting the challenges and establishing the importance of DRES in energy access, we can easily affirm that the main barriers to achieve sustainable energy for all are policy, and current paradigm in electricity.

First the lack of flexibility in the existing paradigm is very difficult to move on in term of evolution of the sector. In fact, for World Bank and the Govci, grid is the only viable systems which can permit to achieve sustainable electricity access for all (economically and technically) off grid solutions are lower important and are considered as compensating solutions.

Secondly, difficulties in shift of electrification paradigm find his origins in considerations, hypothesis and assumptions that cannot be justified objectively. The first of them is the principle of per equation. Coming from French administrative law relative to equal access of public services recognized to citizens; this principle is source of many discussions even in French. Its means that all the people placed in the same category should have the same treatment in term of supply and price. That is the major argument of Govci to be slow in Mini grid development.

For the Govci and the utility business as usual has permitted to create one of the best electricity environment in Africa (affordability, organization of the sector, technology, model of financing, politically…). Bringing mini grid in this circle is sources of numerous uncertainties and can increase the risk of trouble in the sector. In fact, for the Govci mini grid are most expensive; less attractive correlation quality -price, difficult to manage, regulate and control, quality of services cannot be assessed easily (reliability), will bring more crisis

between operators and Govci and is difficult to manage at security level. According to the strategic position of electricity sector economically and politically, off grid solutions don't give a lot of guarantee at this stage to be considered as viable and complementary option (Ministry of petroleum, and development of renewable energy).

All these assumptions are not based on disponible scientific researches to the population. So we still looking for real cost analysis and in depth analysis integrating externalities, technology comparisons and SDG targets.

6.3 Opportunities

Despite all the challenges and barriers, many opportunities are offered to the country. Low energy access rate, offers possibility to African countries to innovate and achieve more impacts from electricity access. That is different in most advanced countries.

As we are suggesting, these innovations can be found and tackle at all level.

The fist is rising of innovation in the country. Electricity sector like mobile at beginning of 90's in Africa can permit to bring numerous innovations that we call here IDRES. these IDRES can permit to solve cross existing problems of the continent like poverty, climate change (reduction of GHG), gender inequalities, social injustice, education, jobs, health, local development and contribute efficiently to realize SDG's agenda 2030 and AU agenda 2063

IDRES are great opportunity to achieve SDG7 faster and with more positive impacts.

At policy level, they can permit policy to existing and anticipate future problems. For example, systemic electrification integrating grid, mini grid and stand alone is easier to build a solid and sustainable sector. This can bring fiscal evolution and development of the cross sector linked to electricity (mobile banking, baking systems, Mfi.).

At Technology level, today solutions, lifi led, smart meters, software for paygo, digital monitoring of systems permit to drive technology innovation in Africa.

Financial innovation and new business models which can permits to focus on last miles and pro poors communities like paygo, Mfi development, community-based models,

Develop electrification models decentralized systems like lateral electricity driven by Nano grid, productive use driven by mini grid can permit to create local impacts and operate a qualitative transformation in the sector.

Chapter 7 Recommendations and conclusion

Through this research will formulate some recommendation to the government and West African countries. The main one is to change the current path of electrification systems and plans in order to align it with sdg 2030 and Au agenda 2063. Sustainable development must be the key driver of all our electrification plans. Rural and peri-urban should be considered as the top priorities in energy policy plans.

Achieve sustainable development goals means achievement of SDG7 and creation of conditions to permit to sdg 7 to drive others sdg's

This virtual circle can also be possible through more than a simple change of paradigm but needs innovation. Innovate at all level, from policy, technology, business model, electrification models are the key to achieve sustainably our targets and create infinite impacts

This can be possible by creating of enable environment for IDRES development.

Adoption of this approach means, investments in research and development in energy sector, training, creation of new institutional framework integrating new actors (private sector, Ngos providing, creation of new tiers, and transformation in supply by adoption of energy ladder (basic need, productive use, modern energy) with an emphasis on productive use of energy in rural and peri urban areas. The following figure expresses this vision:

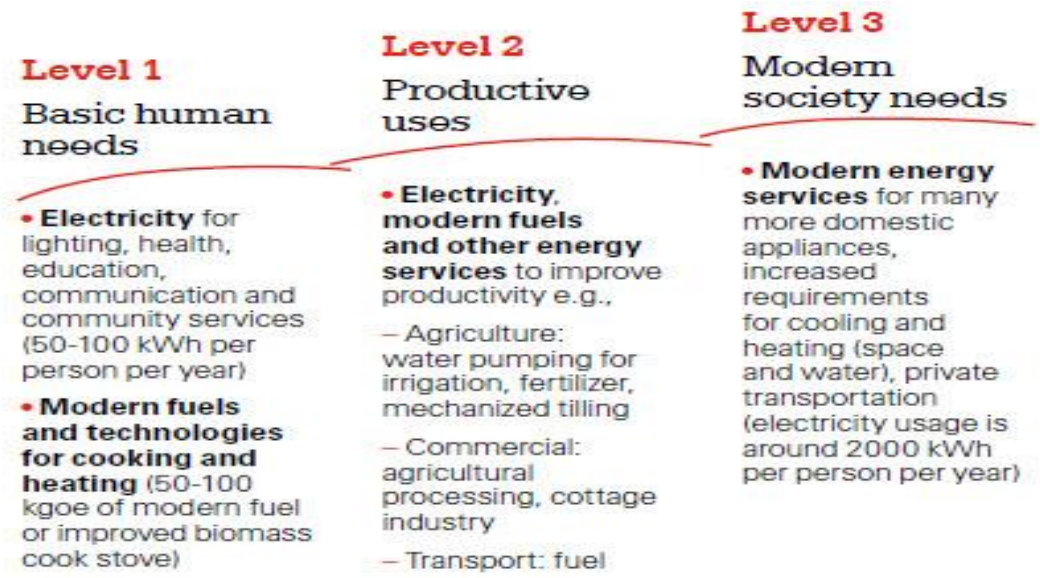

Figure 35: Energy access Ladder

Many institutional evolutions must come in the sector in order to build an integrated and efficient ecosystem for energy access. the graph below gives a synthetic snap of the institutional framework:

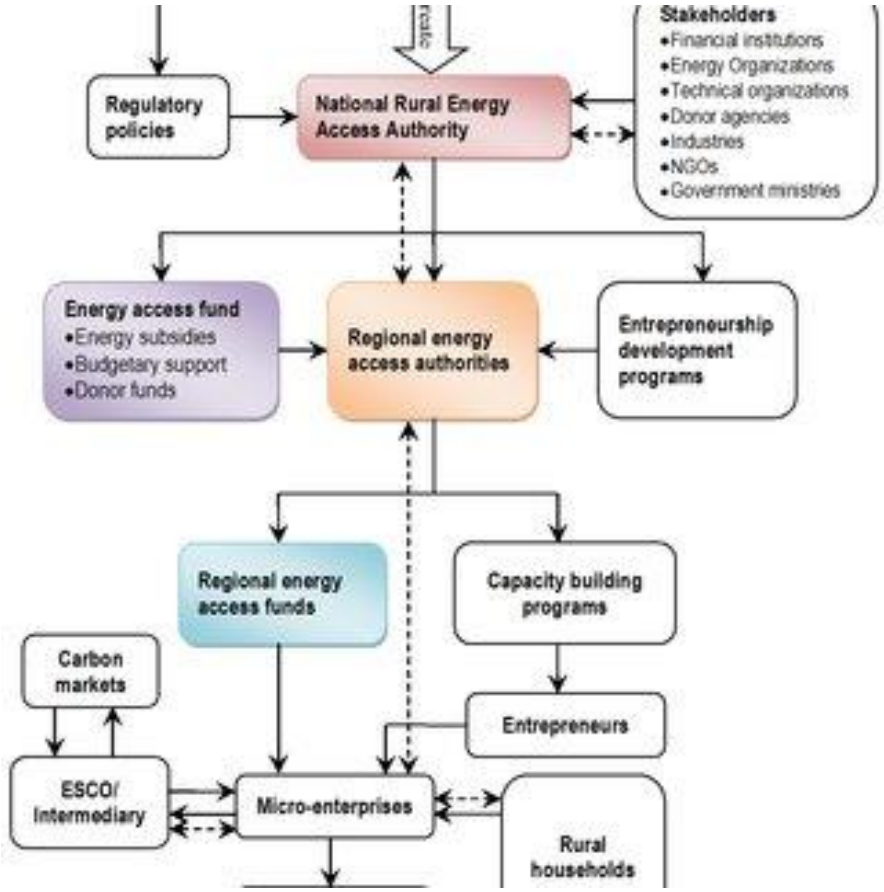

Figure 36: Institutional framework

We discovered with this research that many reforms need to be done in order to guarantee sustainable electricity access in Cote d'ivoire. This evolution calls a radical shift in electrification paradigm, with a complementary role of decentralizes renewable energy systems (mini grid and stand-alone)

Our research suggests the following approach as electrification plan:

Grid for big cities and communities near the grid

Mini grids for localities far from the grid with dense population and geographic obstacles for grid extension with a focus on productive use of energy

Stand alone for villages far from the grid or near but with few population and scattered household.

We suggest these broad solutions:

- Use Rise Esmap to assess existing policy;
- Adopt Irena Retip renewable energy technology innovation policy to faster transition (Irena, innovation week;
- Liberalized distribution sector breaking CIE monopoly;
- Set clear regulation like feed in tariffs, off grid policy act, rural electrification act;
- Encourage utility to shift to off grid solution development. Utility should quickly operate and manage mini grids and off grid systems to be more competitive;
- Decentralize rural electricity sector reducing CI energy attributions;
- In deep research on 3 methods and select the most cost-effective systems (grid, off grid, mini-grid and resources assessment) using capex opex + socio eco and environmental impacts analysis+ externalities;
- Transversal approach in energy planning all key ministries (health, agriculture, education ... target in energy access);
- Creation of Rural electrification agency;
- Increase participation of local government and local population in policy planning and energy projects;
- Invest in training centers for RE and electricity;
- Establish more strong quality standard for off grid and develop policy and partnership for mini grid;
- Focus priority on productive use of energy;
- Set a target for quick elimination unreliable source of lighting through program (education and health). For example: Power all socio-economic basics infrastructure schools and hospital with RE) and establish standard for all new buildings (should have electrification plan using Renewable);
- Use minigrid for water generation and agriculture;
- Develop electrified economic activity zone in villages;
- Increase subsidy of renewable and reduce subsidies for diesel;
- Set recycling standards for renewable equipment in place;
- Promote Renewable Street lighting for efficiency and reduce consumption.

Conclusion

As we can see, ensure sustainable electricity for all is an international and national duty for all governments. Sustainable development goal and AU Agenda 2063 should be the guideline for regional policies. this is more valuable for energy polices due to the importance of Sdg 7 and electricity access particularly for the other goals and for local development, this is not a priority for the government of cote d'ivoire after analysis of existing policies and international assessments indicators (Rise). Or let say despite the effort and existing policies and investment the country is not on the right path to achieve his target in energy access.

We discovered that this can be possible through innovation and change of paradigm in our electrification planning (conception) , from case studies we suggest IDRES , driven by Decentralized renewable systems and renewable energy market as viable way to contribute to achieve faster sustainably ,efficiently , with higher impacts on local development and sustainable development .Pro poor solutions, human development and environmental preoccupation need to be considered as key driver of policies in energy sector. As Africa knew mobile revolution and is benefited of its impacts, IDRES, can contribute to the development of the continent starting from poorest communities

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Appendices

Annex A: Questionnaire for market survey

Business case indicator	Lead question	Who the question is addressed to
Define market size	How many products are sold in the A2E segment?	Partner
	What are the pain points of the existing offer?	Customer & Partner
	What are the main enquiries floating in the market?	Partner
Define product features	What's the size of the typical TV that's available in the market?	Partner
	Is it a AC TV or DC TV?	Customer & Partner
	What are the other domestic appliances used?	Customer & Partner
	What are the appliances used & what's the wattage?	Customer
	How many hours is each of the appliance listed above used?	Customer
	Where will they expect offer be placed in the household?	Customer
	How many USB devices are used in the household?	Customer
Schneider Electric brand awareness	Have you heard about SE? What are the products of SE that you know of?	Customer & Partner
Creating access channels	What are the present solutions to abate the customer pain points?	Partner
	How do you ensure product availability?	Partner
	How is financing of the offer be taken care of?	Partner
Promotional communication material	How does the partner get in touch with the OEMs?	Partner
Price positioning of the offer	What's the average income to the target household?	Customer & Partner
	What is the price used for addressing the existing pain point?	Customer & Partner

Annex A (Contd): Questionnaire for market survey

Business case indicator	Lead question	Who the question is addressed to
PAYG functionality	Has the partner heard about the PAYG function? If so, from whom?	Partner
	Key features expected in PAYG?	Partner
	How does revenue collection happen? (manual/automated/semi-automated)	Partner
	Comments on data & SMS connectivity	Partner
	Tie-up/partnerships with MFI or telecom service providers	Partner
	Operating mode of the technology (keypad/SMS/etc)	Partner
	Model number & specifications (Wp,Wh,type of battery, number of lamps,lumens level of the lamp) of the product being used.	Partner
	Token type (alphanumeric or number only) & how is token generated & validated	Partner
	Is PAYG an add-on module in the hardware or all systems come with it?	Partner
	How is the PAYG de-activated when the customer ends up paying the installments	Partner
	Grace period given for non-payment	Partner
	How easy is the reproduibility of the payment code	Partner
	If S.No is erased or lost, how is future payment handled	Partner
PAYG pricing	What is the license/development cost incurred in the PAYG one-time deployment?	Partner
	What is the transaction fees of PAYG	Partner
	Payment duration, periodicity (weekly, monthly, daily)	Partner
	What are the mobile charges incurred	Partner
	How much is the interest or credit risk taken by the resellers?	Partner

Annex B: Rise result energy access cote d'ivoire

Regulatory Indicators for Sustainable Energy (RISE)

2016 Country Data - Côte d'Ivoire

- **Energy Access**

Indicator	Score
Existence and monitoring of officially approved electrification plan	40
Scope of officially approved electrification plan	0
Framework for grid electrification	50
Framework for mini-grids	22.5
Framework for stand-alone systems	35.56
Consumer affordability of electricity	100
Utility Transparency and Monitoring	87.49
Utility Creditworthiness	33.83
Total	46.17

- **Energy Efficiency**

Indicator	Score
National energy efficiency planning	33.33
Energy efficiency entities	100
Information provided to consumers about electricity usage	40.97
EE incentives from electricity rate structures	88.89
Incentives & mandates: large consumers	0
Incentives & mandates: public sector	0
Incentives & mandates: utilities	0
Financing mechanisms for energy efficiency	0
Minimum energy efficiency performance standards	0
Energy labeling systems	0
Building energy codes	0
Carbon Pricing	0
Total	**21.93**

- **Renewable Energy**

Indicator	Score
Legal framework for renewable energy	100
Planning for renewable energy expansion	47
Incentives and regulatory support for renewable energy	100
Attributes of financial and regulatory incentives	67
Network connection and pricing	0
Counterparty risk	74
Carbon pricing and monitoring	0
Total	55.43
Overall Score	41.18
Energy Access	
Existence and monitoring of officially approved	**40**
electrification plan	
Is there an officially approved national electrification plan?	Yes
No	
but not yet been approved?	
Name of the electrification plan	National Programm for Rural Electrification (PRONER : 500 villages/year x 5 years) - 2014 Programm
	Electricity For All (PEPT : +200,000 homes connected/year x 5 years) - 2014 Comprehensivemaster plan for Production, transport and distibution - 2015
Are the electrification plan and the updates publicly available?	No
When was the last update of the electrification plan?	2014
Is there an institution responsible for tracking progress of the plan?	No
Name of the tracking institution	0
Is there a timeframe defined in the electrification plan?	No

Scope of officially approved electrification plan	Score
Does the plan target a service level (e.g., power availability,number of guaranteed hours of power supply, etc.)?	No
Details on service level target	0
Does the electrification plan include both grid and off-grid?	No
Does the plan include community facilities?	No
Does the plan include productive use?	No
Are there geospatial maps conveying the timeframe of planned grid extension?	No
Are these geospatial maps made publicly available?	No

Framework for grid electrification	Score	50
Does the government have a dedicated funding line or budget for electrification (e.g., funded national program, budget item, rural electrification fund to finance grid extension)?		Yes
Are there capital subsidies paid to the utilities to provide distribution systems to rural areas/villages?		No
Details on funding support for grid electrification		
Are there consumer financing mechanisms (i.e., utility loans, on bill financing, micro-loans, etc.) and/or direct subsidies available to support the payment of connection fees by consumers?		No
Details on mechanisms to support the payment of connection fees		0
Does the government specify standards of performance on reliability along with new connections (e.g., number of guaranteed hours per day, etc.)?		Yes

Framework for minigrids	Score: 22.5
Are minigrids legally allowed to operate in the country?	Yes
Name and date of the regulation for minigrids	Electricity Law - 2014
Can minigrids be owned and operated by private operators?	Yes
Do regulations clarify what will occur when the interconnected grid reaches a mini-grid?	No
To convert from a power producer to a power distributor that buys electricity from the interconnected grid and resells to its local customers	No
To sell electricity to the interconnected grid operator and no longer sell electricity to retail customers	No
To sell its distribution grid to the interconnected grid operator and receive compensation for the sale of the asset	No
Other	No
Do the regulations detail procedures for consumers to get connected to minigrids?	No
Do the regulations differ by size of minigrids?	No
Are mini-grid operators legally allowed to charge a different tariff from the national tariff?	No
Is there a retail electricity tariff schedule for minigrids?	No
Examples of minigrid tariffs	0
Name of the regulation on minigrid tariffs	0
Are there publicly funded mechanisms to secure viability gap funding for operators?	No
Do subsidies exist for minigrids?	No
Details on subsidies for minigrids	0
Name of the document referring to minigrid subsidies	0
Do subsidies exist for power generators?	No
Do subsidies exist for energy storage systems?	No
Do subsidies exist for distribution systems?	No
Do subsidies exist for monitoring systems?	No
Do subsidies exist for other equipment related to minigrids?	No
Do duty exemptions exist for minigrid systems?	No

Framework for minigrids (Contd)	Score: 22.5
Details on duty exemptions for minigrids	50% VAT reduction for solar equipment
Name of the document referring to mini-grid duty exemptions	Decree law no15/009 about fiscal incentives and duty exemptions on electricity production, transmission and distribution - 2015
Do duty exemptions exist for energy storage systems?	Yes
Do duty exemptions exist for distribution systems?	Yes
Do duty exemptions exist for monitoring systems?	No
Do duty exemptions exist for other equipment related to minigrids?	No
Do subsidies exist for stand-alone systems?	No
Do subsidies exist for solar modules?	No
Do subsidies exist for batteries?	No
Do subsidies exist for charge controllers?	No
Do subsidies exist for power conditioning equipment?	No
Do subsidies exist for safety equipment?	No
Do subsidies exist for other equipment related to stand-alone systems?	No
Details on subsidies for stand-alone systems	0
Name of the document referring to subsidies for stand-alone systems	0
Do duty exemptions exist for stand-alone systems?	Yes
Details on duty exemptions for stand-alone systems	50% VAT reduction on solar equipment
Name of the document referring to duty exemptions for stand-alone systems	Fiscal Annex - Decree N°2011 – 480 on State budget management
Do duty exemptions exist for solar modules?	Yes

Framework for minigrids (Contd)	Score: 22.5
Do duty exemptions exist for batteries?	Yes
Do duty exemptions exist for charge controllers?	Yes
Do duty exemptions exist for power conditioning equipment?	Yes
Do duty exemptions exist for safety equipment?	Yes
Do duty exemptions exist for other equipment related to stand-alone systems?	No
Are there legal restrictions that limit the prices standalone home system retailers or service providers can charge?	No
Are there specific financing facilities available to support operators/consumers to develop/purchase stand-alone home systems?	No
Are there specific market financing facilities available to support operators to develop stand-alone systems?	No
Are there specific government financing facilities available to support operators to develop stand-alone systems?	No
Are there specific market financing facilities available to support consumers to purchase stand-alone standalone systems?	No
Are there specific government financing facilities available to support operators to develop stand-alone systems?	No
Are there technical standards detailing the requirements for minigrids to connect the grid?	No
Are technical standards made publicly available?	No
Name of the document detailing technical standards	0
Are there safety standards for minigrids?	No
Are these safety standards made publicly available?	No
Name of the document detailing safety standards	0
Does the government implement certification programs for minigrid installers?	No

Framework for minigrids (Contd)	Score: 22.5
Does the government provide or endorse certification programs for one or more components or equipment required for minigrids?	No
Has the government adopted international quality standards for stand-alone systems?	Yes
Name of the document detailing quality standards	Codinorm - Norms catalogue - 2015
Has the government adopted international testing methods?	No
Does the regulation accept testing done elsewhere/in another country (vs in-country testing required)?	Yes
Is there a governmental certified program for solar equipment installers?	No
Are there environmental regulations on the disposal of solar devices and standalone home system products or components?	No
Name of document detailing environmental regulations	0

Framework for stand-alone systems	Score: 35.56
Are there publicly funded mechanisms to secure viability gap funding for operators?	No
Do subsidies exist for minigrids?	No
Details on subsidies for minigrids	0
Name of the document referring to minigrid subsidies	0
Do subsidies exist for power generators?	No
Do subsidies exist for energy storage systems?	No
Do subsidies exist for distribution systems?	No
Do subsidies exist for monitoring systems?	No
Do subsidies exist for other equipment related to minigrids?	No
Do duty exemptions exist for minigrid systems?	No
Details on duty exemptions for minigrids	50% VAT reduction for solar equipment
Name of the document referring to mini-grid duty exemptions	Decree law no15/009 about fiscal incentives and duty exemptions on electricity production, transmission and
Do duty exemptions exist for power generators?	Yes
Do duty exemptions exist for energy storage systems?	Yes
Do duty exemptions exist for distribution systems?	Yes
Do duty exemptions exist for monitoring systems?	No
Do duty exemptions exist for other equipment related to minigrids?	No
Do subsidies exist for stand-alone systems?	No
Do subsidies exist for solar modules?	No
Do subsidies exist for batteries?	No
Do subsidies exist for charge controllers?	No
Do subsidies exist for power conditioning equipment?	No

Framework for stand-alone systems (Contd)	Score: 35.56
Do subsidies exist for safety equipment?	No
Do subsidies exist for other equipment related to stand-alone systems?	No
Details on subsidies for stand-alone systems	0
Name of the document referring to subsidies for stand-alone systems	0
Do duty exemptions exist for stand-alone systems?	Yes
Details on duty exemptions for stand-alone systems	50% VAT reduction on solar equipment
Name of the document referring to duty exemptions for stand-alone systems	Fiscal Annex - Decree N°2011 – 480 on State budget management
Do duty exemptions exist for solar modules?	Yes
Do duty exemptions exist for batteries?	Yes
Do duty exemptions exist for charge controllers?	Yes
Do duty exemptions exist for power conditioning equipment?	Yes
Do duty exemptions exist for safety equipment?	Yes
Do duty exemptions exist for other equipment related to stand-alone systems?	No
Are there legal restrictions that limit the prices standalone home system retailers or service providers can charge?	No
Are there specific financing facilities available to support operators/consumers to develop/purchase stand-alone home systems?	No
Are there specific market financing facilities available to support operators to develop stand-alone systems?	No
Are there specific government financing facilities available to support operators to develop stand-alone systems?	No

Framework for stand-alone systems (Contd)	**Score: 35.56**
Are there specific government financing facilities available to support consumers to purchase stand-alone standalone systems?	No
Are there technical standards detailing the requirements for minigrids to connect the grid?	No
Are technical standards made publicly available?	No
Name of the document detailing technical standards	0
Are there safety standards for minigrids?	No
Are these safety standards made publicly available?	No
Name of the document detailing safety standards	0
Does the government implement certification programs for minigrid installers?	No
Does the government provide or endorse certification programs?	No
for one or more components or equipment required for minigrids?	
Has the government adopted international quality standards for stand-alone systems?	Yes
Name of the document detailing quality standards	Codi norm - Norms catalogue - 2015
Has the government adopted international testing methods?	No
Does the regulation accept testing done elsewhere/in another country (vs in-country testing required)?	Yes
Is there a governmental certified program for solar equipment installers?	No
Are there environmental regulations on the disposal of solar devices and standalone home system products or components?	No
Name of document detailing environmental regulations	0
Are there national programs which aim to develop stand-alone systems or support the development of stand-alone systems?	No
Details on the national program promoting stand-alone systems	0

Consumer affordability of electricity	**Score** **100**
What is the annual cost of subsistence consumption (30kWh/month) as a percentage of GNI per household of bottom 20 percent of population?	2.03%
Tariff schedule / tariff structure taken into account	(ANARE website) Interministerial decree no 569, December 2012
Is there a mechanism to support low-volume consumers such as cross-subsidization, social or lifeline tariff?	Yes

Utility Transparency and Monitoring	**Score 87.49**
Are the financial statements of the largest generation company publicly available?	No
Are the financial statements of the largest transmission company publicly available?	Yes
Are the financial statements of the largest distribution company publicly available?	Yes
Are the financial statements of the largest retail electricity sales company publicly available?	Yes
Are the financial statements of the largest generation company audited?	No
Are the financial statements of the largest transmission company audited?	Yes
Are the financial statements of the largest distribution company audited?	Yes
Are the financial statements of the largest retail electricity sales company audited?	Yes
Is the transmission loss rate published in a primary official document (by the utility, regulator or ministry and/or government)?	Yes
Is the distribution loss rate published in a primary official document (by the utility, regulator or ministry and/or government)?	Yes
Is the bill collection rate published in a primary official document (by the utility, regulator or ministry and/or government)?	Yes
Is the amount of electricity available for sale to end-users published in a primary official document (by the utility, regulator or ministry and/or government)?	Yes
Is the utility operating an incidence/outage recording system (or SCADA/EMS with such functionality)?	Yes
Is the utility measuring the SAIDI and SAIFI or any other measurements for service reliability?	Yes
Are the measurements reported to the regulatory body?	Yes
Are the measurements available to public?	Yes

Utility Creditworthiness	**Score 33.83**
Current ratio (working capital ratio) of selected utility	1.67567
EBITDA margin of selected utility	7.15
Debt service coverage ratio of selected utility	25
Days payable outstanding of selected utility	0