Mini-Grid Market Opportunity Assessment: Guinea Conakry

Green Mini-Grid Market Development Programme: Sustainable Energy Fund for Africa & African Development Bank

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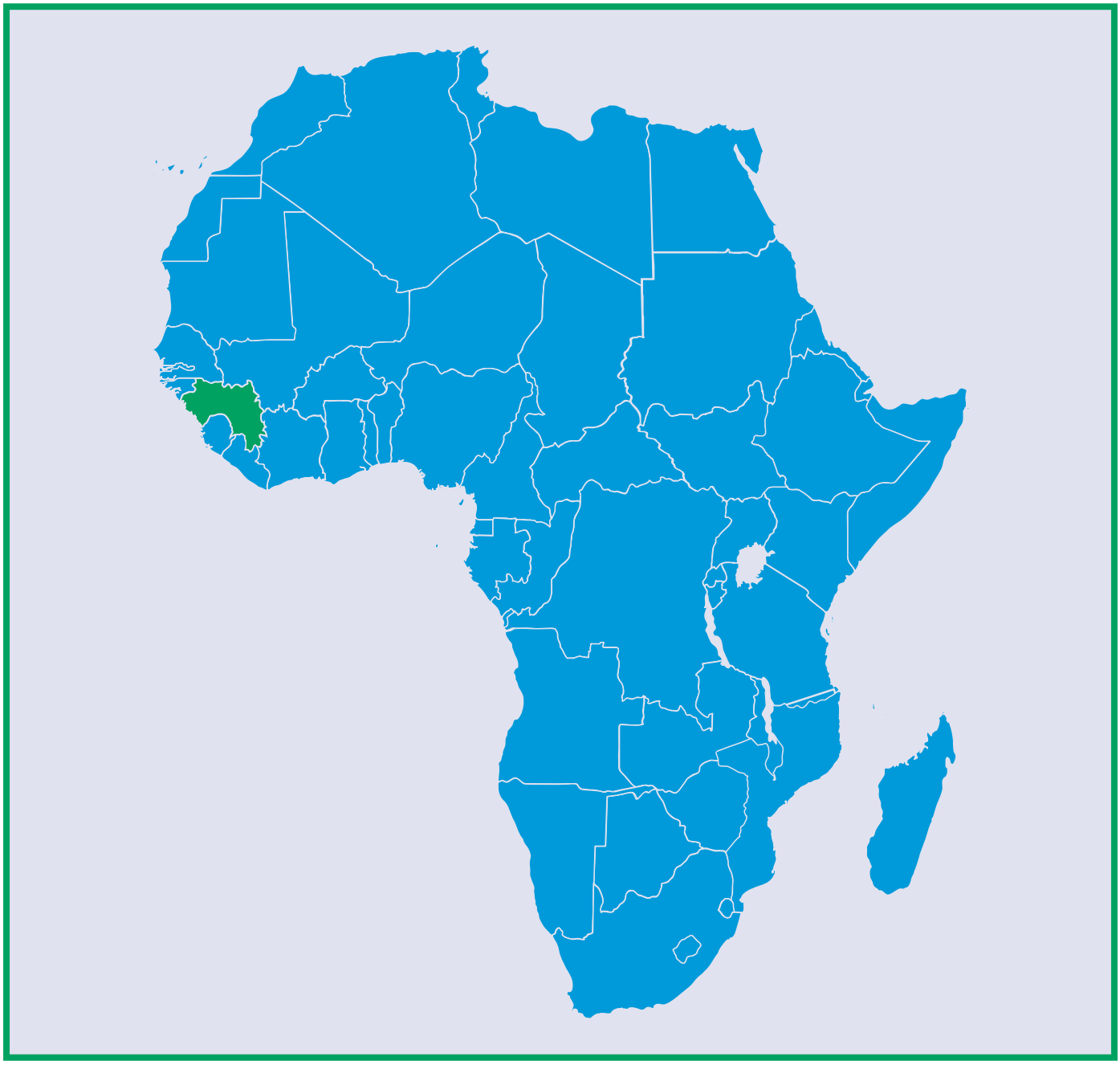

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The African Development Bank Group is Africa's premier development finance institution. It comprises three distinct entities: the African Development Bank (AfDB), the African Development Fund (ADF) and the Nigeria Trust Fund (NTF). On the ground in 41 African countries with an external office in Japan, the Bank contributes to the economic development and the social progress of its 54 regional member states.

The Sustainable Energy Fund for Africa (SEFA) is a special fund administered by the African Development Bank in order to support African countries to accelerate the transition towards greener and more sustainable power systems. SEFA supports small and medium-scale renewable energy and energy-efficiency projects through early stage interventions that enhance project bankability and unlock private sector investments in new technologies and businesses. SEFA focuses its interventions on three thematic areas: (1) green mini-grids to accelerate energy access to underserved populations; (2) green baseload to support clean generation capacity; and (3) energy efficiency to optimise energy systems and reduce energy intensity.

The Carbon Trust wrote this report based on an impartial analysis of primary and secondary sources. The Carbon Trust's mission is to accelerate the move to a sustainable, low carbon economy. It is a world-leading expert on carbon reduction and clean technology. As a not-for-dividend group, it advises governments and companies around the world, reinvesting profits into its low carbon mission.

The Carbon Trust would like to thank the following organisations who made this report possible: particularly the Agence Guinéenne d'Electrification Rurale (AGER) who facilitated the organisation of interviews and the success of Carbon Trust's mission in Guinea, Ministère de l'Energie et de l'Hydraulique (MEH), Fondation Energie pour le Monde (Fondem), UNDP, World Bank, AfDB, Electricité de Guinée (EDG), Autorité de Régulation des Secteurs d'Electricité et Eau (ARSEE), SOBEL, SAGNO, Association des Professionels des Energies Renouvelables (APER), Zero pauvres Afrique.

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PREFACE

This paper, part of the Green Mini-Grid Market Development Programme (GMG MDP) document series, assesses the green mini-grid market in Guinea Conakry, referred as Guinea thereafter in this report. Green-mini grids include mini-grids powered by renewable energy resources – solar radiation, wind, hydropower or biomass – either exclusively, or in combination with diesel generation.

Mini-grids are not a new phenomenon in Africa. Almost all national utilities own and operate diesel-powered generating facilities not connected to the main grid, which supply electricity to secondary towns and larger villages. This solution to rural electrification often results in significant financial losses for the utility, needed to sell power at prices significantly below the cost of production and delivery. It also leaves the most remote towns and villages unelectrified. The latest Sustainable Energy for All (SEforALL) Global Tracking Framework estimates that the urban-to-rural divide in access to electricity in Africa is as high as 450 percent, with 69 percent of the population in urban areas electrified compared to only 15 percent in rural areas.

There are three principal options for providing new connections to currently unserved populations in Africa, namely: extension of the national grid; installation of separate "mini" grids to operate independently from the main grid; and stand-alone generating systems that supply individual consumers. The most cost-effective approach for powering mini-grids is to use renewable energy sources, which are widely available across Africa.

However, the development of GMGs is not without its challenges. In addition to unfriendly policy and regulatory frameworks, barriers to growth of the private mini-grids sector in Africa include the lack of proven business models, market data and linkages, key stakeholder capacity, and access to finance.

In response to these challenges, the SEforALL Africa Hub at the African Development Bank (AfDB) designed and launched Phase 1 of the GMG MDP in 2015 with grant funding from the AfDB's Sustainable Energy Fund for Africa (SEFA).[1] The GMG MDP is a pan-African platform that addresses the technical, policy, financial and market

1. The SEforALL Africa Hub partnership includes the African Union Commission, the New Partnership for Africa's Development (NEPAD), the United Nations Development Programme (UNDP), and the Regional Economic Communities (RECs), which are represented on a rotating basis. http://www.se4all-africa.org

barriers confronting the emerging GMG sector. It is part of a larger Department for International Development (DFID) funded GMG Africa Programme, which also includes GMG initiatives in Kenya and Tanzania; country-specific GMG policy development through SEFA; and an action learning and exchange component implemented by the World Bank's Energy Sector Management Assistance Program (ESMAP). Phase 2 of the GMG MDP, greater in scope and scale as compared to Phase 1, was launched in November 2017.

In its Africa Energy Outlook 2014, the International Energy Agency (IEA) predicted that by 2040, 70 percent of new rural electricity supply in Africa will most affordably come from stand-alone systems and mini-grids. The GMG MDP, SEforALL, SEFA, ESMAP and similar programmes, which are contributing to falling costs, technological advances and efficiencies in GMG development, will help ensure that up to two thirds of this supply is powered by renewables.

The goals of the GMG programme are central to AfDB's mission of spurring sustainable economic development, social progress and poverty reduction in its regional member countries. Off-grid and mini-grid solutions are a key component of the AfDB's New Deal on Energy for Africa, launched by the Bank's president in January 2016. The New Deal, a transformative, partnership-driven effort, aspires to achieve universal access to energy in Africa by 2025.

This report was prepared by the Carbon Trust at the request of the AfDB. It was written by Sophie Bordat and reviewed by Benjamin Curnier of the Carbon Trust. Carbon Trust is a mission-driven organisation helping businesses, governments and the public sector accelerate the move to a low carbon economy.

The content of this report was reviewed by the Programme Officer Goran Lima of the Sustainable Energy Fund for Africa (SEFA), Minkailou Halidou Touré and Emmanuel Boujieka from the AfDB.

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LIST OF ACRONYMS

AFD	Agence Francaise de Développement
AfDB	African Development Bank
AGER	Agence Guinéene d'Electrification Rurale
APER	Association des Professionnels des Energies Renouvelables
ARSEE	Autorité de Régulation des Secteurs d'Electricité et d'Eau
BAU	Business As Usual
BERD	Bureau d'Electrification Rurale Decentralisée
BOT	Build-Operate-Transfer
CAPEX	Capital Expenditure
CER	Conseil a l'Electrification Rurale
CLSG	Cote d'Ivoire Liberia Sierra Leone Guinea
EDG	Electricité de Guinée
EGF	European Globalisation Adjustment Fund
FDI	Foreign Direct Investment
Fondem	Fondation énergies pour le monde
GDP	Gross Domestic Product
Guinea	Guinea Conakry
IBRD	International Bank for Reconstruction and Development
ICBC	Industrial and Commercial Bank of China
ICT	Information and Communication Technology
IFC	International Finance Corporation
INDC	Intended Nationally Determined Contributions
IPP	Independent Power Producer
IsDB	Islamic Development Bank
LPDSE	Lettre de Politique de Développement du Secteur Energetique
MEH	Ministère d'Energie et Hydraulique
MSC	Management Services Contract
OMVS	Organisation pour la mise en valuer du fleuve Sénégal
OMVS	Organisation pour la mise en valuer du fleuve Sénégal
OPEX	Operational expenditure
PASE	Projet d'Amélioration de l'efficacité du secteur de l'Electricité
PEHGUI	Projet Petite Electricité Hybride
PERD	Project d'Electrification Rurale Décentralisée
PNDES	Plan National de Dévelopement Economique et Social
PPP	Public-Private Partnership
PREREC	Projet de Réhabilitation des Réseaux à Conakry
PRSE	Projet De Redressement du Secteur de l'Electricité
ROGEP	Regional Off-Grid Electrification Project
SSA	Sub-Saharan Africa
UA	Unit of Account
VAT	Value After Tax
WAPP	West Africa Power Pool
WB	World Bank

EXECUTIVE SUMMARY

This country report is one of a series of country reports under the Market Intelligence business line of the African Development Bank's Green Mini-Grid Market Development Programme (GMG MDP). The MDP has the ultimate objective of fostering access to electricity across Africa by promoting the development of green mini-grids where they represent a technically and economically better option than the extension of the main grid. The Market Intelligence business line aims at providing comparable, actionable data on the potential for GMGs across countries in Sub-Saharan Africa (SSA). This report provides an analysis for Guinea. Previous country reports can be downloaded from the GMG Help Desk (https://greenminigrid.afdb.org/).

This report's methodology combines a high-level opportunity assessment with practical knowledge and information targeted at mini-grid practitioners. Information provided covers key stakeholders, raw data on physical and non-physical factors and a policy and regulatory analysis. Assessing the potential for mini-grids is challenging as such analysis requires plenty of data and assumptions. A thorough assessment must include several criteria that are driven by the particular business model and approach of the implementing agency for each case. This report therefore aims at capturing available data and highlight general assessments that would be relevant to most mini-grid stakeholders. Raw data is provided with this report so stakeholders may further conduct their own specific analysis.

Guinea is one of the poorest countries in the world based on GDP. Guinea ranks ninth from the bottom of the Human Development Index and 73% of the population lives under the poverty line (under $1.90/day) (World Bank, 2018). Bauxite reserves are estimated at seven to eight billion tonnes while annual per capita income is estimated at US$531, compared to US$1,571 in the rest of SSA region in 2015 (World Bank, 2018). The country is marked by low levels of literacy and access to infrastructure and services.

It is estimated that the Ebola crisis impacted the economy negatively with about a $35 million in GDP loss in 2015, the urban employment rate nearing 17 and declining rural incomes in that period (World Bank, 2019). The outbreak also had a major impact on the delivery of many donor funded programmes. In fact, most of the energy sector related projects in operations at the time experienced major delays.

Guinea is slowly recovering from decades of political violence and the Ebola crisis. After the succession of military coups, Alpha Condé, the current president, was the first democratically elected president in 2010. Since 2015, the president has managed to stabilise the economy and implement the National Development Plan of the country with large infrastructure projects.

Guinea has rich natural endowments, with the largest hydroelectric power potential in West Africa and owning one-third of the world's Bauxite reserves. Guinea possesses a large mining potential that is yet untapped due to weak infrastructures, particularly a lack of road networks. In terms of hydropower the country is putting structures in place to attract investment towards developing new hydroelectric plants. Guinea has a hydropower potential of 6,000MW and is expected to feed into Western Africa Power Pool Interconnector generation projects.

The short and long-term strategies for the energy sector are set out in the Ministry of Energy National Energy Plan (2012) and the National Economic and Social Development Plan (2016 to 2020). These documents set out high-level objectives with respect to electricity generation, electricity access targets and incentivising private sector participation. More recently, two key documents have contributed in providing more specific targets and milestones to reach universal access. The National Least Cost Electricity Access Scale Up Programme in 2015, financed by the World Bank and developed by Castalia, lead to the country's Investment Prospectus optimising the least expensive technology for each region.

To address energy poverty, the Government has set out ambitious policies to scale up electricity access, to achieve 35% electrification by 2020, and 100% by 2030. These ambitious energy sector transformation targets will require significant private sector investments. This is unlikely to happen without regulatory and policy reforms, to create a more favourable environment for private investors. Presently, only a handful of private sector organisations

are involved in rural electrification, only three sites are still operating from the 30 installed in the 2003 pioneering mini-grid project of the country Projet d'Electrification Rurale Decentralisée (PERD- Decentralised Rural Electrification Project). An additional three mini-grid sites with the total capacity of 100kW were commissioned in 2019 and operated by private operators on concession contracts agreed with the Ministère de l'Energie et de l'Hydraulique (MEH - Ministry of Energy and Water Resources). There is further interest in developing mini-grids within larger electricity access programmes such as the World Bank and Agence Française de Développement (AFD) 2019 Electricity Access Scale Up Project.

One of the main barriers hampering private investments in mini-grids is the low affordability levels in Guinea due to the poverty of the population and uncertainty with regards to rural tariffs. Rural communities in Guinea on average have a very low consumption, estimated at 67kWh by Castalia, with low affordability driven by the low level of economic development in rural areas. This varies from one rural area to another, therefore previous and existing mini-grid tariffs applied service-based tariffs depending on consumption and services. For all projects, in depth technical and economic studies were conducted to understand localities ability and willingness to pay and estimate a tariff reflecting local contexts. However, there is no tariff harmonisation between rural and urban areas, and the current national electricity tariff is one of the lowest in the whole SSA region at barely $0.01 to $0.03 per kWh.

The government is trying to develop a mini-grid regulatory framework to provide greater certainty; it estimated that off-grid projects can serve 110,000 households while waiting for grid arrival based on assumptions that favour grid deployment. The government tend to plan for an electrification mostly delivered by grid development, while our estimation considers a higher potential for mini-grid opportunity based on population density and distance to the current and future grid. Several technical assistance projects have developed studies and recommendations to support the government in establishing off and on-grid perimeter delimitation to help with rural electrification. The current outdated electricity law is about to be renewed and include more clarity on concessions mechanisms, perimeters, thresholds and requirements. However, this new sectoral law was supposed to be seen in the course of 2018 to 2019 but this has been delayed.

Our report estimates that there is a potential market for mini-grids of around US$15m in Guinea, based on average per capital annual spend on electricity in rural areas. This estimate was based on a market population size of 5.94 million potential customers in Guinea; people who would be best served by mini-grids, who are currently without access to electricity. To arrive at this estimate, Guinea's land area was segmented into three area categories — grid extension, mini-grid and standalone system (SHS) — based on distance between the existing and upcoming (OMVG, CLSG and Guinea-Mali interconnexion projects) transmission and distribution network and the population. Those best served by mini-grids are those outside of a 15km 'grid extensions buffer zone', and in areas where there is sufficient population density to justify this type of solution.

Table 13 on page 45 lays out the assumptions of the different scenarios we use to estimate a market size. It is worth noting that the market size presented in this report is a conservative estimate based on the local electricity average tariff of US$0.02 per/kWh charged by the grid utility. However, we acknowledge that mini-grid projects in Guinea have been able to apply higher tariffs. For example, if we calculate the market size based on World Bank's estimated applicable US$0.2/kWh tariff for the forthcoming Electricity Access Scale Up Programme, the annual mini-grid market size value is 80% higher reaching a value of US$151 million.

1. INTRODUCTION TO THE GREEN MINI-GRID MARKET DEVELOPMENT PROGRAMME

The African Development Bank's (AfDB) Green Mini-Grids Market Development Programme (GMG MDP) aims to foster access to electricity across Africa. The MDP assists a range of stakeholders in overcoming the challenges for widespread and sustainable implementation of Green Mini-Grid (GMG) projects, by:

- Establishing a comparable, actionable understanding of the GMG market opportunity in Sub-Saharan Africa (SSA);
- Promoting the linkages between communities, public institutions, developers, financiers, and technology providers needed for successful mini-grid development;
- Strengthening capacity of developers to develop and operationalise GMG business models;
- Promoting a sound policy and regulatory environment; and
- Engaging project financiers and supporting the development of suitable financial solutions.

This country report is one of a series of country reports of the MDP's Market Intelligence business line, each of which provides and analysis of the GMG potential per country. These reports provide comparable, actionable data on the GMG potential across countries in SSA. GMG Opportunity Assessments for other countries can be downloaded from the GMG Help Desk (http://greenminigrid.se4all-africa.org).

The Market Development Programme is implemented by the Sustainable Energy Fund for Africa (SEFA).

The development of clean energy mini-grids is also the primary objective of the Mini-Grid Partnership, for which the Bank is playing a lead role for Africa. The partnership seeks to galvanise action on the barriers facing the sector, with the engagement of public, private and civil society expertise and resources. The Mini-Grid Partnership (formerly the Clean Mini-Grids HIO), including the co-ordination group, secretariat and wider membership, is the established forum for discussion and co-ordination of the efforts of development partners to advance the adoption of GMGs. The MDP was designed from the beginning to be integrated and closely co-ordinated with the activities carried out in the framework of the partnership.

2.1 Country Overview

Located in West Africa, Guinea is a coastal country, bordered by six countries and the Atlantic Ocean. The country is flanked by Sierra Leone and Liberia to the south, Cote d'Ivoire to the east, Mali and Senegal to the north and, Guinea-Bissau and the Atlantic Ocean to the west.

Figure 1 Guinea Administrative division (Nations Online Project)

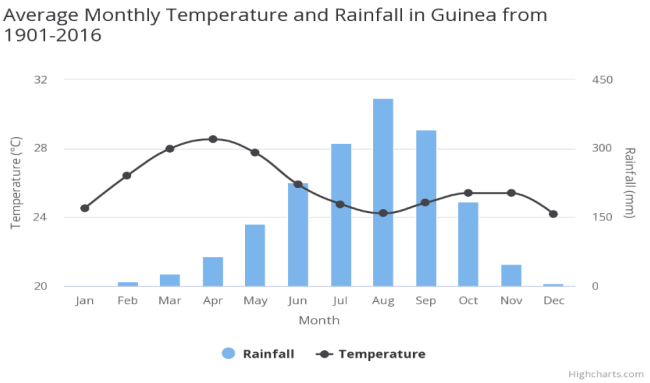
Guinea has a land mass of 245,717km2 and a population of 11.8m. Population density is similar to the SSA average: 50.52 people per square kilometre of land compared with 50.76 in the region. The population is largely concentrated in the West and South of the country. Approximately, a third of the population (36.4%) lives in urban areas, 1.7m (14%) in the capital Conakry alone (World Bank, urban population Guinea, 2018).

As with many West African countries, the country is characterised by its hot and humid climate. Guinea has two main seasons (1) monsoonal-type rainy season between June and November when monthly precipitations can be up to 450mm (typically in August), and (2) a dry season from December to July.

Blessed with abundant natural water sources, Guinea's many rivers supply water to much of West Africa. The country is locally known as the 'Chateau d'eau d'Afrique' ('African water tower'). The river Niger flows north from the southern highlands into Mali before turning south again through Niger and Nigeria. As a result Guinea represents the largest hydropower potential in West Africa, estimated at 6,000MW (World Bank, 2018).

The country also has varied topography and ecosystems. The coastal plain is made up of mangrove swamps, while inland are the Fouta Djalon hills which form several distinct ranges and plateau over the whole western Guinea. In the northeast, savannah plains of the Sahel region stretch into Mali. To the south are mountains which are heavily forested.

Figure 2 Guinea annual average temperature and rainfall 1901-2016 (World Bank, 2016)



Guinea is divided into four natural regions and seven administrative regions as described in Table 1. La Guinée maritime (Maritime Guinea) covers 18% of the country, La Moyenne Guinée (Middle Guinea) covers 20%, La Haute Guinée (Upper Guinea) covers 38% and La Guinée Forestière (Forested Guinea) covers 23% and is both mountainous and forested. Guinea is then divided in 34 prefectures and 341 communes, of which 303 are considered rural. Guinea consists of over 26,000 localities which can be defined as small villages where more than 50 people live. Nearly 80% of rural localities have a population of fewer than 800 inhabitants (ECREEE, 2018). The capital, Conakry, is on the Atlantic coast in Guinée maritime, and is made up of five communes.

Table 1 Guinea Natural and administrative division

Administrative region	Natural region
Conakry	Maritime Guinea
Kindia	
Boke	Maritime & Middle Guinea
Labé	Middle Guinea
Mamou	
Faranah	Upper Guinea
Kankan	
Nzérékoré	Forested Guinea

Guinea has only very recently experienced a period of relative stability after decades of severe conflict and violence. After being the first French colony to declare independence in 1958, Guinea has been through successive periods of political upheaval, which damaged the economy and has left the country extremely fragile. The first leader following independence was Sékou Touré, who governed the country for nearly 30 years until his death in 1984. Following Touré's governance, Lansana Conté seized power, and remained until his death in 2008.

In the late 1990s and early 2000s, Guinea became embroiled in civil wars in neighbouring Sierra Leone, Liberia and Côte d'Ivoire as rebels and refugees crossed over into Guinea. It is estimated that at times during this 10-year period, there were more than one million refugees in a country with a population at the time of eight million. Following Conté's death in 2008, another coup lead to Captain Moussa Dadis Camara taking power at the head of military junta. Camara's rule was short-lived, however. After taking power, the army, having been ordered to disperse a demonstration against his rule, committed the massacre and mass rape of unarmed civilians in September 2009, and caused the ruling regime to lose all credibility. Under pressure from the international community, brokered by Burkina Faso, the first multiparty presidential elections were held in 2010. These were won by the current president Alpha Condé.

During his first term after 2010, Condé gradually managed to restore some order to the economy and reinstated civilian control of the military, but this was set back by the West African Ebola outbreak. In 2014, the West African Ebola epidemic hit Guinea, Liberia, and Sierra Leone. Guinea, at the centre of the outbreak, was particularly affected, with the disease infecting nearly 8,000 people and killing 2,600 of these (Centers for Disease Control & Prevention, 2019). It is estimated that the Ebola crisis negatively impacted the economy by c.$35 million in 2015 and pushed urban employment rates as low as 17% (World Bank, 2019). The disease outbreak also had an impact on non-health related donor funding with most of the energy sector related projects under implementation at the time experiencing major delays. As an example, the World Bank Electricity Sector Efficiency Improvement Project was delayed by two years relative to its original 2013 to 2015 planning. Guinea is just recently beginning to emerge from that severe shock.

Despite the stability, there remains a political risk for investors due to lack of transparency regarding political processes. Presently, uncertainty continues around if Condé will look to amend the constitution to permit himself a third consecutive presidential term. In late February 2013, political violence erupted in Guinea after protesters took to the streets to voice their concerns over the transparency of the upcoming May 2013 elections. The demonstrations were fuelled by the opposition coalition's decision to step down from the electoral process in protest at the lack of transparency in the preparations for elections. Nine people were killed during the protests and around 220 were injured. Many of the deaths and injuries were caused by security forces using live ammunition on protesters. President Alpha Condé's second term is ending in October 2020 without the possibility of being re-elected for a third term under the current constitution. Yet, during the second half of 2019, the presidency made early announcements around the possibility of a constitutional review. Although not explicitly referring to presidential terms, popular interpretation of these announcements is that Condé is attempting to pave the way for a third presidency term if elected democratically. This has caused several civil riots and protests throughout the latter half of 2019, resulting in more protestor deaths at the hands of the army. Any sort of formal confirmation on a constitutional reform is yet to be seen.

Guinea's political system is divided into the executive and legislative branches. The executive branch is organised around democratic elections to vote for a president of the republic elected for a five-year term. Executive power is centralised with the president nominating of 25 civil ministers and all administration officials. The legislative branch is composed of a National Assembly composed of 114 elected members for a four-year mandate. Seventy six of the 114 members are elected through proportional representation and the remaining in a single member constituency. The legislative body did not meet from 2008 to 2013 when it was dissolved after the military coup.

Guinea's history is such that development has been extremely limited. Guinea ranks ninth from the bottom of the Human Development Index and 73% of the population lives under the extreme poverty line (under $1.90/day) (World Bank, 2018). Guinea is one of the world's poorest countries despite having abundant natural resources. Guinea has the world's largest untapped iron deposits, and has two-thirds of the world bauxite resources (reserves are estimated at seven to eight billion tonnes). Annual per capita income is estimated to barely reach US$531 compared to US$1,571 in the rest of SSA region in 2015 (World Bank, 2018). The country is ranked last in the Global Competitiveness Report due to a combination of low levels of literacy, and extremely limited access to infrastructure and services (poor quality public and private institutions, limited infrastructure, poor health and education services, and a limited financial market) (World Bank, 2018). Only 32% of the population can read, 22% has access to sanitation and only 29% of the population has access to electricity (World Bank, 2019). This situation is exacerbated in rural contexts located in remote areas, e.g. only 3% of the rural population has access to electricity.

Guinea's economy is only worth USD$10 bn, driven by services (42%), industry and mining (38%) and agriculture (19.5%) (CIA, 2017). The services sector is driven predominantly by a growing telecommunications industry, with some transport services. With mobile phone network extension activity and internet high bit rate speed offerings, telecommunications represent 47% of the services economy in 2018 (AfDB, 2018).

GDP growth is mainly driven by Foreign Direct Investment (FDI) in the mining sector. The mining industry grew at an annual rate of roughly 50% in 2016 and 2017, as opposed to 5.4% growth rate of the 'non-mining' sector in 2018 (World Bank, 2018). The mining sector also accounts for 90% of the country's exports, and 17% of tax revenue, but only 2.6% of employment. This can be explained by the fact that Guinea is not involved in any in-country added value creation of mining resources, in fact it exports 95% of its bauxite in raw form (World Bank, 2018).

Agriculture is the country's main source of employment and is considered as a critical sector to help in reducing poverty and supporting rural development. Agriculture accounts for about 95% of jobs in the economy (Afdb, 2018), but only represents 10% of exports today. One of the challenges in the agricultural sector is the low labour productivity per worker which is half that of Senegal and one-fourth that of Mali while the agricultural sector employs 50% of the working population (World Bank, 2018).

To boost the country's economy and support human and social development, a post-Ebola recovery plan for 2015 to 2017 was developed, followed by the 2016 to 2020 Plan National de Développement Economique et Social (PNDES National Economic and Social Development Plan). PNDES seeks to put the country back on the path toward a sustainable development, focusing on stimulating strong and high-quality growth to improve well-being, and to initiate structural transformation of the economy. The key investment pillars to sustain the economy include ambitious infrastructure projects, particularly in the energy and transport sectors to improve low electricity access and road coverage rates of the country. In total, the government has planned to invest ~US$30 bn in infrastructure over the course of 2016 to 2020 in order to implement the national plan. This includes US$10.5 bn in energy infrastructure and US$19.8 bn in road, port and train transport (AfDB, 2018).

However, unlocking funds for infrastructure investment is a big challenge in Guinea. Of the US$30 bn expected, Guinea has only been able to mobilise US$5.24 bn so far. This is partly due to a lack of resources in executing infrastructure feasibility studies for projects but also the lack of government capacity in executing investments characterised by lengthy bureaucratic and procurement processes. Over the course of 2010 to 2014, on average Guinea was only able to execute 53.1% of investments financed by the national budget for development and 39% of those financed by international budgets (AfDB, 2018).

2.2 Overview of the Energy Sector

2.2.1 Energy Mix, Emissions and Trends

Like many other predominantly rural African countries, biomass contributes to the bulk of the country's energy balance. In 2008 (no more recent data available), total primary energy supply was estimated to be 4.7mtoe, of which 77% was supplied by biomass, and a further 20% was from imported fossil fuels (EU, 2016).

Without any local production, Guinea is highly dependent on liquid fuel imports which represent c.20% of primary energy consumption. In 2015, net oil product imports amounted to 499ktoe.

Electricity production is extremely low, with final electricity production estimated to be c.2 to 3% of total primary energy consumed. Of the 109ktoe electricity produced, 56% was generated from hydropower sources and 43% from fossil fuels.

Electricity consumption is likewise extremely low. In 2014, domestic consumption was estimated to be average 408kWh per household per year (Castalia, 2015).

Energy demand in Guinea is expected to grow, mostly driven by electrification projects and the development of mining industries. In 2015, electricity demand grew by 13% and is expected to keep growing at ~10% per year over the next five years (World Bank, 2018). This is driven by meeting underserved demand through the implementation of electrification projects to reach a 35% electrification target by 2025, but also the likely development of industrial activities particularly in the mining sector. Conservative predictions in the National Electricity Production and Transmission Master Plan estimate a growth in electricity demand from 1,666GWh in 2016 to c.16,000GWh in 2035 (Studi International , 2019).

Total energy mix, and electricity mix, is expected to shift with substantial hydropower development planned (UNEP, 2016). The current electricity mix of Guinea is dominated by hydropower and fossil fuel-based sources. Guinea is recognised as having the greatest hydropower potential in West Africa with the estimated potential of over 6,000MW (World Bank, 2019). Therefore, hydropower development has been one of the main developmental priorities. Recent developments include the commissioning of the 240MW Kaleta hydropower plant with a generation potential of 660GWh/year. In the near future Guinea will also commission the 450MW Souapiti dam, expected to generate on average 2,000GWh/year. An additional 805GWh/year is also expected with the development of the 294MW Koukoutamba dam as part of a regional project under the Senegal River Basin Development Organisation (OMVS).

Guinea is a Least Developed Country, with GHG emissions in 2014 contributing to 0.06 percent of global emissions. Total GHG emissions in 2014 were 30.18 million MtCO2e, with the land-use change and forestry being the predominant source of emissions, accounting for 46.9% of emissions. Energy only accounted for 2.88% of emissions (USAID, 2019).

Guinea's Draft Intended Nationally Determined Contribution (INDC) set out a conditional, upon receipt of international support, commitment to cut GHG emissions by 13% below the business as usual (BAU) scenario (base year 2005) by 2030. This was proposed to be done by increasing the share of renewable energy in the country's energy mix and improving natural resource management practices.

2.2.2 Key Energy and Electricity Sector Stakeholders

The main public sector entities that make up the energy sector are the Ministère de l'Energie et de l'Hydraulique (MEH - Ministry of Energy and Water Resources), the Autorité de Régulation des Secteurs de l'Electricité et de l'Eau (ARSEE - Electricity and Water Sector Regulator), and the country's grid-based utility Electricité de Guinée (EDG – Electricity of Guinea). As detailed in Table 2, the MEH is the ministry responsible for overseeing energy sector development by planning and creating new energy policies and strategies. ARSEE acts as the sector regulatory authority specifically tasked with setting tariffs for the utility and ensuring market performance in the electricity sector through regulation. Note that ARESEE was only made operational in 2017, therefore its involvement in rural electrification is yet to be determined. Expectations are that it will also regulate off-grid tariffs and be involved in granting concessions (World Bank, 2019).

Table 2 Energy Institutions

Entity	Description and Responsibilities
Ministère de l'Energie et de l'Hydraulique (MEH-Ministry of Energy and Water Resources)	• Overall sector oversight • Prepares and implements energy policies and strategies
Autorité de Régulation des Secteurs de l'Electricité et de l'Eau (ARSEE - Electricity and Water Sector Regulator)	• Reviews and sets EDG's tariffs agreed with the MEH. • Will potentially have a role in rural electrification, including reviewing tariffs and granting permits and concessions. This is, however, yet to be defined
Electricité de Guinée (EDG – Electricity of Guinea)	• State-owned utility • EDG is responsible for electricity generation, transmission and distribution through the main grid(s) • Also provides rural energy access by running a number of diesel powered mini-grids/isolated grids in smaller towns • For the last four years EDG has been managed by Veolia-Seureca under a World Bank-supported Management Services Contract (MSC) in an effort to improve operational and financial performance
Four fossil fuel and one Hydro Independent Power Producers (IPPs)	• Fossil fuel IPPs: o AON o K-Energie o Aluminia Company of Guinea o Private operator in Kamsar • Hydropower plant (PPP): o China Water Electric • IPPs sell their production to EDG • 75% of power production used in EDG's system comes from IPPs.

The primary institutional organisation in rural electrification and energy access is the Agence d'Electrification Rurale (AGER –Rural Electrification Agency). The agency was created in 2013, but only became operational in 2017. It oversees the development of rural electrification programmes including off-grid projects. However, the MEH through the Direction National d'Electricité (DNE – National Electricity Directory) remains responsible for setting out the country's electrification targets, whereas AGER acts as an implementation arm. The legal and regulatory framework that relates to off-grid technologies such as mini-grids, is unclear.

Today, the private sector's involvement in the power sector is only seen with IPPs who sell power to EDG. There are currently four fossil fuel Independent Power Producers including AON, K-Energie, Aluminia Company of Guinea and a fourth private operator in Kamsar (region of Boké).

Further, the country's most recent hydropower plant (Kaleta) was developed and is managed by China Water Electric under the first Public-Private Partnership in Guinea. The Kaleta hydropower plant is the first project developed under a PPP scheme right after the enactment of the 2017 PPP 0032 Law. This has enabled the government to sell 51% of Kaleta hydropower plant's shares in order to raise equity to invest in the new Souapiti 450MW hydropower project currently under construction (World Bank, 2019). In 2017, the Kaleta hydropower plant and the four fossil fuel IPPs together produced 75% of Guinea's electricity generation, reaching 1,250GWh (MEH, 2017).

EDG is the state-owned utility in the country responsible for electricity generation, transmission and distribution. EDG operates one main interconnected system that covers approximately nine to 12 major towns including Conakry; a second larger isolated system known as Tinkosso that powers three cities and c.14 mini-grids running on diesel installed in smaller towns. In 2017, EDG sold 1,117,358MWh and had over 270,000 customers. EDG is expected to increase its customer portfolio as it aims to electrify most of Guinea's population through grid extension, notably in rural areas. This is a challenging task for the utility as Guinea's population is characterised by having low energy consumption and affordability levels. Therefore, the utility has been applying non-cost reflective tariffs (between US$0.01/kWh and US$ 0.03/kWh) for residential consumers who represent 45% of EDG's costumers (World Bank, 2018).

EDG has historically been characterised by its operational underperformance and is seen as being an unreliable electricity supplier. The power sector has faced significant barriers such as low access rates, poor service quality, high operational inefficiency and unsustainable financial and commercial performance. These challenges have been significantly exacerbated due to political unrest between 2008 and 2010, and later in 2014 during the Ebola epidemic. These two critical periods slowed any infrastructure and service development in the country, investments or donor support were interrupted as all efforts focused on stabilising Guinea. Therefore, EDG has

been lagging, unable to respond to a growing population and energy demand. In 2016, the company was estimated to provide only ~12 hours service a day in Conakry where over 60% of EDG's customers are located. This is even worse in smaller cities where four to six hours are available on any given day, and might only be available one in every four days. Unreliability is rampant, Guinea reported 1,962 outages due to breakdowns per year, and perception on reliability is low with 20% of the population believing that electricity is never reliable (World Bank, 2018).

System losses are estimated to be at c.35% due to old distribution networks, Illegal connections and poor commercial performance (World Bank, 2019). In 2017, EDG reported that out of 1,742GWh energy supplied only 1,117GWh were paid for. Distribution networks are outdated, and the level of fraud is high and unsustainable. Operational and management issues include poor development and maintenance of the transmission and distribution networks as well as poor billing and weak collection rate (collection rate was estimated at c.81%), all of which are compounded by the gap between electricity tariffs and cost of supply which prevents EDG from making new investments (World Bank, 2018). In 2017, EDG officially served 160,000 clients in Conakry alone, however the actual consumers are estimated to be twice that figure when taking into account illegal connections and electricity thefts (World Bank, 2019). Eighty percent of EDG customers do not have a meter installed, and as a result pay a flat fee to EDG regardless of the quantity consumed. In addition, as most of the energy supplied is generated from hydropower plants, Guinea's energy system is vulnerable to load shedding. To mitigate this challenge, EDG relies on fossil fuel IPP plants with costly power purchase contracts locked by a take-or-pay PPA. This significantly affects EDG's cost and operations; buying electricity from IPPs represents EDG's largest proportion (42%) of cost for supplying electricity (World Bank, 2019). As a result, revenue collected per kWh sold is below cost recovery. In 2017, revenue was estimated at US$0.09 per kWh on average as opposed to a cost of service per kWh sold of ~US$0.25 (World Bank, 2019). With this context, EDG is trapped in a vicious circle of chronic deficit from a tariff which is unable to cover high operational costs. Deficit is combined with high indebtedness from infrastructure development projects. The company's debt to equity ratio is up to 112% affecting EDG's solvency and liquidity.

Between 2015 and 2019, EDG has been managed under a World Bank-supported Management Services Contract (MSC) in an effort to improve the company's operational, financial and commercial performance. Veolia-Seurca consortium was contracted to support the management of EDG under an MSC. Improvements in operation and maintenance of grid infrastructure have been successful including a reduction in the duration of power interruptions. Between 2015 and 2017, the rate of non-planned outages of power plants decreased from 28% to 18%, and generation capacity was increased in secondary cities with the installation of mini-grids. The MSC also helped improve technical and managerial practices, and operational expenditures decreased by 32% during the same period (World Bank, 2018). However, EDG's commercial performance has remained weak, with the share of customers billed on meters marginally increasing from 1% to 8.6% (with a target of 80% by 2018) due to strong resistance by the population. The contract ended in late 2019 and was not renewed.

2.2.3 Government Energy Policies, Strategies, Targets, Roadmaps, Plans and Programmes

The Government of Guinea's long-term strategy for the energy sector is set out in two key documents. Both lay out the high-level objectives in terms of meeting growing energy demand, extending the grid, and increasing the contribution of renewables. The two documents are:

- The 2012 Lettre Politique de Développement du Secteur Energétique (LPDSE – 2012 National Energy Development Policy)
- 2016 to 2020 Plan National de Développement Economique et Social (PNDES - National Economic and Social Development Plan)

LPDSE is the first energy policy document whose ambitions for the energy sector include:

a. Guaranteeing the security of supply to contribute to national security
b. Reducing the dependency on fossil fuels
c. Increasing electricity exports by exploiting Guinea's hydro potential
d. Promoting renewable energy and energy efficiency programmes

These objectives were broken down into more specific energy sub-sector ambitions relating to power, rural

electrification, hydro production, renewable energy production and energy efficiency. However, these ambitions were set as high-level actions that would help strengthen the country's energy sector. Those were set without any specific targets, milestones, timelines or budgets planned/ associated to each objective.

Table 3 LPDSE's objectives

Sub-sector	Objectives include

Power	• Ensure viable inexpensive and safe energy supply
	  o Improve EDG's financial performance
	  o Create a Management Service Contract to improve EDG's management and commercial performance
	  o Action plan to reduce fraud
	  o Conduct an institutional study of the sub-sector to facilitate private sector involvement
	  o Review Electricity Law to allow a regulated competitive market
	  o Protect private investment
	  o Develop hydro potential with an associated fund financed by revenues from the mining sector
	  o Develop an institutional framework for sectoral development

Rural electrification	• Develop a PPP strategy • Adopt a concession mechanism and increase local communities and associations participation • Create fiscal framework to improve market attractiveness into rural energy sector • Develop a fund for rural electrification
Hydro	• Develop an independent storage facility • Mitigate environmental impacts caused by developing hydroelectric plants • Develop a tax mechanism to support private operators to cover operations costs
Renewable Energy	• Value biomass energy sources sustainably • Share benefits and profits generated from exploiting resources in a specific area with communities surrounding renewable energy sites • Promote solar, wind and biogas energy • Develop a database on household consumption
Energy Efficiency	• Develop a new energy efficiency strategy and an associated institutional framework

After the LPDSE, and with help from donors, the government produced the PNDES, whose energy component provided the next level of detail to LPDSE's objectives. The document explicitly highlights the need to increase access to sufficient, reliable, and affordable modern energy services for socioeconomic transformation. According to the PNDES, the energy sector will play a crucial role as a cross-sectorial enabler of the development of Guinea's economy. The document aims to increase access to electricity from 18% in 2014 to at least 35% by 2020 and increase the share of renewables (excluding hydropower) to 10% by 2020.

Donors have played a key role in developing Guinea's power sector through grid rehabilitation initiatives and improving EDG's performance. Since 2006, there has been a rescue effort among donors to improve the sector's efficiency and strengthen EDG's capacity to make the utility commercially viable while supplying reliable electricity (detail on all projects is included in table 4). First, the World Bank US$30 million Projet d'Amélioration du secteur de l'Electricité (PASE – Energy Efficiency Improvement Project) in 2006 focused on rehabilitating distribution lines in Conakry and commissioning new generation plants to improve supply. A key component of this project, to help improve EDG's commercial performance, was to introduce prepayment meters in one district of Conakry in order to overcome poor billing and customers' default payment. However, this initiative failed dramatically. Due to the population's resistance, only 566 prepayment meters were installed as opposed to the 13,600 planned as explained in Table 4. In 2011 and 2012, World Bank and AFD co-financed a comprehensive Power Sector Diagnostic and Recovery Plan that provided recommendations on improving EDG's commercial performance, restructuring and reorganising EDG and updating the legal framework

for the sector and Public-Private Partnerships (PPP). To fulfil those recommendations, a medium-term investment plan of over US$1 billion was recommended to address infrastructure, institutional and regulatory hurdles. This included hydropower plant development, network rehabilitation and technical assistance to improve EDG's operations. In fact, this recovery plan led to the signature of the MSC between the Government of Guinea and Veolia-Seureca under the ongoing Projet de Redressement du Secteur de l'Electricité (PRSE-Power Sector Recovery Project). The Afdb has also contributed to grid rehabilitation work, particularly through the Projet de Renforcement et de Réhabilitation des Réseaux a Conakry that initiated in 2008 and followed with a second phase in 2011, as explained in Table 4.

Table 4 Donor funded power sector projects

Donor/Implementing agency	Description
World Bank (2006 to 2016)	Projet d'Amélioration de l'efficacité du secteur de l'Electricité (PASE - Electricity Sector Efficiency Improvement Project), US$30 million grant focused on improving the distribution network in the city centre of Conakry to help EDG's commercial performance. Closure originally planned in 2009, was delayed to 2016. Project included : • Introduction of 13,600 prepayment meters in Kaloum district of Conakry, to help reduce default payment. EDG was only able to recover US$ c.31 for every potential dollar it would produce, due to technical losses, theft, inadequate metering, or lack of billing and collection control. Unreliable and scarce supply stunted business investments and forced reliance on uneconomical captive generation and deprived access to electricity and other services. Installing prepaid meters was one of the main project outputs to facilitate commercial recovery of its targeted zone. However, the Government of Guinea suspended efforts to rollout prepayment meters. As a consequence, only 566 prepaid meters were installed. Post-pay meters were, however, successfully installed (with a target of 556 post pay meters). • Upgrading distribution lines • Actions to rehabilitate power generation facilities and improve their management. The commissioning of Kaleta hydropower plant (240MW) in 2015, together with 175MW fossil fuel IPPs helped improve service reliability. • Technical assistance for Energy Efficiency and Institutional and Business Process Strengthening, this component included identification and implementation of corrective measures based on energy audit, development of tariff, fiscal incentives for energy efficiency and other measures including supporting the Ministry of Energy to implement programmes and measures. Measures such as introducing energy efficient products was also supported by GEF's US$4 million envelope. In terms of tariffs, only an industrial tariff increase of 25% was adopted by the cabinet in 2016.
Multi-donor (2008 to 2017)	Projet de Réhabilitation des Réseaux a Conakry (PREREC - Conakry Electric Grid Rehabilitation and Extension). The first phase of this project was initially funded by the Islamic Development Bank (US$2 million) and AfDB (12 million Unit of Account - UA)[2] in 2008 to help rehabilitate and extend Conakry's grid through 30 neighbourhoods. A second phase initiated in 2011, to restructure the power sector and EDG, involved extending the distribution network to a further 12 neighbourhoods in Conakry. For this second phase project zones were divided and financed between AfDB, AFD, WB and the IsDB.
World Bank (2014 to 2020)	Projet de Redressement du Secteur de l'Electricité (PRSE - Power Sector Recovery Project) planned to close in December 2020, is the follow-on project of PASE, the project focused on improving technical and commercial performance of the national power utility. This involved: • US$14 million financing of a Management Services Contract to support EDG performance improvement. This financed an MSC between MEH and Veolia-Seureca to provide management, operation and capacity building services for EDG over three to five years. • US$33.7 million selected investments to support improvement of the Conakry distribution network and commercial performance of EDG. This included other donors' support to conduct rehabilitation work of different zones of the city. • US$2.3 million Technical Assistance to MEH planning and project implementation support.

2. Unit of Account (UA) is a reporting currency used by the AfDB, equivalent to the IMF's Special Drawing Right (SDR) that is computed daily in U.S. dollars by the IMF. The Bank uses an exchange rate to translate currencies into UA.

The energy sector is weakly regulated in Guinea. The main law L/93/039 dates back to 1993, enacting the Electricity Code. The Electricity Code regulates the power sector's production, transmission and distribution rights. In 2012, the LPDSE was the key document seeking to promote private sector involvement in the power sector. Following the enactment of LPDSE, the first law allowing IPPs was introduced that same year (Law 98/012). One approach to further leverage private sector involvement has been to adopt PPPs for large energy infrastructure. This was made possible through the enactment of the 2017 PPP law 0032 detailed in the table below. Through this framework, Guinea has embarked on the construction of several large hydro plants in Souapiti, Koukoutamba and Fomi, plus four micro-hydro schemes. The Government hopes to achieve an 85% private contribution vs 15% government ownership mix.

Guinea is about to update the 1993 Electricity law with a new loi cadre (sectoral law), aimed at providing greater clarity for private investors. The development of the new electricity law has been funded by the AfDB and executed by IdeaConsult. The major changes include aligning the electricity code to the recent PPP law, creating a new agency to promote energy efficiency in Guinea, developing a fund for the energy sector that will be mobilised for energy developments, predominantly in renewable assets. This fund is expected to receive financing from a proposed carbon tax on sales of fossil fuels. It could also pay for rural electrification projects, although the mechanics of this fund are presently uncertain. The law will recognise the establishment of the ARSEE and the AGER, both institutions were created with the law 061 which is the only law providing a framework for off-grid development. The new law will also better recognise the jurisdiction of EDG and AGER, to provide a clearer understanding of concessions demarcation and opportunities for operators to join the off-grid sector.

Table 5 Frameworks for private sector involvement in the energy sector

Law	Main characteristics
Law 98/012 - Build-Operate-Transfer (BOT) contracts	This framework is used to finance, build, exploit, maintain, and transfer large power plants built by private operators. Existing IPPs are still operating under BOT contracts in the country.
Law 0032/2017 - Public-Private Partnerships framework	This framework aims to reduce private sector investment barriers. The law provides a framework to facilitate property transfers, reduced taxes and lower legal notary fees. This law also enacted the creation of a PPP special unit within the Ministry of Finance in charge of promoting and supporting PPP's creation. There are three types of PPP contracts: (1) Affermage (lease): this contract type offers limited government responsibility, with the private sector in charge of covering operating costs but also generating revenue from their systems. In exchange of this, the private operator pays a royalty fee to the government. (2) Concession: under a concession the operator gets full responsibility of the system, it also has to cover any risk-related cost, but the operator benefits from users payments to generate revenue. The government is not involved in any transaction and no fee is required. (3) Contrat de partenariat (partnership contract): Under this framework, operators are paid by the government independent of any revenue generated from the service provided to users.

2.3. Overview of the Power Sector

2.3.1 Generation

Installed capacity in 2017 was 699MW, supplying peak domestic electricity demand of approximately 335MW (World Bank, 2019). The full list of power plants with their respective available installed capacity is shown in the table below. Guinea's installed capacity is dominated by hydroelectric and fossil fuel plants (approximately 475MW and 225MW respectively). The current government has made diversification of the energy mix a high priority so far focused on increasing hydropower's contribution. The PDNES goal is to add over 500MW sourced from large hydro, which will be achieved through the construction of

two large hydropower projects, 425MW for the Souapiti site and 90MW on the Poudalé hydro site. At the time of writing, only the Souapiti dam was under construction to be commissioned by 2020 (World Bank, 2019). The interconnected grid supplies electricity sourced from eight hydropower micro and large plants in addition to five thermal plants. There are three other smaller hydro plants that generate electricity to the regional larger isolated grid system in addition to smaller thermal systems. Guinea also has 14 thermal generators in the country operated by the main utility, in addition to hybrid systems currently being developed by private operators. Further information on mini-grids is detailed in the following off-grid section.

Table 6 Guinea's installed capacity

Power Plant	Installed Capacity 2017 (MW)
Hydropower	474.37
Interconnected grid	472.4
Garafiri	75
Samou	47
Grandes Chutes	27
Donkea	15
Baneah	5
Kaleta (IPP)	240
Kinkon	3.4
Mini hydro	60
Regional grid	1.97
Tinkisso	1.65
Samankou	0.16
Loffa	0.16
Fossil fuel power	224.6
Interconnected grid	215.2
Kaloum 1 (IPP)	24
Kaloum 2 (IPP)	26
Kaloum 3	44.8
Kaloum 5	32.4
Kipe (IPP)	50
Guineenne d'Energie (IPP)	38
Regional grid	9.4
Boke (IPP)	2.4
Faranah	1.4
Kankan	2.8
N'Zerekore	2.8
Total Capacity	698.97

The power sector key strategy document is the Plan Directeur de Production et Transport (Production and Transmission Master Plan) developed by the consultancy Energie-Studi. This document was recently created and is awaiting official approval by the MEH. The master plan was developed as a follow-on of the World Bank's National Least Cost Electricity Access Scale Up Programme (NLCEAP) 2016 to 2020. This programme aimed at developing guidance on how to best connect Guinea's region with the least expensive technology. Castalia was commissioned to develop a study in 2015 that led to SEforALL investment prospectus based on connection targets specified in Castalia's report. More detail on targets are in the off-grid section of this report. The master plan was then developed based on the connection targets detailed by Castalia to connect 1.7 million households by 2030, mainly through grid extension (Castalia, 2015). Although not officially adopted by the government yet, the master plan, with Castalia's document, is now viewed as the long-term electrification plan and although focused on grid connection, it also details off-grid connections.

The master plan developed three scenarios indicating different electricity production targets based on domestic and mining energy demand growth. With an expected conservative annual GDP growth of ~5% by 2035, the document forecasts an increase to the installed capacity up to 2,580MW, of which 73.4% would be sourced from hydropower generation between 2016 and 2035 at an estimated cost of US$7 billion (Studi International , 2019). This is expected to meet an estimated growth in electricity demand from 1,666GWh in 2016 to c.16,000GWh in 2035 (Studi International , 2019).

To meet medium and long-term energy needs, the country has started developing Guinea's hydropower potential. Guinea is the West African country with the largest hydropower potential, with the World Bank estimating a potential of over 6,000MW, most of it in Konkouré basin (World Bank, 2018). The construction of Souapiti 450MW hydroelectric plant is the largest hydropower project (US$ 1.4 bn) in Guinea. Other projects are being considered by the government to exploit Guinea's hydro potential including a 128MW dam in Sambangalou region on the Gambian river, 300MW in Amaria, 100MW in Korafindi, 90MW in Frankonedou. All these potential projects still need financing.

Other potential renewable projects have been considered by the International Financial Corporation (IFC) and the World Bank through the Korea World Bank Partnership Facility with US$6 million grant for the Mali – Guinea Regional Interconnection project. This involves integrating solar PV into the national grids (IBRD, 2019). These projects will help reinforce Guinea's capacity to supply its

own growing demand and reduce the high operational costs of its fossil fuel plants by 2023 (World Bank, 2018).

The Government of Guinea is also looking to finance other smaller hydro projects. These would be constructed under Build-Operate-Transfer (BOT) contracts to facilitate private sector involvement. Under BOT contracts suppliers provide and install their respective plants and include a subsequent operating service in the supply package. EDG would take over the operation of the plant after a pre-arranged span of time. The aim is to give the construction and routine operations to private sector experts to give time to EDG to become familiar with all aspects of how these systems function. Small Hydro plants identified include:

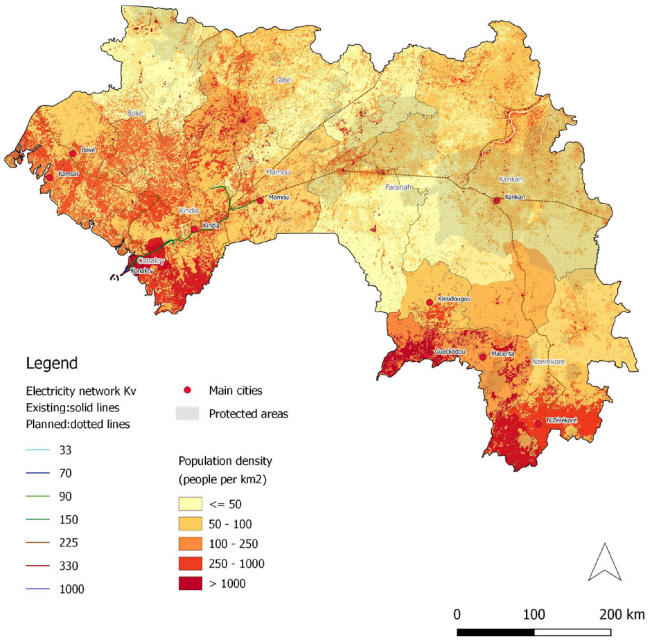
- Keno 7.4MW
- Mini-Hydro Daboya 2.8MW
- Mini-Hydro Kogbédou 44MW
- Mini-Hydro de Touba 5 to 10MW
- Mini-Hydro de Zebela 27MW

The Government is hoping to start these projects in 2020 (MEH, 2019). All of the listed mini-hydro plants are part of Guinea's master plan objective to increase mini-hydro production. The master plan, estimates that 90MW from mini-hydro generation is needed to supply the demand unlikely to be met by the interconnected grid by 2035. An estimated US$4 billion investment would be needed to install these systems. Only 6MW from solar mini-grids are included in the master plan at a cost of US$151 million estimated in 2016 (Studi International , 2019).

2.3.2 Transmission

Guinea's transmission infrastructure is composed of two separate grid systems: Grid of Greater Conakry (known as RIC) and the central zone grid (known as Tinkisso system). Conakry's system connects four main cities in Maritime Guinea and four other cities in Middle Guinea with an infrastructure composed of 116km of 225kV lines, 601km of 110kV lines and 82km of 60kV lines. Tinkisso's system is a network of low voltage lines powered by hydroelectric plants. The government's future plans included in the master plan is to extend high voltage lines to reach approximately 1,543km of HV lines in total with a US$479 million budget (Studi International , 2019).

Figure 3 Existing and Planned Transmission Lines, and Population Density Map (Source: Carbon Trust Analysis)



The Government of Guinea is prioritising regional interconnection projects to extend the national grid system. Guinea is part of three major regional interconnector projects;

- the Organisation pour la Mise en Vigueur du fleuve Gambie (OMVG The Gambia River Basin Organisation) Energy Project (interconnexion of Guinea, Guinea-Bissau, The Gambia and Senegal);
- the Côte d'Ivoire, Liberia, Sierra Leone and Guinea (CLSG) Interconnector Project; and
- the Guinea-Mali Interconnection Project.

Guinea is expected to play an important role in the future regional market of the West Africa Power Pool system thanks to its hydropower potential.

The government has already mobilised financing from the Industrial and Commercial Bank of China (ICBC) to construct the transmission line between Linsan and Fomi as part of a section of the Guinea-Mali interconnection. In 2020, the Chinese counterpart has stalled the project and therefore the commissioning has been delayed. The line will be constructed by the China International Water and Electric Corporation that already operates the recently developed Kaleta hydropower plant (World Bank, 2018).

The Guinea-Mali Interconnection project involves constructing five substations in N'Zerekore in Guinea that will also be connected to the CLSG system with a 714km 225kV transmission line from N'Zérékoré in Guinea to Sanakoroba in Mali. To implement this project, US$317.3 million will be co-funded between IDA, AfDB, EU, European Investment Bank (EIB), Islamic Development Bank (IsDB), ECOWAS Bank for Investment and Development (EBID) and West African Development Bank (BOAD) (World Bank, 2018). At the time of writing, the Guinea - Mali Interconnection project was at procurement stage and is expected to be commissioned by 2022. The CLSG project is expected to electrify potentially up to 32 localities surrounding the substations. Another substation in Fomi will be connected to the Organisation pour la Mise en Valeur du fleuve Gambie (OMVG) through the future Linsan-Fomi transmission line in Guinea. The OMVG system is planned to connect Western Guinea with a 225kv line to Guinea-Bissau and Senegal.

Electricity tariffs for households are one of the lowest in West Africa currently between US$0.01-0.03 per kWh for households (World Bank, 2019), well below the SSA median tariff of US$0.15 per kWh (World Bank, 2018). During interviews with Guinean electricity sector stakeholders, concerns over current low tariff levels of electricity were shared. The cost of supply of power to end users is estimated to be about US$0.25 per kWh, partially because of the high cost of diesel generation used to replace hydropower seasonal supply; poor investment planning in the construction of emergency fossil fuel generation capacity but also due to grid losses, power thefts and poor billing. With non-cost-reflective tariffs currently in place, Guinea's power sector generated quasi-fiscal deficit of 2.1%3 in 2016, higher than 0.9% average of 39 countries in SSA (World Bank, 2018). As a result, EDG owes around US$240 million or 3% of the country's GDP to suppliers and the Government of Guinea owes about US$160 million. Tariffs are national on-grid standardised tariffs that haven't been reviewed since 2009. Increasing tariffs is considered as a sensitive political matter as affordability levels are low in Guinea.

2.4 Overview of the Off-Grid Sector

Energy Access Policy and Planning

Almost 70% of Guineans are without access to electricity. Only 3% of those living in rural areas have access against 48% in urban areas (World Bank, 2019). The PDSE has set ambitious targets to increase energy access rates to 35% by 2025, and universal access by 2030. However, this would require almost a doubling of the present energy access rate by 2030, given only 18.1% of the population have 'legal' access to energy (World Bank, 2019). The rate of energy access is significantly below the average Sub-Saharan African rate of 43%, even after counting illegal connections which stand at 11% of the Guinean population (which brings the electrification rate up to an average of 29%).

The main document that is seen as a strategy or roadmap for energy access, including off-grid electrification, is The Production and Transmission Master Plan based on Castalia's least cost energy access study. It is this the latter that in turn forms the basis for the SEforALL's Investment Prospectus, and Master Plan, as described in the previous section. The study details both on and off-grid electrification targets based on geospatial and economic analysis, and provides a national electrification plan to 2030. The government used the study as a basis for guiding electrification priorities between 2016 and 2030, which were included in the strategic master plan developed two years later. Castalia's analysis was conducted in three stages that included, (1) mapping a baseline energy access situation based on a 35% energy access horizon by 2020 using existing infrastructure; (2) diagnosing country readiness for the management of a sectoral approach to deliver electrification targets, and (3) developing an investment prospectus and roadmap for improved access to energy in Guinea. This also involved providing institutional and structural sectoral reform recommendations for the programme to be successful.

The preferred electrification strategy remains the use of grid extension and densification. Castalia's electrification target proposes electrifying only 110,000 households out of c.1.7m through off-grid technologies by 2030. In other words, off-grid solutions would only benefit 109 localities (out of 26,253) in remote areas or serve as transition technologies where populations are expected to be connected to the grid beyond the 10 to 15-year timeframe. Approximately 100,000 'pre-electrification connections' are planned in the study to electrify areas that are expecting the grid beyond 2020, while c. 7,000 households are planned to benefit from a mini-grid system as a long-term solution by 2030. In total, approximately 10% of the population would be electrified by mini-grids.

3. Quasi-fiscal deficit refers to the difference between the net revenue of an efficient utility and the net cash it collects (World Bank, 2018).

Results are highly dependent on future regional and national grid extension plans and yearly connection targets suggested by Castalia (described in Table 7) are higher than anything seen historically. In 2019, the country was behind its grid extension or mini-grid connection targets.

Table 7 Connection targets 2016 to 2020 (from Castalia's Investment Prospectus 2015)

	2016	2017	2018	2019	2020
Total yearly connections	11,000	30,000	80,000	200,000	350,000
Total cumulative connections		41,000	121,000	321,000	671,000
Grid extension	9,256	28,256	78,256	198,256	248,256
Mini-grid	1,300	1,300	1,300	1,300	1,299
SHS	444	444	444	444	445
Mini-grid for a transition period[4]	20,000	20,000	20,000	20,000	20,000

In November 2017 all the large international donors gathered at a donor roundtable event in Paris, to co-ordinate their approach to meet energy access targets detailed by Castalia's recommendations. Castalia's study was developed to meet a 35% access rate by 2025 and universal access by 2030. From this roundtable, donors have mobilised US$21 billion overall to fund the energy access scale-up project detailed in Table 8 of the off-grid section. This included AFD's €50 million in electricity access scale up, in addition to another €50 million allocated to grid rehabilitation and extension that would connect ~50,000 households. The AfDB and IsDB are also implementing a joint project to connect 135,028 households (US$ 84.2 million); the World Bank will connect 58,000 households through rehabilitation of distribution systems in Dixinn, Ratoma, Matoto, and the Kaloum districts of Conakry. EU and AFD will co-finance the construction of mini-solar hybrid plants to connect around 20,000 households. Altogether, despite strong joint donor and government efforts, grid extension initiatives are only able to meet 50% of the 662,000 targeted grid-connections planned for 2020 under the NCLEAP (World Bank, 2019).

Several different institutions are involved in rural electrification policy planning and implementation. There appears to be some overlap, and uncertainty in their roles. So far there are four institutions involved:

- **The MEH,** within which sits the Direction Nationale de l'Energie (DNE – National Directorate of Energy): the MEH supervises energy policies and DNE is responsible for facilitating energy access planning through legislations, electrification plans and supervising their implementation, including off-grid.
- **AGER:** was created to support the development of the rural electrification sector by assisting project developers. The agency was created under the 2013 Law 061 describing the role for AGER but was officially enacted with its status in May 2017.
- **ARSEE:** The authority was recently created and is responsible for regulating the electricity sector including reviewing and setting tariffs for the national utility. In terms of off-grid regulation, the authority is likely to be involved in the future to regulate tariffs. However, this is yet to be defined.
- **EDG** is the main actor involved in rural electrification mostly by expanding the grid. Guinea's isolated system, Tinkisso, goes through rural areas and the utility has 14 mini-grids. The main rural electrification project is the AfDB funded 'Projet d'Electrification Rurale' (PER) between 2011 and 2014 aimed at electrifying one million people living in rural areas with the grid.

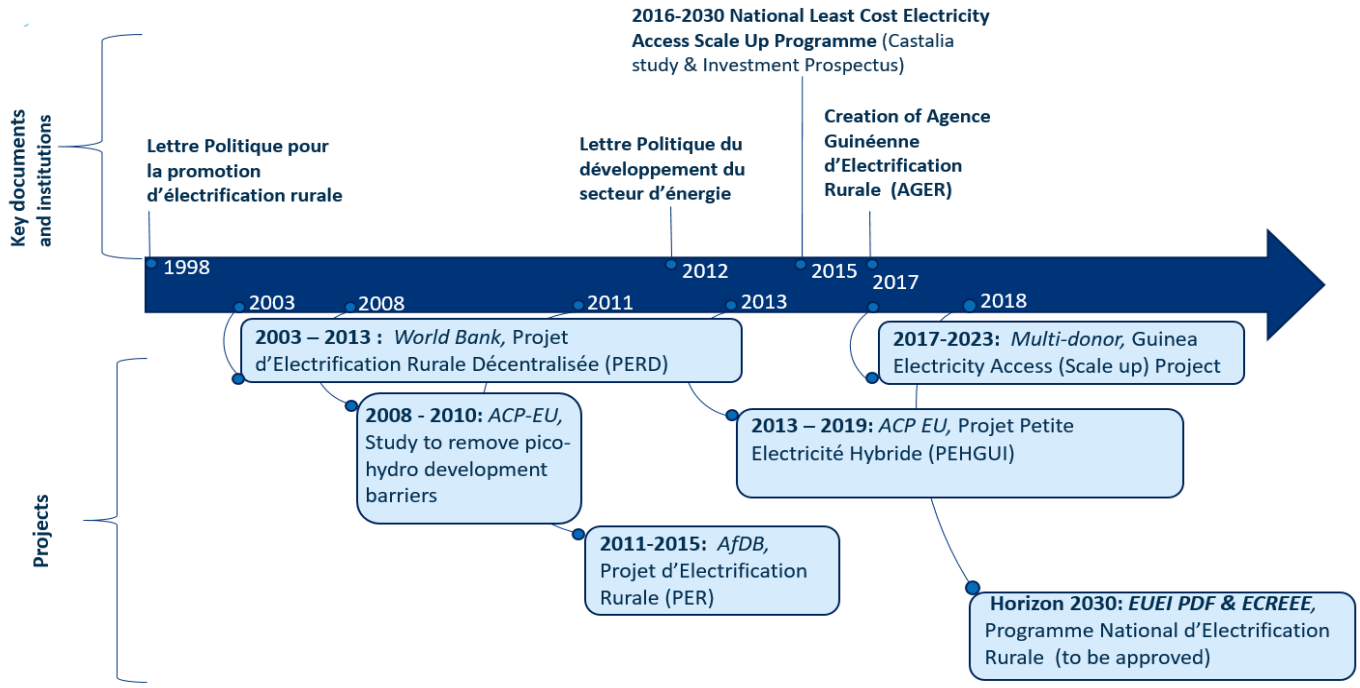
In 1998, the Government's first rural electrification policy document, the 'lettre politique de promotion d'électrification rurale' (Policy Letter for the promotion of rural electrification) was launched. This document permitted the participation of private operators in the off-grid space. It paved the way for the first off-grid project with the support of the World Bank and the European Globalisation Adjustment Fund (EGF). The Projet d'Electrification Rurale Décentralisée (PERD- Decentralised Rural Electrification Project) aimed to test private sector intervention for the first time, and further led to the creation of a rural electrification desk, later to become the AGER. Subsequent to PERD, the 1998 letter was enacted within the broader 2012 Energy Policy 'Lettre Politique du développement du secteur d'énergie' (Energy Sector Development Policy Letter) which formalised the aim of stimulating private intervention in off-grid rural electrification and officially regularised the concessional regime for mini-grid operators (under 500kW) used under PERD.

Since then, the country's rural electrification and off-grid development has been driven by donor intervention. In the

4. Castalia recommended a 100,000 mini-grid connection target set as a pre-electrification method to connect regions that would be waiting for the grid arrival beyond 10 to 15 years.

last 16 years, diverse off-grid activities have been conducted such as installing technologies, analysing the potential for hybrid systems or delivering technical assistance to support the country in setting up electrification priorities; institutions and regulations, yet to be officialised.

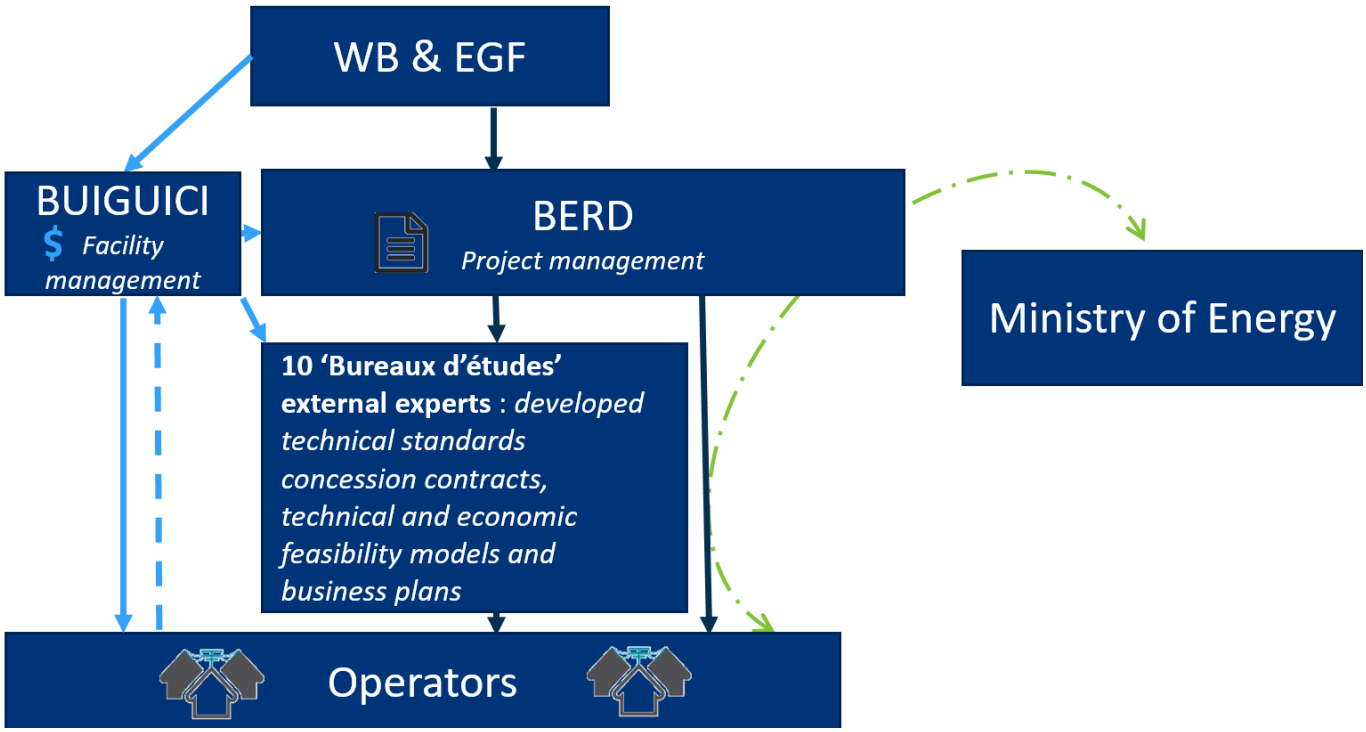
Figure 4 Chronological summary of key rural electrification projects, institutions and documents



PERD tested institutional, technical and financial mechanisms to install 30 diesel mini-grids and support private operators. In 2003, the WB and EGF together funded the country's first (and only) US$7 million mini-grid project which financed 30 privately owned and operated diesel mini-grids. To co-ordinate the role of the private sector (designers, builders and operators) PERD set up the Bureau d'Electrification Rural Décentralisée (BERD – Office for Decentralised Rural Electrification) which was the precursor to AGER. Originally the project aimed to crowd in commercial finance from local banks. However, the only bank which was deemed capable of doing so at the time was the BICIGUI bank (a subsidiary of the French bank BNP), who ultimately only agreed to manage the facility on behalf of the project (and not to co-fund). Nevertheless, the facility went ahead, and the project specific fund provided grants and concessional loans into projects. Each site was funded by a blended finance mechanism that included a 50% capex grant, 30% concessional debt and a 20% operator equity. The annual interest rate for the concessional loan was fixed at 20% including VAT (World Bank , 2013). To capacitate the private sector, BERD provided capacity building and training to operators and installers. Additionally, external experts were placed within BERD to develop a number of documents including technical standards, concession contracts, technical and economic feasibility models and business plan documents for each project site. All of these were tailored to each locality to adapt to local abilities to pay and test non-standard tariffs. All business plans were developed with a service-based tariff, that would offer different tariff levels according to levels of consumption of services requested (light bulbs, plugs, etc).

Out of the 30 mini-grids developed under PERD only three are still operational today due to rising fuel prices. At the time when business models for each mini-grid were being developed, fuel cost was at 2,000GNF (€20c) per litre of diesel. Unfortunately, fairly rapidly fuel cost moved to 10,000 GNF (1€), rendering most of the projects unviable within a few years. In addition to this challenge, most of the systems were only able to perform for a couple of hours during the day.

Figure 5 PERD governance structure, roles and responsibilities



At the time, Guinea had no energy access roadmap or master plan to prioritise areas of intervention, therefore BERD conducted pilots and studies to identify development areas. At the start, PERD conducted studies to identify four sites, aiming to test applicability of the development approach in each of Guinea's four 'natural regions'. Thus, a feasibility study for each region was conducted by the BERD before issuing a call for proposal to select operators. The feasibility studies resulted in relatively closely defined TORs for each diesel mini-grid development. In 2007, the first sites were developed with an agreed concessional contract signed with the MEH. At the time, although renewable energies were considered, diesel technologies were deemed to be the easiest and most financially viable to deploy, with financial and business plans demonstrating a good balance between affordability and return for the private sector. After these first four sites, the subsequent 26 sites were identified, and proposed by operators themselves. Many of these were entrepreneurs who wanted to electrify their home villages, and as a result 70% of operators were members of the locality where they were managing a site. After selecting operators, BERD would then support each operator with further feasibility studies, business and technical advice to develop the project (via the aforementioned technical capacity building). To provide this support, 10 local consultancies or 'bureaux d'études' within BERD, helped with project design and feasibility studies to support for operators in different regions. BERD was also the intermediary to develop the concessional contracts giving the rights for production, distribution and commercialisation and have them signed with the MEH.

At the close of PERD in 2013, AGER was created to take over the role of BERD. The ambition of PERD had always been to leave a more permanent rural electrification agency to replace the BERD, which at the time was purely a project management unit. Eventually, AGER was created after long bureaucratic processes and lobbying efforts. Back in 2013, many stakeholders thought that the AGER should be created as part of the 'loi cadre' process. Still not promulgated in 2019, it became apparent that the law would take too much time, and stakeholders therefore lobbied for a separate piece of legislation. In 2013, the law no. 061 created the AGER, which was a subsector law planned to be enacted within the future sectoral law. The 2013 law also legislated concessions for operators of systems below 500kW enabling private operators' involvement in off-grid electrification through direct proposal submission, or responding to expression of interests launched by donors or the government directly. However, at the time of writing, there still hasn't been any example of direct proposal submission to MEH for mini-grid development.

It was only in 2017 that AGER was officially created due to lack of administrative capacity and project funding. Crucially this meant that a number of people involved in the BERD in 2013 were forced to move on and so much of the institutional experience was lost. Today, however AGER is composed of 25 staff and receives government budgetary funding for operational costs. Staff are composed of engineers, with one administrative and finance executive, an accountant and a director appointed by the ministry. AGER is now responsible for overseeing rural electrification projects in the country and managing concession contracts between operators and the ministry, including getting the approval for tariffs from the ministry and the regulatory authority.

PERD unlocked further energy access projects and studies. Part of PERD and BERD's role was to understand rural electrification opportunities, type of infrastructure and resource potential in the country. As Guinea was already known for its water streams characteristic and hydro potential in the continent, in 2008 the EU funded a study under BERD to identify where mini-hydro sites could be developed (as per Figure 4). Through the study over 43 feasible sites were identified within 3km of large localities. In 2013, the EU followed with the ~€ 2million 'Projet de Petite Electrification Hybride en Guinée' (PEHGUI - Small hybrid electrification project) initially called Petite Hydraulique en Guinee (Small hydro project in Guinea) to pilot three hybrid mini-grids in Moyenne Guinée, and to further develop a programme to install renewable hydro or solar sites connecting 10 extra rural localities in Moyenne Guinée.

PEHGUI was designed based on PERD learnings. The project had initially planned to develop hybrid hydro but due to high operational cost this technology was switched to solar hybrid systems with storage. The project officially started in 2015, implemented by the French NGO Fondation Energie pour le Monde (FONDEM – Foundation Energy for the World), the project was designed based on PERD's model in terms of concessions, and support for developing business plans. The main differences included the selection of a community manager in charge of operating the three sites as well as a business model where the EU financed 100% of the CAPEX and the operator covered all the OPEX. Similar to PERD, a service-based tariff was developed to enable viability of the project. Three mini-grids with a total capacity of 100kW each in the commune of Kouramangui were successfully installed and finally commissioned in October 2019. These systems will connect 400 households benefiting approximately 20,000 people in Kouramangui. This project is the first example of rural installations with pre-payment meters included in Guinea.

To operate systems developed under PEHGUI, FONDEM trained and managed a community operator, two technicians, an accountant and a manager for each site. To ensure acceptance from rural villages, all staff members were selected as members of the locality. Selected technicians have either an electrician or fossil-fuel based energy background in order to ensure that technical staff are equipped with maintenance skills, particularly to manage the storage technologies included in the system.

Following the 2015 Castalia study and SEforALL investment prospectus, the WB, and Agence Française de Développement (AFD - French Development Agency) have committed to further fund components of the Electricity Access Scale-Up Programme. Total funding is in the order of $108m, ($58m from WB and $50m from AFD) with just over $100m going to grid extension and densification, and a further $7m for the development of 10 rural mini-grids to be implemented by AGER. Pre-feasibility studies have now been conducted on 20 localities of which the most attractive 10 will be funded. Of these 10, there are new sites, while some are part of the 30 previously electrified with the PERD which will be re-electrified. Criteria for location selection was based on (1) distance to the grid, at least 100km from a substation (to avoid risk of grid encroachment); (2) population headcount of at least 1,000 households; (3) easy to moderate accessibility to the site to facilitate operations; (4) existence and potential development of small and medium enterprises; (5) potential supply to social institution (health, school etc); (6) locality expressed interest in private sector participation. The next step is to prepare operators' pre-qualification criteria, and launch the calls for expressions of interest. The sites will be solar diesel hybrids, with battery storage also, and pre-payment meters (with local agents for credit sales). The projects will be financed through both a capex grant (expected to be up to 80% as the minimum amount necessary to ensure tariff levels are affordable by the local population), and private sector (operator) equity. At the moment there is explicit aim to attract international operators in a joint venture with local operators. The pilot will promote a replicable PPP model, including a targeted subsidy scheme or sub-grant as well as private sector equity financing.

In early 2020, donors have agreed to provide technical assistance to support AGER with the implementation of

green mini-grid projects. The World Bank, AFD and AfDB have agreed to support up to $US25 to 30 million in helping AGER implement green mini-grid projects to meet the country's electrification targets as lay out in Castalia's Investment Prospectus. Fifty seven sites will be developed in the forthcoming years and these will be installed in areas where the grid should not arrive in the next 10 years. These sites will be between 200kW and 600kW and will connect around 30,000 households which would benefit 150,000 people without electricity and generate productive uses of energy for at least 100 micro and small enterprises. AfDB's SEFA will finance ~US$0.8 million to help AGER with pre-feasibility studies, management of call for proposals of 37 sites, and provide capacity building to AGER.

Table 8 Donor funded energy access and rural electrification projects

Donor/Implementing agency	Description
World Bank (2003 to 2013)	Projet d'Electrification Rurale Decentralisée (PERD - Decentralised Rural Electrification Project), US$7 million. The objective of this project was to test institutional and financial mechanisms to attract private sector intervention in the off-grid rural electrification space. More detail in the 2.4 off-grid section is given on this project. Overall the plan was to : • Install 30 privately operated diesel mini-grids • Connect 13,500 households within 20 villages • Create a dedicated rural electrification agency • Allocate a rural electrification facility to support operators Today only three of the 30 sites are still in operation.
AfDB (2011 to 2014)	Projet d'Electrification Rurale (Rural Electrification Project). This project financed the National Energy Directorate within the MEH to increase energy access in rural areas through grid extension. The AfDB funding amounted to UA 15.053 million. The project targeted 31 localities in Maritime and Middle Guinea to benefit one million people. The project was delegated to EDG.
EU ACP (2013 to 2019)	Projet Petite Electrification Hybride en Guinée (PEHGUI - Small hybrid electrification project) initially called Petite Hydraulique en Guinee (Small hydro project in Guinea), €1.7 million to provide electricity to 20,000 beneficiaries with solar hybrid systems living in a rural village of Kouramangui. More detail on this project is given in the off-grid Section 2.4 of this report.
World Bank, ESMAP (2015)	The Government of Guinea commissioned the preparation of the National Least Cost Electricity Access Scale-Up Program (2016 to 2020) based on optimising on and off-grid technologies. This was financed through ESMAP and delivered by Castalia consultants in 2015. The report provides guidance on how to best connect each region based on adequate and least expensive technology. The objective being to increase the energy access rate from 18% (2014) to 35% by 2020 and reach universal access by 2030. The study lead to the investment prospectus which further helped donors funding mobilisation to support the sector and meet electrification targets. This report is referred to as the reference report for electrification projects, the Production and Transmission Master Plan was developed based on recommendations of this report.
World Bank and SEforALL (2015)	US$2.1 million bank-executed technical assistance TF015026 activity, closed in 2017 to achieve: • An agreed set of priority projects and associated funding requirements outlined in an investment prospectus to meet energy targets. This outcome was achieved in 2017 after the commissioned preparation of the WB National Least Cost Electricity Access Programme, which led to an optimisation of off and on-grid technologies to set a plan for electrification. This flowed through to a SEforALL investment prospectus, and in November 2017 as a first step to mobilise required financing of around US$644 million over 2016 to 2020, including technical assistance to increase the number of connections through grid extensions (662,280) and off-grid solutions (57,000). Donors pledged US$388 million and the Government has now mobilised US$288 million with ongoing projects (financed by WB, AfDB, IsDB, AFD, EU, Government) • Increase the capacity of Ministry of Energy in PPPs, and the development of the hydropower atlas for the country

World Bank. AFD
 	
(2019 to 2023)
	Electricity Access Scale Up Project is a ~$108 million WB & AFD funded project to increase electricity access in Guinea. The project is divided into three components:
	• (US$86m) Reinforce and expand grid access in selected regions and reduce illegal consumption through
	  o Regularisation of illegal connections in Conakry
	  o Rehabilitating and extending distribution networks in three areas of Conakry to reduce losses and connect 56,100 new customers
	  o Rehabilitate, densify and extend distribution networks in secondary cities to improve existing service for 15,000 customers and supply to 38,000 new customers
	• (US$ 7m) electrify remote areas with privately operated hybrid systems
	  o Pilot hybrid with storage mini-grids in 10 locations which will not benefit from the main grid within 10 years
	  o Connect 50,000 households by 2022
	• (US$ 15m) Technical assistance, capacity building and project implementation support

AfDB's SEFA (2020 to TBC)	Technical Assistance of ~$0.8 million to support AGER for mini-grid development. This project is part of a wider Technical Assistance support of $25 to 30 million, co-financed with the World Bank and the AFD to help the sector install 57 mini-grids to meet the least cost electrification plan targets determined in the Investment Prospectus. AfDB's support will specifically: • Support 37 mini-grid site pre-feasibility studies (technical, economic, financial, environmental studies) • Support and advise on the development of a call for proposal for mini-grid development • Capacity building and knowledge transferring to AGER.

In 2018, ECREEE and EUI-PDF provided technical assistance to develop the future Programme National d'Electrification Rurale to 2030 (National Rural Electrification Programme) and the sectoral institutional framework. ECREEE has been responsible for putting forward rural electrification perimeters division between private off-grid operator's concessions and EDG referred as Rural Electrification Zones based on administrative boundaries. ECREEE has also been developing the National Rural Electrification Plan preparation which involves establishing an institutional framework through capacity building budgeted at US$1.2 million. The PNER will seek to develop sub-programmes segmented in short, medium and long term which are estimated to cost over ~US$900 million through grid extension and off-grid renewables.

i2d consultancy was contracted to provide recommendations to include in the PNER and clarify the institutional off-grid framework. It recommended concessions and EDG perimeter boundaries definitions, EDG should cover localities within 5km of the main grid where a population of 500 to 1,000 people are concentrated. Or, those at 10km from the main grid for villages with over 1,000 people should also be covered by EDG. Recommendations emphasise the need for fully developed mini-grid specific regulations, and standards and tariffs to attract investment and ensure return on investment. The future PNER should also break down the 12-year programme into annual programmes with specific rural electrification targets and project budgets to electrify localities with the relevant technology based on population density, distance to the planned grid economic activity and cost of technology for a given service. Additional capacity building support is also suggested for the development of the PNER. This would include providing greater autonomy to AGER in terms of GIS data management and monitoring for rural electrification. Currently, the DNE is the only institution with access to electricity and energy-related GIS data; to avoid overlaps the programme report recommends improving co-ordination between both organisations. However, in 2019, the programme and its recommendations have been only partially validated.

ECREEE's recommendations are expected to be included in the new sectoral law to be developed with the support of AfDB/SEFA in the near future. However, this still remains uncertain. The new 2020 sectoral law should integrate rural electrification perimeters and also a grid arrival compensation mechanism to protect operators. The law will also increase mini-grids authorised size from 500kW initially legally approved (2013) to 1MW, and establish a fund for rural electrification that would help financing operators profitability gap through a combination of concessional credits and subsidies similar to PERD's financial mechanism.

Overall Guinea has 14 mini-grids operated by EDG, three diesel mini-grids and three hybrid systems being operated by private operators. In addition to these, the World Bank and AFD have planned to install 10 mini-grid pilots

followed by an additional 10 sites by 2023 through the World Bank Energy Access Scale-Up Programme. EDG is not planning on developing other small systems as its priority is to expand and rehabilitate the grid.

In terms of solar home systems and solar products interventions there appears to be little activity in Guinea. There is no real tracking on the number of solar kits and SHS deployed in the country, however Guinea is part of the Regional Off-Grid Electrification Project (ROGEP) that seeks to increase accessibility to modern stand-alone solar systems across West African countries. As part of this project GreenMax consultants will during 2020 conduct a market study on the potential in Guinea. Currently, there are a lot of solar products, and some domestic use solar panels in the market. However, the market is flooded by poor quality products leading to a household's lack of trust in these systems.

There is an Association des Professionels des Energies Renouvelables (APER- Association of Renewable Energy Professionals) in Guinea that aims to promote the use of quality products and align the market to the potential of renewables. APER aims to lobby for usage of quality standards such as Lighting Global. The association is a member of ECOWAS renewable energy association and is championing ECREEE's effort in issuing ECOWAS-wide standards for solar PV. The association includes 25 members including SHS installers, despite being a small market in Guinea. A second objective that APER is trying to support youth employment through capacity building and training.

Licensing and Existing Mini-Grids

The 061 law that created AGER as the rural electrification agency in 2013 also included specific conditions to include in concessional contracts. Notably, the law fixed a maximum threshold of 500kW for rural private operators. Further, the law stipulates a list of broad elements that concessional contracts should cover:

- Modalities to use land for installing and exploiting an off-grid technology
- Rights and obligations of operators
- Financing procedures
- Tariff conditions
- Sanctions
- Procedure in the event of a litigation
- Mechanism in case technology is transferred or sold

Under PERD the minimum project size was for 200 households to ensure project viability, and projects did not exceed a production of 500kW. In reality, all projects varied between 16kW and 250kW production capacity, translating to approximately five hours daily service. Under PEHGUI, the three installations planned are 100kW each and a minimum eight-hour daily supply. Recommendations for the due sectoral law is to increase the maximum mini-grid size to 1MW.

The 2013 regulation codifies two approaches for granting licences but existing mini-grids have all been developed through calls for proposals. The first option is for operators or developers to respond to calls for proposals launched by donors or the government to electrify Rural Electrification Zones prioritised in the PNER (National Rural Electrification Programme). The second option is for developers, private operators or local communities to initiate the process by submitting a proposal directly to the Ministry of Energy. In both scenarios, a concession agreement between the government and the operator is signed and allows operators to be in charge of their sites for a determined period of time.

All existing mini-grids were licenced after responding to a call for proposals launched by donor projects, essentially PERD and PEHGUI thus far. Concessional contracts were defined and agreed between the relevant rural electrification agency (BERD then AGER) and the Ministry. For both projects the operator was awarded the rights for production, distribution and commercialisation through one single licence for a period of 15 years. Under PERD's contracts, the concession would be automatically renewed for a 15-year period, in the event that the government did not provide a six-month notice prior to the termination date of the originally agreed concession.

For PERD, contracts also provided conditions in case the government would like to purchase installations at the end, or prior to, the termination date of the concession. Installations were agreed to be given back to the government once the concession was over and the operator was notified if no contract renewal occurred. The general consensus was that the government and operator would agree on a mini-grid value adjusted to the amount of subsidy the operator would have received if not taken over by the government. In the event that the government purchased the concession prior to the end of the agreed duration, the government needed to notify operators at least two years in advance, and the compensation would amount to a value based on the period left to cover and

the average net profit generated by the operator during its operating period. However, in reality this did not happen as none of the concessions were bought by the government.

In the context of PEHGUI, this is slightly different. Contracts are also signed for a 15-year period. However, with no renewal condition or specific requirements to permit the government to purchase the system. In fact, when PEHGUI's concessions end, community operators will have to go through a competitive process in order to win the concession again.

The selection of operators for PERD was based on least subsidy required. Specific selection criteria to choose operators included equity offered and capex subsidy needed. The future World Bank project is also expected to follow the same process.

In terms of selecting concession areas, both PERD's four pilot sites and PEHGUI perimeters were pre-selected through a pre-feasibility study. Under PERD the bureaux d'etudes were supporting operators in conducting pre-feasibility studies and understanding abilities to pay off different regions. Under PEHGUI, Fondem conducted these studies before commissioning the three existing sites.

AGER is now responsible for granting concessional agreements between operators and the ministry. Under PERD, BERD was responsible for managing concessional agreements signed between operators and the ministry, this role has now passed to AGER, particularly in the context of PEHGUI and the forthcoming Electricity Access Scale Up Programme. However, with the arrival of the new regulatory authority there seems to be some confusion in defining who will be granting concession contracts. It is hoped that this will be clarified within the new sectoral law.

Mini-grid Tariffs

As there is no specific law or regulation for mini-grids, there is no tariff that is specified in regulation for mini-grids or in rural contexts. There is no legal provision for non-standard tariffs but there is precedent through concession agreements for non-standard service-based tariffs. Specifically, projects under PERD and PEHGUI that have been able to set tariffs, have set higher tariffs than the national average of US$0.02 per kWh. Tariffs were offered based on different services (e.g. number of plugs or light bulbs provided) as described in Table 9 and 10 below. These were set based on demand studies conducted prior to the projects In the context of PERD, tariffs were defined when developing operators' business plans with BERD and consultants support. Socio-economic and feasibility studies helped determine affordability levels that were then authorised by the Ministry of Energy through concession agreements. For PEHGUI, service-based tariffs were developed by FONDEM with the support of AGER and approved by the Ministry of Energy and the Regulatory Electricity Authority.

Table 9 PERD mini-grid tariffs

Service	Min monthly tariff per service in USD*	Max monthly tariff per service in USD*
1 Lamp 9 to 11W	1.59	2.65
1 TV plug 70W	2.65	4.25
1 Fridge plug 220W	4.78	8.49

**Exchange rate USD1 = GNF 9,420 on 25/11/2019*

Table 10 PHEGUI monthly tariffs per service

Household services	Service level	Connection cost (USD*)	Av. Min Price (USD/ month*)	Av. Max Price (USD/ month*)	Service	Average min- max consumption
	service 1	16	0.96	3.18	light bulb, radio player, phone charger, video/audio player	0.12 to 0.45kWh/day
	service 2	32	10.62	21.23	light bulb, radio player, phone charger, video/audio player, TV, fridge <200L, radio, computer	0.8 to 2 kWh/day
			Price (USD*/ kWh)			Consumption
Business services	service 3	43	0.53		light bulb, fan, printer, DVD player, video/audio player, phone charger, TV, fridge <200L, radio, computer, small appliance, sewing machine, freezer <150L<200W	Limited consumption 3kWh/day
	service 4	53	0.64		light bulb, fan, printer, DVD player, video/ audio player, phone charger, TV, fridge <200L, radio, computer, small appliance, sewing machine, freezer <150L<200W, welding machine or agricultural processor with power output of 4,000W	Unlimited consumption

WB Electricity Access Scale-Up Programme is targeting a tariff of c.US$0.2 per kWh which is considered affordable. The project has calculated that it will need to finance at least 60 to 80% of the CAPEX in order to achieve this. The World Bank acknowledges that rural areas initially consume small amounts of electricity and generally fall in the lowest tariff category (US$0.02 per kWh average tariff), hence driving the substantial capex subsidy.

Subsidies and Incentives

There are currently no government subsidies or specific incentives for the private sector to invest in the off-grid sector. There are no government incentive mechanisms for mini-grid developers and operators; or publicly funded capital subsidies, with the exception of donor funded projects, such as the WB Electricity Access Scale up programme. It is recognised that currently the government has no resource capacity to fund a subsidy able to support developer's expenditures and initial investments. It should be noted that the 2013 law on rural electrification included a Rural Electrification Fund to be managed by the Conseil a l'Electrification Rurale (Rural Electrification Advisory Committee within the Ministry of Energy). However, this was set without specificities on how the fund would work or be financed. At the time this report was written neither the CER nor the fund were yet created.

VAT and duty exemptions can be granted to projects. For PERD and PEHGUI, both projects were exempted of VAT and duty taxes. These exemptions are given on a case-by-case basis.

With no public subsidy available, donors developed financial mechanisms to support private operators' investments.

- Under PERD, the WB structured a blended finance mechanism. For each site, 20% of CAPEX was covered by operators' equity, 30% concessional loans and 50% through WB's subsidy. Both concessional loans and the subsidy facility were managed by the commercial bank BICIGUI. Concessional loans were to be repaid within 10 years with the first two years being differed. However, of the 30 implemented sites only three are still operational. The operator has only been able to pay back 50% of the concessional loan for one out of three sites.

- In the case of FONDEM's project, the EU facilitated a full CAPEX subsidy for each installation and operators are expected to cover OPEX independently.
- In the context of the World Bank NLCEAP project, as previously explained, the bank will grant 60 to 80% subsidies and the rest will be covered by operators' equity. At the time this report was written, no commercial bank had a financial mechanism in place for green mini-grid investment.

Power Purchase Agreements

PPAs in Guinea are restricted to IPPs, there is no specification for how mini-grids could sell electricity to the main grid. As there is no mini-grid regulation currently, mini-grids have not been designed with an option enabling such mechanism. The Government has however signed a number of PPAs with IPPs running heavy fuel oil-fired power plants at high prices to meet growing demand, in particular when hydropower plants supply limited energy to the grid during the dry season. The only provision for the private sector to participate in the on-grid sector outside of PPAs for IPPs has been the development of PPPs particularly for large hydro projects, such as Kaleta hydro plant. The private sector would not be able to continue to distribute power to customers if the mini-grid were to become interconnected. At this stage the only option would be a local PPA.

Arrival of the Grid

There is no legal provision protecting operators in case the grid arrives. Operators are not provided any financial compensation or any guarantees should this happen. However, PERD included a compensation mechanism in case the government takes over the mini-grid. In the event that the government purchased the concession prior to the end of the agreed duration, it needed to notify operators at least two years in advance, and the compensation would amount to a value based on the period left to cover and the average net profit generated by the operator during its operating period. For PEHGUI's concession contract agreements, a clause stipulating that operators will receive an 'agreed compensation' in case the grid arrives is included. The conditions and exact amount for this disbursement are not specified.

There are no examples of interconnection of mini-grids to the main grid, and one example where a mini-grid has been taken over by EDG. However, operating this mini-grid has meant continued financial losses for EDG (the very reason why it was abandoned by the operator) due to payment defaults, and high operating costs due to difficult access and fuel prices. Since then EDG has not been willing to take over the operation of any private mini-grids unless these become interconnected.

Technical Rules

Concession contract agreements have determined specific standards. As there is no regulation, technical standards have been defined for each site during the business plan development and project proposal under PERD. A Cahier des Charges is also developed with each concessional contract specifying any further technical standards and maintenance processes to follow. Similarly, for PEHGUI and the Electricity Access Scale Up Programme, technical rules are determined in the cahier des charges and are expected to meet international standards. Under PEHGUI for instance, the operator is committed to deliver quality service and use low voltage distribution lines to give access to 230 to 400V and use a nominal current frequency of 50 Hertz.

Mobile Services

Mobile penetration in Guinea is 46%, lower than the regional SSA 74% average due to coverage difficulties (GMSA, 2018). The ICT (Information and Communication Technology) sector in general faces many challenges, and fiscal pressures have forced mobile operators to end investment in rural areas. In addition, taxation applies to retail prices for the use of certain services including the price of text or the use of internet connectivity for businesses. Guinea is also affected by weak broadband service penetration underperforming compared to wider SSA region. Two other key factors slowing the uptake of mobile services are illiteracy and reliable individual identification.

Table 11 Key taxes on mobile consumers, 2016 (GMSA, 2018)

Central taxes	
Customs duty	10 to 20%
Value-added tax (VAT)	18%
Excise duty on telephone consumption	GNF 1 (per second of usage)
Surtax on international incoming traffic (SiiT)	$0.12 per minute of usage

Mobile money account penetration rates lag behind other West African countries. Guinea's mobile money account

penetration rate is 1.5% as opposed to neighbouring countries such as Benin, Burkina Faso, Cote d'Ivoire, Senegal and Togo, which have a mobile money account penetration rate of 24.3% (World Bank, 2018). Mobile banking has experienced a surge in the last decade with more registered accounts than commercial banks and microfinance. However, only 6% of these mobile accounts are active. Two mobile operators launched financial services, Orange in 2012 and MTN in 2014. Together, both operators counted 620,000 active accounts out of ~2 million accounts. Orange leads the market with an average of 210,000 transactions per day amounting to €5 million (World Bank, 2018). There is limited to non-existent evidence for mobile-based payment of services in Guinea.

Barriers to Mini-grid Deployment

Today, the biggest barrier limiting mini-grid deployment in Guinea is a lack of legal and institutional framework permitting and protecting private sector involvement. Guinea's mini-grid deployment history has been driven by donors' interventions, which have looked to test financial and institutional mechanisms to attract investors. However, currently the country is lacking specific boundaries between EDG's perimeter and operators' concessions, a clear definition of the role of the regulatory authority within the mini-grid space and protection of private sector investments in the event of grid arrival. There is also an ambiguity in the delimitation between urban and rural areas which creates a greater confusion in terms of governance structures and rural electrification perimeters. It is hoped that the new sectoral law which was due at the end of 2019/early 2020 will include off-grid sector regulations and provide greater clarity in terms of perimeters, compensation mechanism, technical rules and other institutional frameworks.

Further, most rural areas are characterised by their low ability to pay due to poor socio-economic contexts. Economic levels vary from one region to another, as does the ability to afford electricity. In certain areas operators are at risk of default payment without any protection or subsidy to cover their operational costs. Operation models need to be adapted to the local area's conditions; this might require community management models in some areas with a larger subsidy support, and full, private management in other areas (ECREEE, 2018). An example of higher levels of affordability enabling private operation can be seen in Kouramangui where PEHGUI implemented three sites. The choice was made after conducting a socio-economic study showing that the region is able to afford ~US$0.2/kWh as a result of a developed and well-connected agricultural economy. However, Guinea remains one of the poorest countries in the region with most of the rural population living extremely remotely and characterised by low levels of literacy, little access to road infrastructure and public services.

Rural community perceptions affect operator's ability to bill. Stakeholders have shared their concern regarding the reality of collecting electricity payments in rural communities. There is a general acceptance that energy supply is 'promised' by the government as a free public service. Communities have been reluctant to pay private operators and this has even led to violent reactions in some instances. These negative reactions can also be exacerbated by local affiliations, in some areas, communities are sceptical of receiving a service from an operator that is unknown to the local village.

The lack of public subsidy to support private operators is also a recognised constraint. Off-grid electrification is not a government priority, coupled with limited government budget available there is no financial support at the national level to help with daily operations. So far, the only subsidy has been a donor funded CAPEX subsidy, resulted insufficient to sustain operations in PERD's experience. Cross-subsidy could help support the sector, noting that current on-grid tariffs are too low to ensure projects' viability and profitability.

There is also a gap in local capacity to manage mini-grids as a business and deliver long-term maintenance. Skills and human resources are lacking, as Guinea is characterised by a low literacy rate. The sector lacks people with abilities in operating teams, managing sales and conducting regular billing visits. However, all of the mini-grid projects have been designed with some capacity building activity to support local operators.

There is no local green mini-grid operator able to supply technical equipment. Guinea has seen the deployment of diesel mini-grids through PERD (2003-2013) and has therefore the capacity to provide materials and equipment locally. However, to date, there is no green mini-grid operator able to centralise a supply of materials and equipment for green mini-grids.

3. GREEN MINI-GRID POTENTIAL

Estimating the potential for mini-grids is a challenging task that requires robust data and/or assumptions. Some physical factors, such as resource availability and geographic features, can be collected remotely through satellite data, but other factors require availability of local datasets and surveys. Certain non-physical factors, such as demand and consumption patterns, require precise settlement-level data to be collected. This data is often unavailable, out of date, or highly resource intensive to obtain. In addition, opportunity assessments rely upon criteria that differ depending on the approach of the implementing agency. For example, a private developer might consider purely financial metrics, whereas a community scheme might focus on quality of services provided. Given these constraints, the opportunity assessment in this report is designed to be of relevance to all mini-grid stakeholders but will not address the individual needs of all.

This chapter aims to give mini-grid stakeholders an understanding of the size of the opportunity for green mini-grids in Guinea. Market size estimates are calculated based on a number of considerations: (1) physical opportunity size according to GIS datasets (population density, load centres, existing grid, etc); (2) existing electricity expenditure by rural households; (3) maximum customer affordability and willingness to pay, and (4) tariffs currently allowed in-country. Comparisons will be made between an existing market size, based on affordability and in-country tariff limitations, and the theoretical market size based on cost-reflective tariffs5. The difference between current and theoretical market size will allow an approximation of any subsidy requirement for opening the market (in percentage terms).

3.1 Data Availability

In Guinea, population density data can be sourced from WorldPop6. WorldPop data estimates numbers of people per grid square, with national totals adjusted to match UN population division estimates.

The electricity transmission network map of Guinea was sourced from the West African Power Pool (WAPP) GIS database. This dataset is distributed by ECREEE providing details on the existing and planned transmission grid network (medium and high voltage lines) in the whole Economic Community of West African States (ECOWAS) region and some countries in West Africa. Grid extension populations within the 15km buffer of the current grid were inferred based on a combination of high voltage (HV) line data (obtained from the IFC GIS data: electricity transmission and distribution grid maps) and satellite mapping of night-lights. Off-grid populations are those outside of these areas. Unfortunately, at the time of writing, GIS data on the different grids and transmission lines was not available. As a result, Tinkisso's system was not mapped in Figure 6 showing Guinea's existing transmission network.

3.2 Assessing Mini-Grid Potential: Methodology

The first step in understanding mini-grid potential in Guinea is to identify numbers of potential mini-grid customers, based on population (or household) density and proximity to the grid. To do this, the country's land area is segmented into three area categories — grid extension, mini-grid and standalone system (SHS) — based on distance between the existing transmission and distribution network and the population.

- Grid extension areas: defined as areas within 15km of the grid
- Mini-grid areas: defined as areas further than 15km from the grid[7], with household density greater than 50 households per km^2
- Standalone system (SHS) areas: defined as areas

5. Cost-reflective tariffs are assumed to be $0.4/kWh across SSA, based on cash flow modelling for typical mini-grids seen across SSA and elsewhere in the world. It should be noted that $0.4/kWh may be conservative in some markets, particularly those that face supply chain challenges.

6. www.worldpop.org.uk

7. While we have assumed GMG, populations are those beyond 15km of the grid, some developers may also wish to consider regions already serviced by the grid. In some areas currently reached by the grid, mini-grid market potential exists due to both high main grid connection costs, as well as its lack of reliability due to the aging grid network. The possibility of mini-grids in proximity to the main grid is not considered in our analysis due to its high dependence on the business model used and local demographics.

further than 15km from the grid, with household density less than 50 households per km^2

To understand where these different areas lie, the national grid is inferred using a combination of high voltage (HV) line GIS data and satellite mapping of night-lights, buffered by 15km to produce the grid-extension area8. Potential off-grid populations are outside of this grid extension area, with mini-grid populations identified based on population density greater than 50 households per km2.

Once mini-grid population sizes are established, mini-grid market sizes can be estimated by multiplying the number of potential mini-grid customers by likely electricity expenditure (either per capita or by household). This report uses four different electricity expenditure scenarios:

1. Existing rural household expenditure on electricity based on the World Bank Global Consumption Database (World Bank, n.d.). This approach assumes that 60% of rural household energy expenditure is on electricity, and that household revenue comprises 60% of the total revenue of a mini-grid (when including revenue from businesses, public sector buildings and industrial users).

1. Existing rural household expenditure on electricity based on other literature and sources. This may be based on international or local studies, or local stakeholder interviews (in theory, this should yield similar results to scenario (1) above, although this may not be the case in practice).

2. Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SEforALL Tier 2/3 energy access nationwide, and an average allowable tariff currently used in-country. This approach assumes that the average rural household's electricity use would be approximately 2.2 kWh/day; according to the SEforALL Multi-Tier Framework. This represents a supply level between Tier 3 (1kWh per day) and Tier 4 (3.4kWh per day), which allows for electrical lighting, air circulation, television and phone charging (Tier 2 level), plus additional appliances that can allow for productive uses.

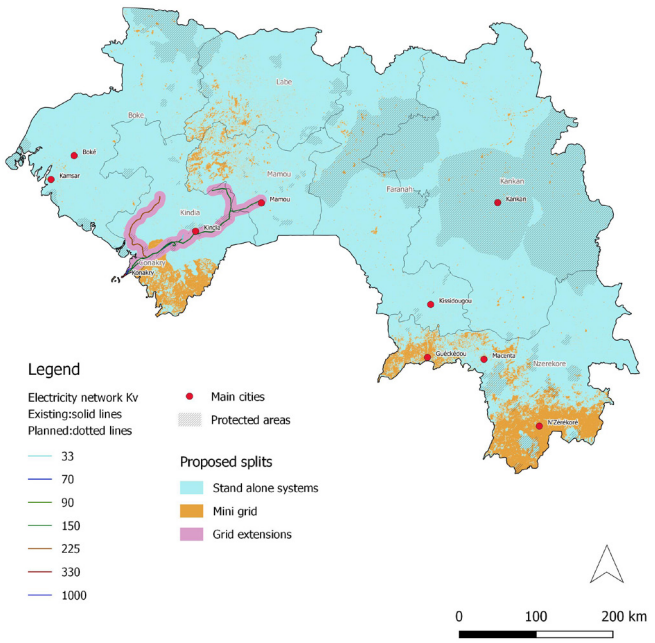
3. Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SEforALL Tier 2/3 energy access nationwide, and a flat tariff of $0.4/kWh. This tariff has been chosen as the minimum tariff needed for private developers to recover their costs. Such a rate is assumed to be one which in many contexts in Sub-Saharan Africa, and in other developing countries, is cost-reflective. It has been used to allow comparisons across countries in terms of market size, but also to highlight the shortfall between feasible tariffs, and often-cost-reflective tariffs.

Results from these four scenarios are discussed in the results section that follows.

3.3 Assessing Mini-Grid Potential: Results

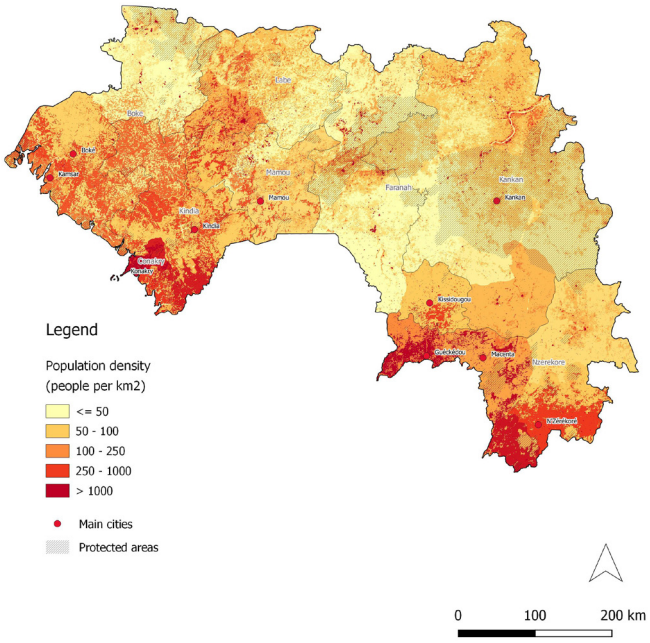
Guinea has two isolated grids, The Greater Conakry Grid and Tinkisso's system. Only Greater Conakry's system has a 225kV line in the south of the country. Unfortunately, at the time this report was written, data on the entire transmission lines in the country was not available to include both grids in our map as shown below. Future plans include interconnecting the country to its neighbouring regional interconnector projects, mostly with 225kV lines.

Figure 6 Guinea's existing grid network



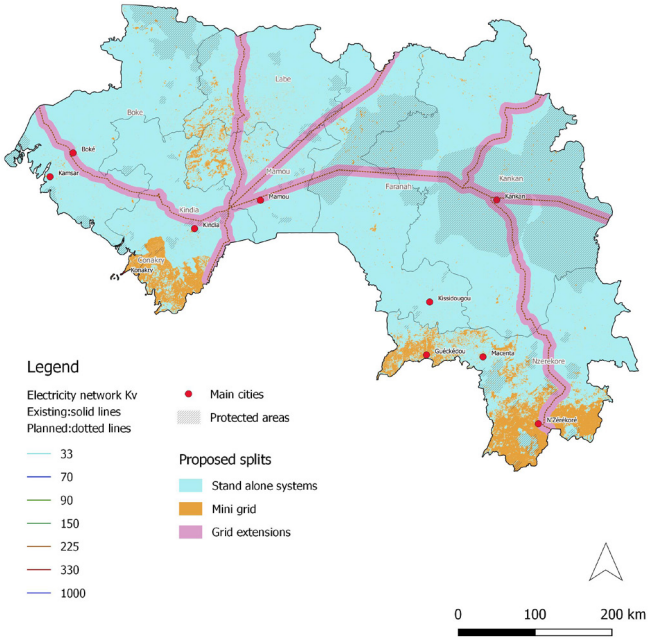
8. Using this combination of night-lights and HV line datasets provides a more comprehensive picture of current electrification than using HV lines alone. Although HV grid line data is commonly available for countries in Sub-Saharan Africa, these lines provide a limited view of electrified areas, since medium voltage (MV) lines are often used to reach towns at distances exceeding 15km. This analysis therefore infers the position of the MV lines from satellite data of night-time light emissions, pre-processed to provide yearly-average datasets from which noise and cloud cover have been removed.

Figure 7 Population density Guinea



By inferring the presence of the transmission and distribution lines using night-lights, and overlaying population density (Figure 7) onto the resultant map, we can identify those areas best served by mini-grids (Figure 8) .

Figure 8 Regions best served by grid extension, mini-grid and standalone systems (Carbon Trust analysis)



Our analysis estimates that 5.94 million people (49% of the non-electrified population) will be best served by mini-grid solutions in Guinea. A further 3.3 million people (28% of the non-electrified population) will be best served by solar home systems (SHS) and 2.76 million people (23% of the non-electrified population) will be best served by grid extension, based on proximity to the existing grid. This calculation is based on the current grid coverage only9; any planned grid extensions will reduce the estimated market size.

The Guinea mini-grid market is mostly in Upper and Middle Guinea where most of the rural population lives. This is due to their low electrification rates (i.e.~ 3% on average in rural areas), limited grid coverage, and population densities high enough to support mini-grids. Our analysis shows that the mini-grid market potential is spread among the following four main regions, i.e. N'Zerekore, Labé, Mamou, Faranah. The number of people that will be best served by mini grids respectively in each region is ~2 million; 746,000; 553,000; 522,000 corresponding to around 68% of the population on average in each region. The provinces with the largest percentage of the population best served by SHS technologies are Kankan and Boke located in upper and middle Guinea, corresponding to approximately 50% of the population in each region. The population best served with SHS in Boke is concentrated in the northern end of the region in Middle Guinea side where most of the rural population is concentrated. As opposed to Boke's coastal and southern areas where that concentrates more people and where the regional capital Boke is located.

Population sizes best served by either grid extension, mini-grid or SHS are shown by province in Table 12:

9. High voltage lines plus lights seen from satellite, which are used to infer the presence of medium and low voltage lines (note: this method may camouflage a significant existing off-grid contribution from diesel gensets, meaning that this mini-grid market size result is likely to be conservative; further studies in-country are required)

Table 12 Suitable electrification solutions per region in Guinea (Carbon Trust analysis)

State	Current grid network					Planned grid network to 2030			
	Electrification rate	Population (thousands)			Mini-Grid Market ($,thousands)	Population (thousands)			Mini-Grid Market ($,thousands)
		< 15km of grid	Mini-Grid	SHS		< 15km of grid	Mini-Grid	SHS	
Boke	-	146	445	606	1,135	332	337	559	859
Conakry	-	1,787	31	0	79	1,786	31	0	79
Faranah	-	-	522	379	1,332	98	462	341	1,178
Kankan	-	14	804	878	2,052	565	384	752	980
Kindia	-	682	689	481	1,758	816	622	419	1,588
Labe	-	-	746	318	1,903	281	512	287	1,307
Memou	-	131	553	238	1,412	371	374	178	955
Nzerekore	-	3	2,147	437	5,480	309	1,863	422	4,754
Total	29.1 %	2,765	5,936	3,338	15,151	4,557	4,585	2,962	11,701

In terms of potential revenue, the size of the market based on 5.94 million potential customers varies according to the four electricity expenditure scenarios described in section 3.2 (assessing mini-grid potential: methodology):

1. Existing rural household expenditure on electricity from the World Bank Global Consumption Database: According to this database, average rural household spend on energy consumption in Guinea is US$40.8 annually. To convert this to expenditure on electricity, we use two assumptions: (1) that around 60% of household energy spend is on electricity, and (2) that household spending comprises 60% of the total revenue of a mini-grid (when including revenue from businesses and community buildings). Given that the average number of persons per household in Guinea is 6.3, this translates to per capita electricity expenditure of approximately $3.86 annually, or an overall market size of $23m annually (assuming 5.94 million customers). Based on grid expansion projections to 2030, this market size will drop to $18m (assuming 4.6 million customers).

2. Existing rural household expenditure on electricity based on other reports/literature: this assumes a national average per capita annual spend on electricity of $2.55 when applying the average national domestic grid tariff (US$0.02/kWh). To get the $2.55 value, we based our calculations on studies and project reports, we determined the average rural monthly consumption. In 2015, SEforALL investment prospectus, designed by Castalia, estimated that projected monthly household consumption five years after being connected would be around 67kWh/month with a baseline of 34kWh/month per household in 2014 (Castalia, 2015). This figure was confirmed by FONDEM's tariff options applied for their rural mini-grid services in Kouramangui as part of PHEGUI project. Household tariffs proposed are determined on a consumption basis varying between 0.5kWh per day to 3kWh per day per household, or between 15kWh and 90kWh per month per household. Therefore, we calculated the per capita annual spent on electricity based on the 67kWh monthly household consumption. The national domestic tariff sits within the lowest of the Sub-Saharan African region, within US$0.01 to 0.03 per kWh; we used the averaged value of US$0.02 per kWh (World Bank, 2018). As a result, based on the current tariff, we can estimate a market size of $15m annually. We chose to use the average electricity national utility domestic tariff to keep a conservative approach. However, we acknowledge that this market value can be higher as there is no plan for tariff harmonisation of urban and rural tariffs. In other words, rural tariffs currently vary on a project basis and are higher than EDG's services. For instance, in the context of PEHGUI project, tariffs offered are between US$0.32 to 0.63 per kWh, varying with the services households subscribe to (plugs, light bulbs, refrigerators, etc). However, evidence on billing is to be seen as the project was only commissioned in the second half of 2019. The forthcoming mini-grid component of the WB Electricity Access Scale-Up Project estimates that selected areas could have a tariff of ~$US0.20/kWh. In general, Guinea's affordability levels, especially in rural environments, are very low, but these can depend on socio-economic levels of each community. In depth pre socio-economic studies

before developing mini-grid projects, similar to those conducted for previous projects, would help determine the exact tariff to apply based on the economic context and community willingness to pay for each targeted area.

3. Potential rural household expenditure on electricity, based on a bottom-up calculation of what would be required to deliver SEforALL Tier 2/3 energy access nationwide, and an average allowable tariff currently used in-country: Annual cost of electricity from a mini-grid was estimated on forward-looking household electricity consumption of 2.2kWh per day, representing annual per capita electricity demand of 127Wh (6.3 people per household), with the average US$0.02 per kWh tariff applied. Based on this assumption of growing demand, the estimated market size reaches around $15 million annually and $12 million with projected grid extension plans to 2030.
4. Potential rural household expenditure on electricity, based on a bottom-up calculation of what would be required to deliver SEforALL Tier 2/3 energy access nationwide, and a flat tariff of $0.4/kWh: This tariff is assumed to be cost-reflective. Based on annual electricity demand of 127kWh per capita, a tariff of $0.4/kWh gives an average annual electricity expenditure of $50.98 per capita: an overall annual mini-grid market size of $303 million given a mini-grid population of 5.94 million. However, estimating a tariff of $0.4/kWh does not reflect the current market conditions of Guinea considering tariffs currently applied, and the limited ability to pay for electricity services and broader buying power in rural areas.

A summary of these four market size estimates is shown in Table 13.

Table 13 Market size estimates for the four scenarios

Scenario	Estimated per capita annual costs for GMG	Market Size given current GMG population	Market Size of GMG population (given planned grid extension)
1 World Bank Database	US$ 3.89	US$ 23,065,782	US$ 17,814,076
2 Other Reports	US$ 3.83	US$ 15,151,053	US$ 11,701,403
3 'Bottom-up' + existing tariff	US$ 2.55	US$ 15,132,208	US$ 11,686,849
4 'Bottom-up' + theoretical tariff	US$ 50.98	US$ 302,644,164	US$ 233,736,984

Scenario (1) rural household energy consumption data is based on World Bank Global Consumption Database. Scenario (2) is based on 2015 Castalia's indicative household energy consumption reflected in the current active mini-grid project (PEHGUI) estimations. This scenario takes the average domestic tariff offered by the grid. However, tariffs applied in rural areas vary and tend to be higher, therefore this is a conservative estimate that could be re-evaluated with more accurate on the ground estimated or applied tariffs depending on rural areas affordability and economic activity. Scenario (3) is based on national grid tariffs in Guinea and on demand levels observed elsewhere in SSA. Finally, scenario (4) is based on a theoretical higher tariff than currently available and on demand levels observed in SSA. Scenario one, three and four are more likely to give a theoretical view on the market as opposed to scenario two that uses observed in-country rural energy consumption and applied national grids tariff.

In summary, this report estimates an annual mini-grid market size of $15 million in Guinea, based on an average tariff of $0.02/kWh, and average per capita annual consumption of 128kWh in rural areas (based on an average rural monthly consumption varying between 15kWh and 90kWh). This implies per capita annual electricity expenditure of $3.83 within the population best served by mini-grids. Based on an estimated cost-reflective tariff of $0.4/kWh across SSA, it is therefore estimated that 93% of project costs would need to be covered by subsidy to open up the mini-grid market to developers (lifetime project costs – with subsidy covering both CAPEX and OPEX).

If we calculate the market size based on the World Bank's estimated applicable US$0.2/kWh tariff, the annual mini-grid market size value is over 80% higher, reaching a value of US$151 million. In this case, per capita annual electricity expenditure is US$26 within the population best served by mini-grids (using the same levels of rural

energy consumption as the paragraph above ~128 kWh). Only 50% of project costs would need to be covered by a subsidy to open up the mini-grid market to developers with the World Bank's tariff.

3.4 Renewable Energy Potential for Mini-Grids

3.4.1 Hydro

Guinea represents the largest hydropower potential in West Africa, estimated at ~6,000MW. The country currently uses less than 10% of its technically exploitable potential. Like other neighbouring countries, it is difficult for Guinea to achieve national self-sufficiency in electricity supply due to the high cost associated with establishing new generation and transmission infrastructure. Guinea is a member of regional power interconnection and river basin management initiatives, OMVG and OMVS, and the West African Power Pool of the Economic Community of West African States. Guinea reached a milestone when it commissioned the 240MW Kelata project on river Konkoure.

The World Bank has supported Guinea in developing a Hydropower Atlas available on the following link here.

The Government has prioritised the development of large-scale hydroelectricity in Guinea, commissioning new plants like the 240MW Kaleta plant and the construction of 450MW Souapiti hydroelectric plant. However, based on the Production and Transmission Master Plan, Guinea is also looking to finance a couple of smaller hydro projects to exploit the 90MW mini-hydro potential estimated at a US$4 billion investment. So far, the list of plants to be financed include:

- Keno 7.4MW
- Mini-Hydro Daboya 2.8MW
- Mini-Hydro Kogbédou 44MW
- Mini-Hydro de Touba 5 to 10MW
- Mini-Hydro de Zebela 27MW

Several organisations including AFD and EU have conducted mini-hydro feasibility studies through their projects such as the 2008 pico-hydro study that was used to develop the PEHGUI project.

3.4.2 Biomass

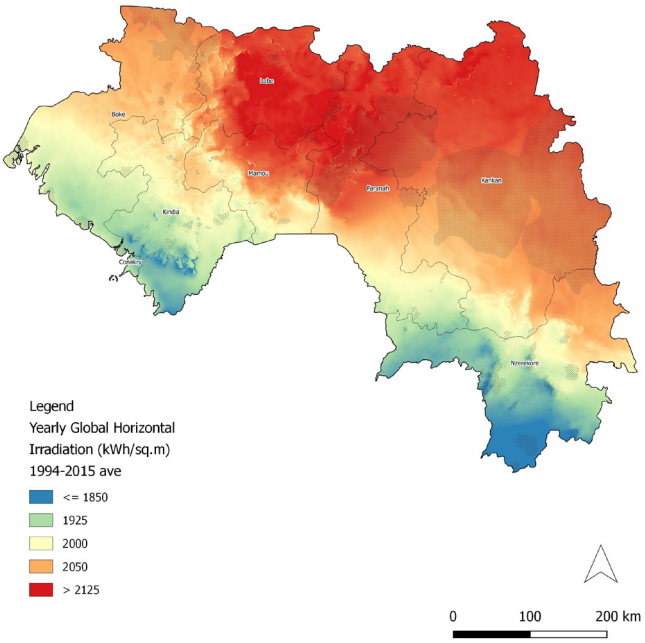
Biomass is listed as a source of energy that the government wants to value and develop sustainably in the LPDSE. However, there has been limited activities in the biomass sector to date. UNDP is the main organisation exploring the development of a biogas market in Guinea through the distribution of bio-digesters. The objective of this project was to understand the potential additional benefits of developing biogas in the country to support the fishing sector by combining the energy provision to enhance economic development. The approach consisted in distributing digesters to homes and industries where waste streams could be optimised to produce gas for lighting or cooking. To date, the project has distributed 1,300 digesters in domestic homes and two industrial digesters.

The Government responded positively to this initiative and has asked UNDP to develop a national agency for biogas development, currently being developed with the aim to have a national agency for bio-digester by 2020.

3.4.3 Solar

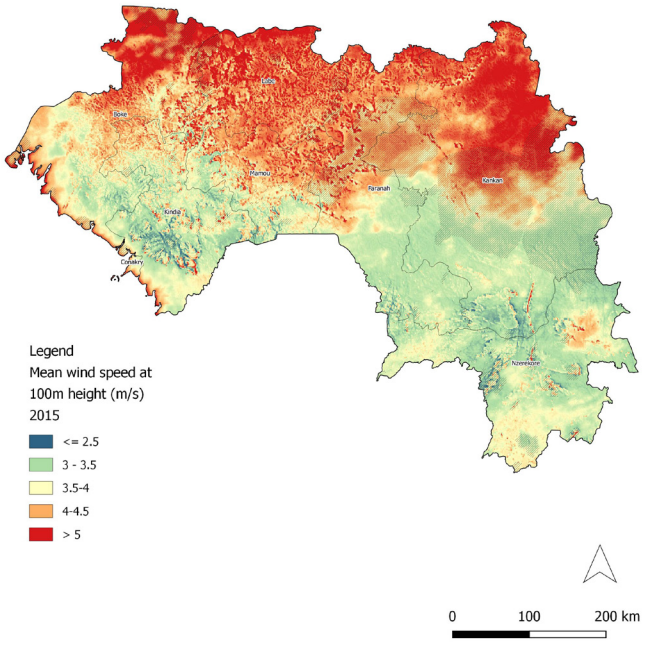
Guinea has a strong solar potential in the northern half of the country with an average yearly global horizontal irradiation of above 2100kWh/sq.m. However, data availability on solar power potential is scarce. Currently, REEP indicates a mean annual insolation of just under 5kWh/sq.m/day and sunshine duration of an average of 2,700 hours a year, indicating commercial viability (UNEP, 2018). In fact, current hybrid mini-grid systems being developed have prioritised solar as opposed to hydro or other technologies due to lower cost. However, Guinea's Production and Transmission Master Plan only includes 6MW from solar mini-grids at an estimated cost of US$151 million in 2016 (Studi International , 2019).

Figure 9 Guinea yearly global horizontal irradiation



3.4.4 Wind

Figure 10 Mean wind speed in Guinea



Wind potential has not been explored in Guinea, there is currently no wind project in the country. Guinea's average mean wind speed is 2 to 4 m/s annually or slightly beyond 5m/s in the northern part of the country as indicated in the map. This may be too low for large-scale wind power production but could be used for smaller applications, such as water pumps (UNEP, 2018).

4.1 Energy Sector Policies and Regulatory Frameworks Directory

Key law and regulations

- Law L/93/039 is the General and first Electricity Law that codified the sector specifying generation, transmission and distribution rights.
- Law L/2001/18 enacted a reform to privatise public enterprises, this law was the first milestone to open the energy sector to IPPs
- Law/98/012 codifies IPPs under Build-Operate-Transfer framework, allowing IPPs to finance, build, exploit and maintain large power plants and transfer ownership to the national power utility who would buy electricity from said IPPs.
- Law 0032/2017 regulates Public-Private Partnerships to reduce private investment barriers. The law provides a framework to facilitate property transfers, reduced taxes and lower legal notary fees. This law also enacted the creation of a PPP special unit within the Ministry of Finance in charge of promoting and supporting PPP's creation.
- L/2013/061 enacted in 2013 rural electrification Law (*Lettre de Politique d'Electrification Rurale* - LPDSE). This law at the time created the AGER as the rural electrification agency. It is the only framework for off-grid technologies supplying less than 500kW in rural areas. The law also codified what concession contracts should stipulate, this includes:
  - Modalities to use land for installing and exploiting an off-grid technology
  - Rights and obligations of operators
  - Financing procedures
  - Tariff conditions
  - Sanctions
  - Mechanism in case of technology transfer or sale
  - Procedure in the event of a litigation

This law also enacted a Conseil a l'Electrification Rurale (CER - Rural Electrification Advisory Committee) planned to be based within the Ministry of Energy as an advisory arm responsible for developing rural electrification programmes and policies. The law also enacted a Rural Electrification Fund (without specificities on how this fund would work or be financed) managed by the CER. Both CER and the fund have not been created at the time of writing.

4.2 Data Sources Directory

Electricity transmission network (medium and high voltage)
File Name: transmissiongridecowas2017.geojson
Source Age: January 2017
File type: Geojson, line
Description: A shapefile of the electricity transmission network of Nigeria
Projected co-ordinate system: WGS_1984 (EPSG: 4326)
Source: Western African Power Pool (WAPP) GIS database, distributed by ECREEE
Link: https://energydata.info/dataset/transmission-grid-ecowas-region

Nigeria Renewable energy power plants
File Name: ecreee_v_energy_generators_simple
Source Age: 2018
File type: ESRI Shapefile, points
Description: A shapefile of power plants in Nigeria
Projected co-ordinate system: WGS_1984 (EPSG: 4326)
Source: ECOWAS observatory for Renewable Energy and Energy Efficiency (ECOWREX) database
Link:http://ecowrex.org:8080/geonetwork/srv/eng/catalog.search#/metadata/57db0a4b-e225-42d9-a493-3932824d69f8

Operational Clean Energy Mini-grids
File Name: cemgs_12032019
Source Age: March 2019
File type: ESRI Shapefile, point
Description: A shapefile of operational clean energy mini-grids in Guinea
Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: ECOWAS observatory for Renewable Energy and Energy Efficiency (ECOWREX) database
Link: http://www.ecowrex.org:8080/geonetwork/srv/eng/catalog.search#/metadata/46e36312-5ee9-4363-8fbc-e93acb50e43a

Night-lights
File Name: GN_SVDNB_npp_20160101-20161231_75N060W_vcm-orm-ntl_v10_c201807311200.avg_rade9.tif
Source Age: 2016
File type: Raster
Description: Night-lights data, annual average for 2015. Adjusted to remove clouds, outlier lights and data noise
Projected co-ordinate system: WGS_1984 (EPSG: 4326)
Data Source: Earth Observations Grou at NOAA
Spatial Resolution: 15 arc seconds
Link: https://energydata.info/dataset/world-night-light-annual-composite-2015

WorldPop Population Density
File Name: GIN14adj1.tif
Source Age: 2014
File type: Raster
Description: 2014 estimates of numbers of people per grid square, with national totals adjusted to match UN population division estimates (http://esa.un.org/wpp/).
Projected co-ordinate system: WGS_1984 (EPSG: 4326)
Data Source: World Pop data portal
Spatial Resolution: 100m
Link: https://energydata.info/dataset/guinea-population-density-2014

Guinea Administrative Boundaries (State and Local Government Area levels)
File Name: gin_admbnda_adm1_ocha_itos.shp *and* gin_admbnda_adm0_ocha_itos.shp
Source Age: 2017
File type: ESRI Shapefile
Description: Shapefiles of State and Local Government Area boundaries
Projected co-ordinate system: WGS_1984 (EPSG: 4326)
Source: World Food Programme
Link:https://data.humdata.org/dataset/guinea-geodatabase

Wind
File Name: NG_wind.tif
Source Age: 2015
File type: Raster
Description: Mean wind speed at 100m height
Co-ordinate system: WGS_1984 (EPSG: 4326)
Source: DTU, IRENA
Link: https://irena.masdar.ac.ae/gallery/#gallery

Solar
File Name: GHI.tif
Source Age: 2016
File type: Raster
Description: Annual total Global Horizontal Irradiation (GHI) (kWh/sqm) averaged over 1994-2015
Co-ordinate system: WGS_1984 (EPSG: 4326)
Source: DTU, IRENA
Link: http://globalsolaratlas.info/downloads/guinea

4.3 Stakeholder Directory

4.3.1 Government and Agencies

Agency: Ministère d'Energie et Hydraulique (MEH - Ministry of Energy and Water Resources)
Description:

- Overall sector oversight
- Prepares and implements energy policies and strategies

Agency: Autorité Sectorielle de Régulation des Secteurs d'Electricité et Eau (ARSEE - Regulatory Authority of Electricity and Water Sectors)
Description :

- Responsible for sector regulation
- Regulates the activities and service quality of entities involved in generation
- Oversees and regulates tariffs
- The authority should also be involved in off-grid tariffs regulation, but this is still to be seen with the new sectoral law to be updated

Agency: Eléctricité de Guinée (EDG)
Description :

- Responsible for electricity generation, transmission and distribution
- Responsible for commercialisation of electricity in urban areas and 'préfectures' (which are administrative capitals of different areas of Guinea)
- Purchases power from fossil fuel and hydro IPPs

Agency: Agence Guinéenne d'Electrification Rurale (Rural Electrification Agency of Guinea)

Description:

- Responsible for overseeing the implementation of rural electrification projects
- Responsible for developing concessions for off-grid operators to be agreed by the government
- Responsible for conducting pre-feasibility studies

4.3.2 Mini-Grid Practitioners and Product Developers

There are a couple of operators who worked on PERD projects. The list includes:

- Société d'Électrification de Soulouta (SES) Sarl
- Société Bronkédou Electricité
- Société Diakole Electrification
- Société d'Electricité Nakoloma Goyala
- Société d'Electrification Rurale de Guinée
- Société Energie Rurale de Gbenson
- Société d'Electricité de Boola
- Société d'Electricité de Bofossou
- Société d'Electricité Rurale de Balia
- Société d'Electricité de Maréla
- Société BERCA Energie
- Société d'Electrification de Kouroukoro
- Société d'Electrification Rurale de Koudian
- Société Bankalaise d'Electricité (SOBEL – this is one of the operators that still operate a system in the country)
- Société Nafa
- Société de Production d'Electricité Rurale de Dialakoro
- Société de Fourniture d'Energie Décentralisée
- Entreprise d'Electrification Banko
- Entreprise Guinéenne d'Electricité et de Commercie (EGELEC)
- Société Tounni Lumiere
- Société d'Electrification Rurale de Guinée (SEGUI)
- Société de Production d'Energie Electrique de Kakoni
- Société Electricité de Donghol Touma
- Société d'Electrification Rurale de Dounet
- Société Dara Développement Rural
- Société de Production d'Energie Décentralisée
- TOPO Electrification Rurale de Guinée
- Société EBOF-GENERATOR

4.3.3 Bilateral and Multilateral Donor Organisations

World Bank

Contact:**Email**: mbah3@worldbank.org
Telephone: +224-624-933-008
Link: https://www.worldbank.org/en/country/guinea

Brief description: The World Bank country office is a key correspondent for the Guinean authorities. It mobilises its entire range of financial tools to finance projects that contribute to sustainable and environmentally friendly growth, with a concern for reducing inequalities. In Guinea, the WB has mainly been focusing on rural and infrastructure development.

Agence Française de Développement (AFD)

Contact:**Email**: afdconakry@adf.fr
Telephone: +222 45252525
Link: https://www.afd.fr/fr/notre-agence-en-mauritanie
Brief description: AFD country focus is around poverty eradication and empowering the agricultural sector. Most projects are around improving education, developing infrastructures and boosting private sector contribution in the country. In 2016, AFD had €93 million euros invested in the country across the listed sectors. AFD has also co-financed several projects with the WB including the latest Electricity Access Scale-Up Project.

European Union (EU)

Contact: **Email**: delegation-guinea@-conakryeeas.europea.eu
Telephone: +(224) 622 35 20 71
Link: https://eeas.europa.eu/delegations/guinea_fr
Brief description: The EU delegation based in Guinea is responsible for representing and defending EU interests in the country. It supports the country in ensuring security and contributing to sustainable socio-economic development. The main contribution of the EU in rural electrification has been providing technical and financial support in

conducting studies on hydro potential and developing the Programme National d'Electrification Rurale (PNER).

United Nations Development Programme (UNDP)
Contact: **Email**: registery.mr@undp.og
Telephone: +224 629 53 00 79
Link: https://www.gn.undp.org/
Brief description: UNDP's main support in Guinea is mostly in supporting the country's development and meeting its targets communicated in the PNDES. UNDP has very little activity in the energy and rural electrification space, most of the work has been studying the potential market development for bio-digesters in Guinea and piloting small bio-digesters and pico-hydro projects in rural areas of Guinea.

BIBLIOGRAPHY

Afdb. (2018). *Guinea Economic Outlook*. Retrieved from https://www.afdb.org/en/countries/west-africa/guinea/guinea-economic-outlook

Castalia. (2015). *Feuille de route et prospectus d'investissement.*

Centers for Disease Control and Prevention. (2019). *2014 to 2016 Ebola Outbreak in West Africa*. Retrieved from Ebola (Ebola Virus Disease): https://www.cdc.gov/vhf/ebola/history/2014-2016-outbreak/index.html

CIA. (2017). *Guinea Country Factbook*. Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/gv.html

ECREEE, E. P. (2018). *Rapport d'Assistance Technique - Assistance Technique portant sur le cadre politque et réglementaire specifique aux mini-réseaux en Guinée.*

GMSA. (2018). *Reforming mobile sector taxation in Guinea: unlocking socio-economic gains from mobile connectivity.*

Government of Angola. (2015). *UNFCCC INDC Submissions: Angola.* Retrieved October 23, 2019, from:https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Angola/1/INDC%20Angola%20deposito.pdf

IBRD. (2019). *Korean-World Bank Partnership Facility.*

IBRD. (n.d). *Korea-World Bank Partnershpi Facility Annual Report 2017 to 2018.*

MEH. (2019). *Systeme d'Information Energetique Guinee*.

MPCI. (2015). *Plan National de Développement économique et social 2016 to 2020.*

SEforALL. (2014). *Evaluation et Analyse des Gaps par rapport aux objectifs de SEforALL .*

Studi International. (2019). *Actualisation du Plan Directeur de Developpement des Infrastructures de Production et Transmission.*

UNDP. (2019). *Least Developed Country Category: Angola*. Retrieved October 2019, from https://www.un.org/development/desa/dpad/least-developed-country-category-angola.html

UNEP. (2018). *Guinea Energy Profile.*

USAID. (2019). *Greenhouse Gas Emissions Factsheet: Guinea*. Retrieved October 2019, from https://www.climatelinks.org/sites/default/files/asset/document/2019-USAID-ATLAS-Guinea%20GHG_Emissions_Factsheet.pdf

World Bank. (n.d). Retrieved from http://datatopics.worldbank.org/consumption/sector/Energy

World Bank. (2013). *Rapport d'achevement PERD.*

World Bank. (2018). *Guinea Electricity Access Scale-Up Project .*

World Bank. (2018). *Guinea - Mali Interconnection Project.*

World Bank. (2018). *Guinea Country Overview*. Retrieved from https://www.worldbank.org/en/country/guinea/overview

World Bank. (2018). *Overcoming growth stagnation to reduce poverty.*

World Bank. (2018). *Overcoming growth stagnation to reduce poverty.*

World Bank. (2018). *Power Sector Recovery Project.*

World Bank. (2018). *Urban population Guinea*. Retrieved from The World Bank Data: https://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=GN

World Bank. (2019). *Guinea Electricity Access Scale-Up Project.* World Bank.

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