Mini-Grid Market Opportunity Assessment: Senegal

Green Mini-Grid Market Development Programme:

SEforALL Africa Hub & African Development Bank

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BANQUE AFRICAINE DE DEVELOPPEMENT
AFRICAN DEVELOPMENT BANK

CARBON TRUST

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TOWARDS SUSTAINABLE ENERGY

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The SEforAll Africa Hub has the mission to facilitate the implementation of the SEforAll initiative in Africa. It is part of a regional hubs network established with the multilateral development banks. The Africa Hub promotes African ownership, inclusiveness and a comprehensive approach to the initiative's implementation. Its main activities include provision of guidance for the SEforAll country action processes globally and in Africa, delivering of technical assistance to partner countries, networking and communication, and mobilisation of financing.

The African Development Bank has an overarching objective to spur sustainable economic development and social progress in its Regional Member Countries (RMCs), contributing to poverty reduction. The Bank Group aims to achieve this objective by mobilising and allocating resources for investment in RMCs, and providing policy advice and technical assistance to support development efforts.

The Carbon Trust wrote this report based on an impartial analysis of the data entries captured within the mini-grid database as of December 2018. 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 ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) aspires to contribute to the sustainable economic, social and environmental development of West Africa by improving access to modern, reliable and affordable energy services, energy security and reduction of negative environmental externalities of the energy system (e.g. GHG emissions, local pollution).

The Carbon Trust would like to thank Senegal's Ministry of Oil and Energy, in particular the Directorate General of Electricity for their contributions which made this report possible. The Carbon Trust would also like to thank members of the following institutions for further input and support: Agence Sénégalaise d'Electrification Rurale (ASER)/Senegalese Rural Electrification Agency, Commission de Régulation du Secteur de l'Electricité (CRSE)/National Electricity Regulator, Programme d'Urgence de Développement Communautaire (PUDC)/Community Development Emergency Programme, Agence Nationale pour les Energies Renouvelables (ANER)/National Agency for Renewable Energy, COPERES, Fongip, World Bank, USAID, Agence Française de Développement (AFD), and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

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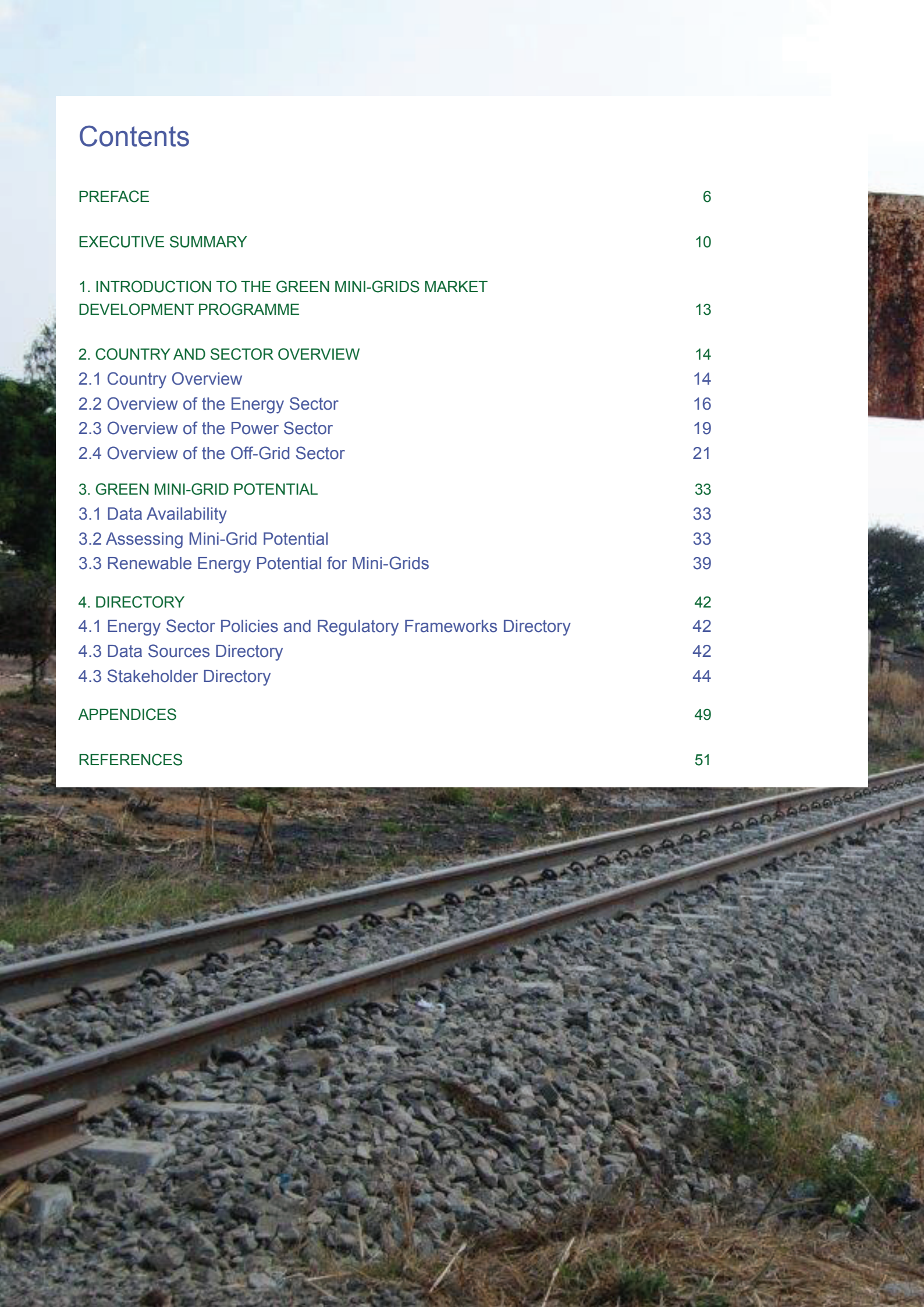

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PREFACE

This paper, part of the Green Mini-Grid Market Development Programme (GMG MDP) document series, assesses the green mini-grid market in Senegal. 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, who may be needed to sell power at prices significantly below the cost of production and delivery. It also leaves the most remote towns and villages without electricity. 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 unfavourable 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 barriers confronting the emerging GMG sector. It is part of a larger Department for International Development (DFID) funded GMG Africa Programme, which also has GMG initiatives in countries including Kenya, Tanzania, Mozambique, Sierra Leone and the DRC; 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 and the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) at the request of the AfDB. It was written by Jon Lane, William Hudson and Micol Salmeri of Carbon Trust and Yuri Lima Handem from ECREEE. Carbon Trust is a mission-driven organisation helping businesses, governments and the public sector accelerate the move to a low carbon economy. ECREEE is a specialised agency of the Economic Community for West African States.

The content of this report was reviewed by Jeff Felten of the AfDB's GMG team. It was edited by Kimberlee Brown.

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

List of Acronyms

AEME	Agence pour l'Economie et la Maîtrise de l'Energie/National Agency for Energy and the Economy
AFD	Agence Française de Développement/French Development Agency
AfDB	African Development Bank
ANER	Agence Nationale pour les Energies Renouvelables/National Agency for Renewable Energy
ASER	Agence Sénégalaise d'Electrification Rurale/Senegalese Rural Electrification Agency
BAU	Business as Usual
CAPEX	Capital expenditure
CER	Concessionnaire d'Electrification Rurale/Rural Electrification Concessionnaire
COPERES	Conseil Patronal des Energies Renouvelables du Sénégal/ Council of the Renewable Energy Private Sector
CRSE	Commission de Régulation du Secteur de l'Electricité/National Electricity Regulator
DFID	Department for International Development
ECOWAS	Economic Community of West African States
ECOWREX	ECOWAS Observatory for Renewable Energy and Energy Efficiency
ECREEE	ECOWAS Centre for Renewable Energy and Energy Efficiency
ERIL	Electrification Rurale d'Initiative Locale/Local Initiative Rural Electrification
ESMAP	Energy Sector Management Assistance Program
FER	Fonds d'Electrification Rurale/Rural Electrification Fund
FiT	Feed in Tariff
FONGIP Fund	Fonds de Garantie des Investissements Prioritaires/Priority Investments Guarantee
FONSIS Investment	Fonds Souverain d'Investissement Stratégiques/Sovereign Fund for Strategic
GDP	Gross Domestic Product
GDT	Gestionnaire Délégué Transitoire/Transitional Delegated Managers
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GMG	Green mini-grid
HV	High Voltage
IEA	International Energy Agency
INDCs	Intended Nationally Determined Contributions
IPPs	Independent Power Producers
IsDB	Banque Islamique de Developpement/Islamic Development Bank

LPDSE	Lettre de Développement du Secteur de l'Energie/Development Lettre for the Energy Sector
LV	Low Voltage
MEDER	Ministère de l'Energie et du Développement des Energies Renouvelables/Ministry for Energy and the Development of Renewable Energy
MDP	Market Development Programme
MNO	Mobile Network Operators
MPE	Ministere du Petrole et des Energies/Minsitry of Oil and Energy
MT	Metric tons
MV	Medium Voltage
MW	Mega Watt
NAMA	Nationally Appropriate Mitigation Action
OMVG	Organisation de Mise en Valeur du Fleuve Gambia/Gambia River Basin Organisation
OMVS	Organisation pour la mise en valeur du fleuve Sénégal/Senegal River Basin Development Organisation
OPEX	Operational expenditure
PANER	Plan d'Action National des Energies Renouvelables/National Action Plan for Renewables
PASER	Plan d'Action Sénégalais pour l'Electrification Rurale/Senegalese Rural Electrification Action Plan
PNER	Programme National d'Électrification Rurale/National Rural Electrification Programme
PNUER	Plan National d'Urgence d'Electrification Rurale/National Rural Electrification Urgency Plan
PPA	Power Purchase Agreement
PPER	Programme Prioritaire d'Electrification Rurale/Rural Electrification Priority Programme
PPP	Private Public Partnership
PSE	Plan Sénégal Emergent/Emerging Senegal Plan
PUDC	Programme d'Urgence de Développement Communautaire/Community Development Emergency Programme
PUER	Programme d'Urgence d'Electrification Rurale/Rural Electrification Urgency Programme
PV	Photovoltaic
REDD	Reducing Emissions from Deforestation and Forest Degradation in Developing Countries
RMC	Regional Member Countries
SEFA	AfDB's Sustainable Energy Fund for Africa
SEforALL	Sustainable Energy for All
Senelec	Société Nationale d'Electricité du Sénégal Senegal national electricity utility
SHS	Solar Home System
SME	Small and Medium-sized Enterprise
SSA	Sub-Saharan Africa

UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
WAEMU	West African Economic and Monetary Union
WAPP	West African Power Pool

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 to provide comparable, actionable data on the potential for GMGs across countries in Sub-Saharan Africa (SSA). This report provides an analysis for Senegal. Previous country reports can be downloaded from the GMG Help Desk (http://greenminigrid.se4all-africa.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 a number of criteria that are driven by the particular business model and approach of the implementing agency for each case. This report therefore aims to capture 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.

Senegal has an estimated population of over 15.7 million people and a landmass of 196,712km^2. The spread between urban and rural population in Senegal is relatively even. According to 2013 projections, the urban population was forecast to reach seven million in 2017, and the rural population 8.1 million. The country is divided into 14 regions, and is one of the most stable countries in Africa. The President of Senegal is the head of state and the Prime Minister of Senegal is the head of government. As in most of West Africa, Senegal's climate is characterised by two principal seasons based on rainfall criteria.

The Government of Senegal adopted the Plan Sénégal Emergent (Emerging Senegal Plan - PSE) in 2014 to foster the country's economic growth. Senegal Gross Domestic Product (GDP) reached $16.4 billion in 2017. The year 2016 had already seen an increase in GDP of 6.2% compared to 2015. Senegal, however, faces a number of challenges that could undermine its economic growth. The economy is very vulnerable to internal supply shocks (rainfall deficit, production sensitivity of some large companies, etc.) and is not resilient enough to external shocks (oil price fluctuations, food supply shocks, etc).

The average energy consumption per capita in Senegal is small, averaging at ~0.272 toe/year compared to an average of ~0.5toe/year in the rest of Africa, and a world average of ~1.2 toe/year. Biomass and petroleum derived products represent more than 95% of the energy balance. The energy sector, more specifically the electricity sector, is largely dependent of imported fuel oil, diesel and natural gas. Net energy imports steadily grew from 0.85Mtoe in 1990 to 2.92Mtoe in 2016. This is expected to change in the midterm with important reserves of natural gas having been discovered in the north of the country.

Senegal's electricity sector has undergone a major transformation aimed at improving the supply of electricity and participating in the country's development objectives by opening up to the private sector. A key milestone for the energy sector includes the five-yearly publication of a Lettre de Politique de Développement du Secteur de l'Energie (Policy for the development of the energy sector - LPDSE). Senegal is also introducing a policy on Feed-in-Tariffs (FiTs), and the harmonisation of tariffs.

The country is one of the first in West Africa to recognise the importance of providing access to electricity in rural areas. This was made clear by Law 98-29 of April 14, 1998, that established the creation of the Agence Sénégalaise d'Electrification Rurale (Senegalese Rural Electrification Agency – ASER) and the creation of the Commission de Régulation du Secteur de l'Electricité (National Electricity Regulator – CRSE).

In April 2015, the Government approved the Programme National d'Électrification Rurale (National Rural Electrification Programme – PNER) as the new rural electrification strategy document. Rural electrification in Senegal has followed a top-down and a bottom-up approach. Firstly, it has been driven by the Programme Prioritaire de l'Électrification Rurale (Priority Programme for Rural Electrification – **PPER**) which introduced divided the country into **10 concession zones**. In March 2016, six out of the 10 areas had been attributed through international tenders, with the Government announcing in 2018 that the remaining four concessions were being assigned to the national utility Senelec. The second approach is the bottom-up development of mini-grids through the Projects d'Electrification Rurale d'Initiative Locale (Local initiative rural electrification projects – **ERILs**). In those areas that did not yet have a top-down concession, ASER encouraged spontaneous village level concessions by communities, consumer groups or private operators. The Programme D'urgence de Développement Communautaire (Community Development Emergency Programme – PUDC) is the structure established by the Government to execute urgent emergency programmes to accelerate access to electricity, to meet its 2025 universal access target. Currently, Senegal counts 163 mini-grids, of which 121 are hybrid, 37 entirely solar and four are diesel generators. The Government is seeking to significantly reinforce the presence of mini-grids in the country and plans on developing ~600 mini-grids with the support of grant donors. A key driver of this increase is expected to be the second phase of the PUDC (~$52 million), with ~$18 million already secured from donors.

Both the top-down and bottom-up approaches to mini-grids deployment have raised issues among stakeholders. While ERILs were initially encouraged by the Government, the majority of these schemes have been operating without licences or tariff reviews since their inception, with only one ERIL having signed a contract with CRSE. With regards to the concession zones created under the PPER, concessionaires failed to meet clear targets on the number of connections and households electrified. The Government has blamed the lack of connections on the price difference of ~25% charged between rural and urban tariffs, and is hoping that connection levels will pick up following the harmonisation of tariffs currently underway. Lastly, despite playing a major role, the PUDC may be distorting the market due to its design. Under the PUDC mini-grids are built and handed over to ASER who is then in charge of transferring operation to a Gestionnaire Delegué Transitoire' (Transitory Delegated Operator – GDTs), or to the concessionaire of the area in which the project has been developed. Operators are then responsible for ensuring connection and immediate exploitation of these mini-grids, yet don't have the ability to influence the ex-ante business models. It is therefore unclear how many of the mini-grids borne under the PUDC currently have connections in place, and whether these are being monitored or not by ASER.

The existing financial framework is not conducive to private investment in the energy environment. The majority of the existing mini-grids in Senegal today are 100% grant-based. The few exceptions (less than six ERILs) have included a 25% private investment and 75% grant. The involvement of the commercial financial institutions is therefore not needed at present. Concerns persist on the ability of the Government to continuously fund these projects, or to raise funds from international donors. The Rural Electrification Fund was never made functional.

There is also a need to improve the co-ordination of the different organisations in the mini-grid sector. Despite having the formal mandate to co-ordinate all activities related to rural electrification, ASER is not always involved in the PUDC selection of the villages and technologies to be used for the electrification in an early stage. ASER sits on the technical committee of the PUDC, yet it seems that efforts to electrify rural villages by these two main players are not always aligned and instead occur in isolation from each other. ASER's formal role should be reinforced to avoid duplication of efforts.

Our analysis estimates that 7% of the non-electrified population (1.1 million people) would be best served by mini-grid solutions in Senegal. A further 1.6 million people (11% of the non-electrified population) will be best served by solar home systems (SHS) and 7.5 million people (50% of the non-electrified population) will be best served by grid extension. To understand the mini-grid potential in Senegal we have identified numbers of potential mini-grid customers, based on population (or household) density and proximity to the grid. This calculation is based on the current grid coverage only; any planned grid extensions will reduce the estimated market size. Based on intended grid expansion to 2025, our analysis estimates that 651,000 people would be best served by mini-grid solutions, corresponding to 4% of the non-electrified population. This difference with current government plans to build ~600 mini-grids could be explained by the distance to the main grid as historically the Government in Senegal has selected villages for electrification through mini-grids according to their distance from the main grid of ~10km.

In summary, this report estimates an annual mini-grid market size of $18.5 million in Senegal, based on an average tariff of $0.17/kWh (post harmonisation), and average household demand per day of 2.2kWh. According to the SE4ALL 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. This implies per capita annual electricity expenditure of $17.06 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 57.5% 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).

1. INTRODUCTION TO THE GREEN MINI-GRIDS 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 provides assistance to 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 an 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 for All (SEforALL) Africa Hub, through a grant of the Sustainable Energy Fund for Africa (SEFA). The SEforALL Africa Hub, hosted by the AfDB, is a partnership of African institutions dedicated to supporting the continent's progress towards the SEforALL initiative's three main objectives on energy access, renewable energies and energy efficiency.

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 coordination of the efforts of development partners to advance the adoption of GMGs. The MDP was designed to be integrated and closely co-ordinated with the activities carried out in the framework of the partnership.

2. COUNTRY AND SECTOR OVERVIEW

2.1 COUNTRY OVERVIEW

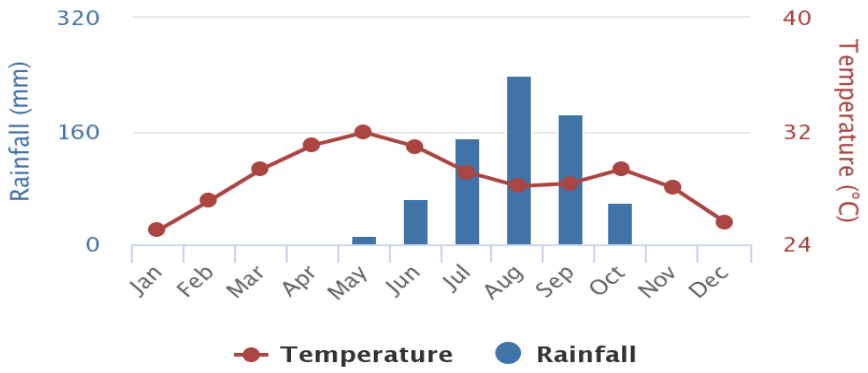
Senegal has an estimated population of over 15.7 million people and a landmass of 196,712km². It is located in West Africa and bordered on the south west by Guinea Bissau, on the south east by Guinea, on the north by Mauritania and on the east by Mali. Senegal also surrounds Gambia, located in its centre west. In 2013, ~55% of the population lived in rural areas, corresponding at the time to 7.4 million people. The density of the population in 2018 is 80 inhabitants per km². According to 2013 projections, the urban population was forecast to reach seven million in 2017, and the rural population 8.1 million. Life expectancy at birth is 64.7 for men and 68.7 for women, and Senegal has a young population with an age average of 19 (ANSD, 2018).

Senegal is divided into 14 regions, 45 departments, 46 Local Government Areas (LGAs), 113 city communes, 370 rural communes, and 13,544 villages. The number of departments increased to 45 following the Decret n° 2012-365. Senegal is also one of the most stable countries in Africa; it has had just three major political transitions, each of them peaceful, since its independence from France in 1960. The President of Senegal is the head of state and the Prime Minister is the head of government. Executive power in Senegal is concentrated in the president's hands. Villages are run by village chairpersons.

Figure 1. Senegal is divided into 14 administrative regions

As in most of West Africa, Senegal's climate is characterised by two principal seasons according to a rainfall criteria. The so-called dry season is only dry in the centre of the country, while the coast benefits from a relatively high humidity and the season is therefore considered as non-rainy. Between 1991 and 2015, the average temperatures ranged from a low of 25 degrees in January to a high of 31.9 degrees in May. Rainfall is on average at its highest in August (World Bank, 2017). Climate change is already having serious impacts in Senegal, with ~927 households of nearly 10,000 people in the city of Saint Louis having been displaced by coastal erosion, or amongst the most vulnerable people currently living within the 20-meter zone considered at very high-risk of flooding (World Bank, 2018).

Figure 2. Average Monthly Rainfall and Temperature for Senegal, 1991 to 2015 (source, World Bank 2017)



After decades of very modest growth, the Government of Senegal adopted the Plan Sénégal Emergent (Emerging Senegal Plan - PSE) in 2014. The development plan is designed to get Senegal out of a cycle of low growth and weak poverty reduction. Senegal's Gross Domestic Product (GDP) has been increasing over the past few years. In 2016 GDP was $14.7 billion, corresponding to an increase of 6.2% on the previous year. In 2017, the GDP reached $16.4 billion (World Bank, 2018), and GDP is expected to double by 2025 (World Bank Group, 2017). Growth in GDP has been driven by a dynamic services sector, growing 6.4% in 2016 compared to 3.3% in 2015 (ANSD, 2018). Generally speaking, however, the primary sector of the economy (extraction of raw materials) is the most dynamic, growing at over 7% (due particularly to agriculture), but the secondary sector (manufacturing) is picking up and is expected to take the lead in a few years' time (World Bank, n.d.).

The economic drivers of growth for Senegal are the political stability and the solidity of the institutions, the viability of the macroeconomic and budgetary framework, the demographic potential of a young population, and the important agricultural, hydro-agricultural and mining resources. In addition, Senegal benefits from the potential of regional platforms of services (education, health and finance), a strategic geographic position and image capital, coupled with international influence, openness to major economic groups such as West African Economic and Monetary Union (WAEMU) and the Economic Community of West African States (ECOWAS) as well as the dynamism of its diaspora. Senegal is part of the eight WAEMU States that share the Franc CFA as their currency. The FCFA has a fixed parity with the Euro (1€= 655.957 FCFA) and is guaranteed by the French Treasury, practically eliminating exchange rate risk.

Two national Funds, FONSIS and FONGIP, were created in 2012 to 2013 to boost the economy of Senegal. FONSIS is the Fonds Souverain d'Investissement Stratégiques (Sovereign Fund for Strategic Investment), created by Law 2012-34. With this instrument, the Government is increasing its investments alongside the private sector. FONGIP (Fonds de Garantie des Investissements Prioritaires) is an innovative instrument of the Senegalese State. The lack of sufficient guarantees required for the financing of small and medium-sized enterprises (SMEs) of Senegal is one of the major obstacles to the country's economic growth and development. FONSIS and FONGIP have not yet participated in off-grid electrification.

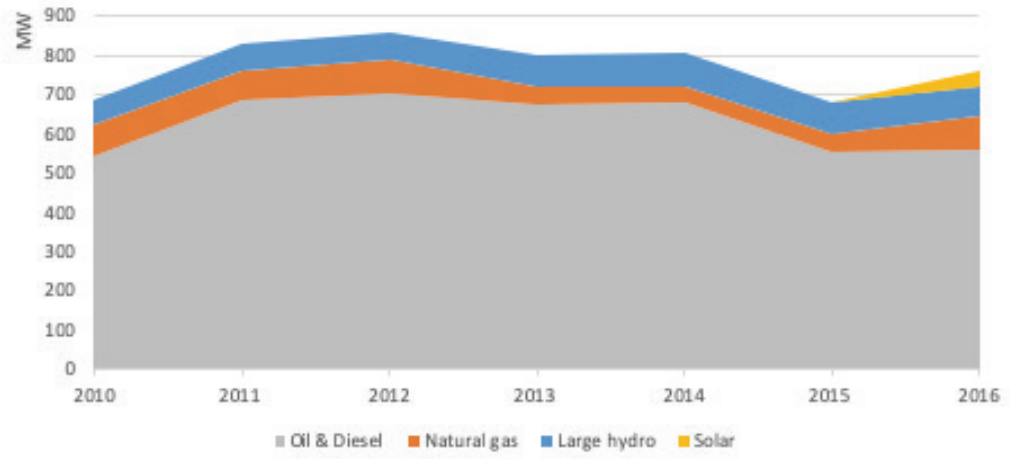
Senegal faces a number of challenges that could undermine its economic growth. The economy is very vulnerable to internal supply shocks (rainfall deficit, production sensitivity of some large companies, etc) and is not resilient enough to external shocks (oil price fluctuations, food supply shocks, decreasing migrant remittances, etc). Challenges relate inter alia to the production of sufficient energy and at a competitive cost, the adequacy of training to the needs of the economy, the elimination of the deficit of infrastructures for the opening up of the region and the strengthening of regional interconnection, the preservation of the environment and the guarantee of a sustainable management of natural resources. The limited financing of economic activities and the lack of fiscal space for social services, as well as problems related to governance and equity, and the efficiency of the administration are also to be noted.

2.2 OVERVIEW OF THE ENERGY SECTOR

The average energy consumption per capita in Senegal is small, averaging at ~0.272 toe/year compared to an average of ~0.5toe/year in the rest of Africa, and a world average of ~1.2 toe/year. This equates to 3.79TWh annually (in 2016), though this is certainly higher in cities where access to electricity is higher (IEA, 2018). Demand on the other hand is growing fast. Between 2012 and 2016 the growth rate of electric peak demand was 7.9% (BNEF, 2017), and demand grew at 40 to 50MW per year, which will require a range of energy sources to keep expanding Senegal's power system (FT, 2018).

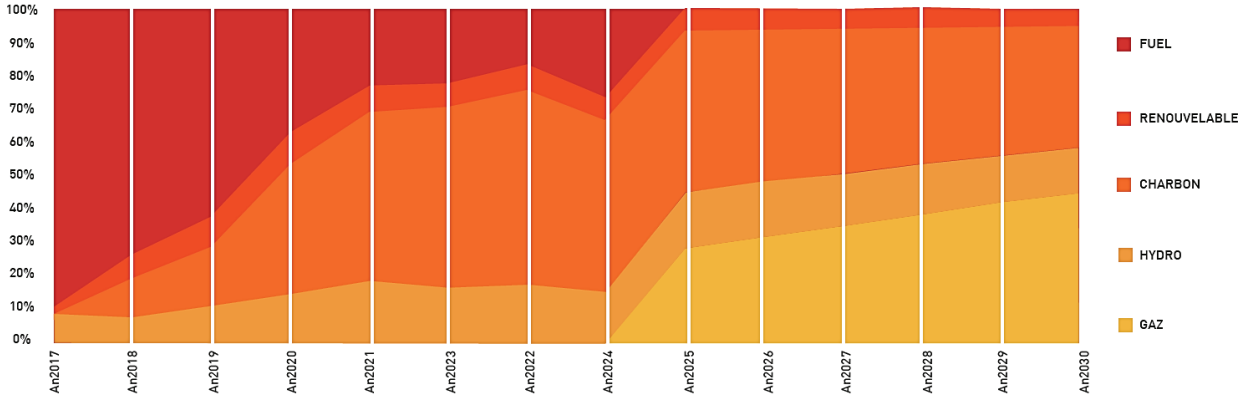
In Senegal, biomass and petroleum derived products represent more than 95% of the energy balance. Most of the country's 864MW of generating capacity involves burning of heavy fuel oil. While renewable energy (including hydroelectricity) only represented about 0.6% in 2004, today there are three solar power stations of 20MW each, one of 30MW and one 2MW which are connected to the grid, providing a total contribution to the electricity mix of 92MW. It is expected that the contribution of renewables in the grid will continue to increase considerably. There are a number of projects in the pipeline, including a government-issued tender in October 2017 for solar projects with a combined capacity of 100MW (part of the Scaling Solar Initiative led by the IFC), the 150MW wind power station, and the Organisation de Mise en Valeur du Fleuve Gambia (Gambia River Basin Organisation – OMVG) (BNEF, 2017).

Figure 3. Installed capacity in Senegal (2010 to 2016), (BNEF, 2017)



The electricity sector is largely dependent on imported fuel oil, diesel and natural gas. Net energy imports steadily grew from 0.85Mtoe in 1990 to 2.92Mtoe in 2016. However, this is expected to change in the midterm with important reserves of gas that have been discovered in the northern part of the country. The World Bank, one of the main partners of the Government in the energy sector, is focusing its support to Senelec, the national utility, in a transition to electricity generated from natural gas. With more than 70% of the cost of production of Senelec coming from heavy fuel oil, this transition is expected to considerably reduce the cost of production of Senelec, while also reducing carbon emissions. The World Bank hopes that this will, in return, considerably reduce or even eliminate the large amount of subsidies paid by the Government of Senegal to Senelec.

Figure 4. Evolution of the generation mix according to Senelec estimates (World Bank Group, 2017)



In its Intended Nationally Determined Contribution (INDC) Senegal committed unconditionally to cut greenhouse gas (GHG) emissions by 5% below the business as usual (BAU) scenario by 2030. This target concerns the energy sector (-6%), industrial waste (-13%), agriculture (-0.19%), and forestry targets. It represents a total emissions reduction of 7mtCO_2e by 2030. Senegal has assessed these goals and it will require $1.8 billion of investment. The country also committed to a further reduction of GHG emissions by 21% below the BAU scenario by 2030, conditional upon international support, and financing amounting to $5 billion (BNEF, 2017).

The Ministry of Oil and Energy is responsible for the Energy Sector in Senegal. The main public sector organisations are described in Table 1 below.

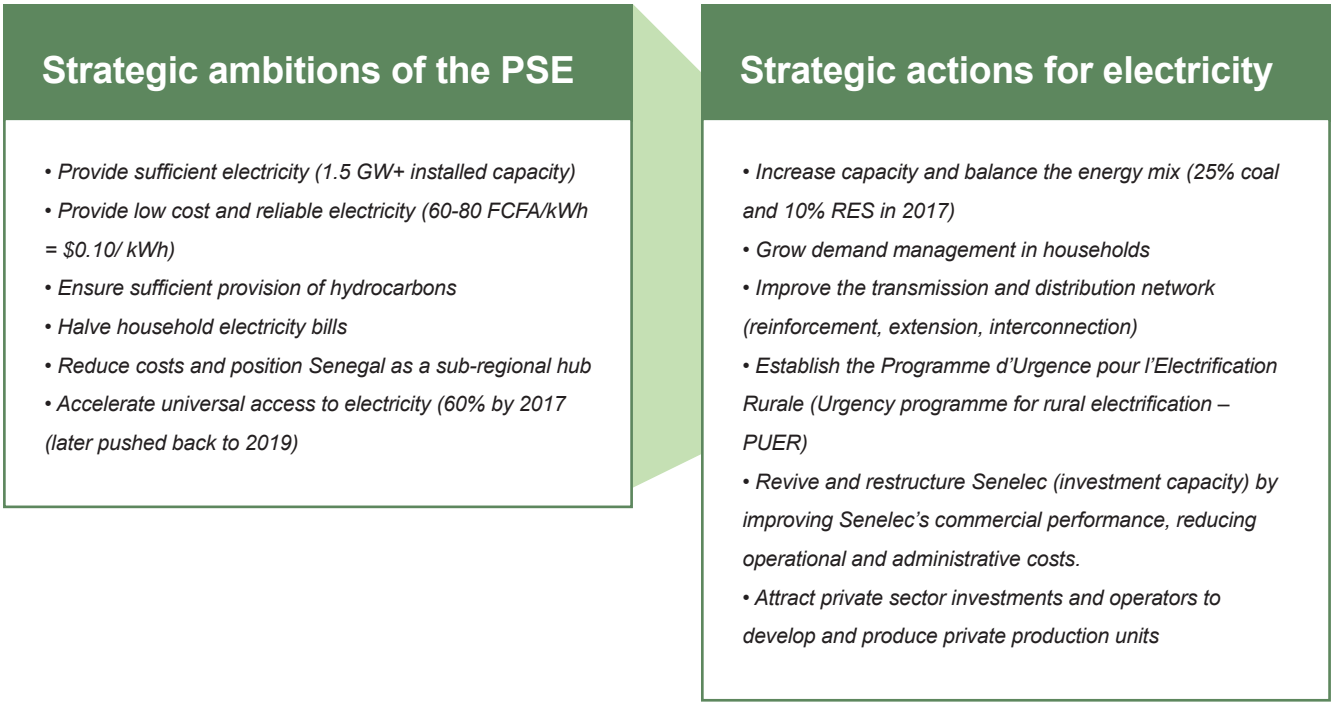
Table 1. Key organisations of the energy sector in Senegal and their mission

Senegal	**Ministry of Oil and Energy/Ministère du Pétrole et des Energies (MPE)** Prepares and implements energy policies
Law 98-29 of 14 April 1998 defining the legal and regulatory framework liberalising the electricity sub-sector	
Commission de Régulation du Secteur de l'Electricité/ National Electricity Regulator (CRSE) Created in 1998 by Law 98-29	- Review licence/concession applications and ensure compliance with ToRs; - Determine the structure and composition of the tariffs; - Ensure compliance with technical standards; - Ensure compliance with competition in the sector; - Submit to the Minister of Energy decrees concerning in particular: the rights and obligations of companies, third party access to the network and the relations between companies and their customers
Agence pour l'Economie et la Maîtrise de l'Energie/ National Agency for Energy and the Economy (AEME) Created in 1998 by Law 98-29	- Participate in the implementation of policies in the fields of energy, the environment and sustainable development; - Propose strategies for the good functioning of the energy sector; - Conduct and evaluate the implementation of energy saving and EE programmes etc.
Agence Sénégalaise d'Electrification Rurale/ Rural Electrification Agency (ASER) Created in 1998 by Law 98-29	- Support the implementation of rural electrification programmes by providing technical and financial assistance; - Providing investment grants; - Involving the private sector (PPP), the voluntary sector and local communities (ERILs);
Agence Nationale pour les Energies Renouvelables/ National Agency for Renewable Energy (ANER) Created in 2013 by Decree 2013-684	- Promotion and development of alternative energies, in all their forms; - Contribute to the development of an attractive legislative and regulatory framework for the development of renewable energies; - Identify, evaluate and exploit the potential for RES available and economically exploitable in the different regions of the country; - Foster the use of equipment for the production of electricity from RES; - Conduct prospective and strategic studies for the development of renewable energies (e.g. the Plan d'Actions National des Energies Renouvelables/National Action Plan for Renewables PANER).
Société Nationale d'Electricité du Sénégal/ Senegal national electricity utility (Senelec) Created in 1983 by Law 83-72	- Ensure the production, transmission, distribution and sale of electricity but also the identification, financing and production of new works within its perimeter

Senegal's electricity sector has undergone a major transformation aimed at improving the supply of electricity and participating in the country's development objectives by opening up to the private sector. From 2008 onwards, the energy sector has also started becoming more favourable to the deployment of renewable energies (MDER, 2015). Some of the key milestone for the energy sector involve the publication every five years of a Lettre de Politique de Développement du Secteur de l'Energie (Policy for the development of the energy sector - LPDSE) and the adoption in 2014 of the PSE 2035, which for the 2014 to 2018 period was anticipating a state expenditure of 304 billion FCFA ($526 million). The New LPDSE (2019 to 2023) will be validated early 2019.

Under the LPDSE, Senegal is also developing a number of additional key policies, in particular a policy on Feed-in-Tariffs (FiTs), and the harmonisation of tariffs. The new LPDSE underwent technical validation and is now awaiting signature from the ministry. The targets for the integration of renewables into the grid have increased to 30% by 2025 (against current targets of ~20%). More information on FiTs and the harmonisation of tariffs is presented in chapter 2.3 and 2.4.

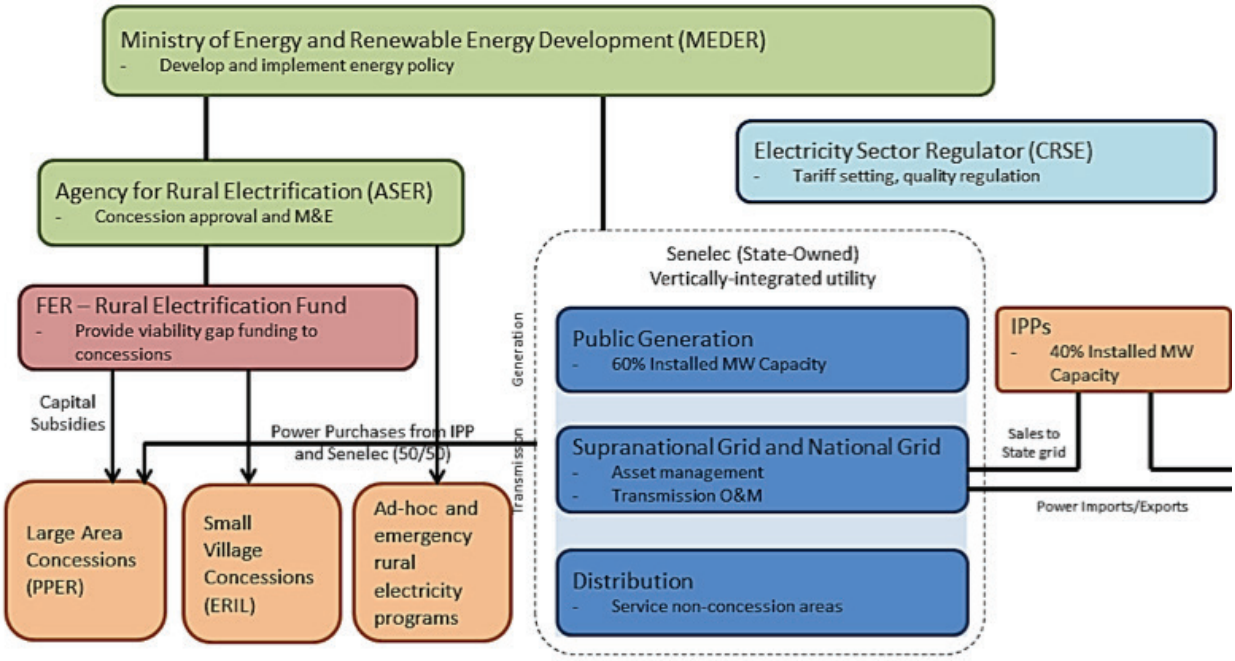
Figure 5. Energy as one of the key pillars of the PSE 2035 and key associated targets



Most bilateral and multilateral development agencies have an active presence in Senegal. Development assistance is being streamlined, in keeping with the Paris Declaration and the Accra Agenda.

2.3 OVERVIEW OF THE POWER SECTOR

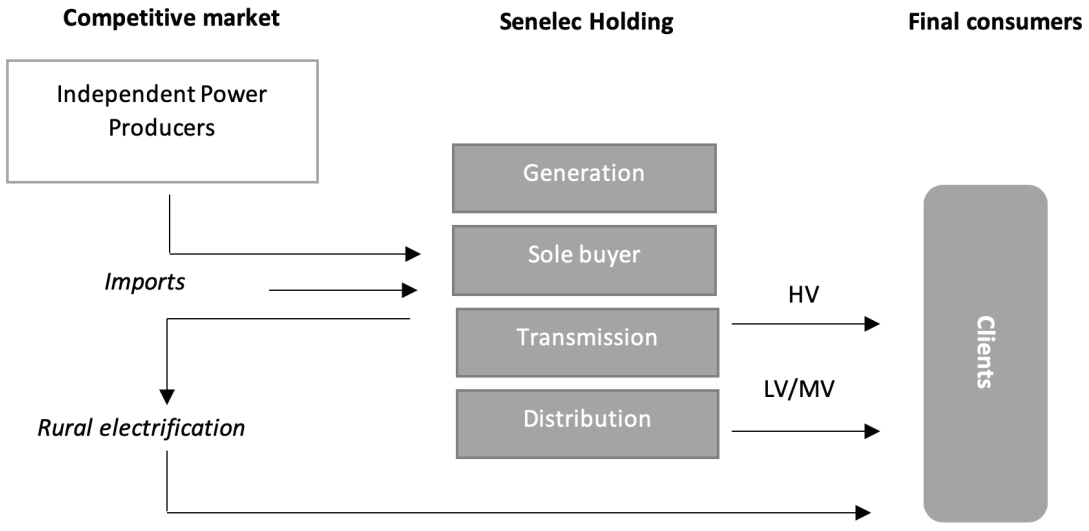
Figure 6. Overview of the power sector in Senegal (World Bank Group, 2017)



Senelec (Société Nationale d'Electricité) is the national electricity utility in Senegal. It was created in 1983 after the nationalisation and merging of **Électricité** du Sénégal and Société S**énégalaise** de distribution d'électricité. The company represents Senegal in the West African Power Pool (WAPP). Senelec ensures the generation, transmission, and distribution of electricity, and has a transmission monopoly. Until now, there was no dedicated off-grid department within the utility, which was focusing on ensuring a good quality of service within its perimeter. This will probably change considering the Government is now handing over the last four concession zones for rural electrification to Senelec. More information on the rural electrification concession zones is presented in chapter 2.4 below.

It is expected that Senelec will be separated into three different companies each in charge of generation, transmission and distribution. The unbundling of Senelec lies at the heart of the electricity reform in Senegal and will allow the private sector to enter the market via fair access to transmission and distribution infrastructure. The transmission company will function as the sole buyer and operator of the system, and will remain principally under public sector control. A visual representation of the possible unbundling is provided in Figure 7 below.

Figure 7. Visual representation of Senelec's degrouping



Main grid generation in Senegal is composed of Senelec's power stations (553.93MW), of Independent Power Producers (IPPs) (413.9MW), and of sub-regional power stations (95MW). The latter are power stations installed in neighbouring countries that provide electricity to Senelec through power purchase agreements (PPAs) (Senelec, 2018). The Interconnected Grid[2] (RI) represents the bulk of the Senelec capacity with nearly 92.53% of the installed capacity in 2017. There are no significant barriers to private sector participation in generation, and the power offtake risk for independent generators is considered to be low (BNEF, 2017).

Since 2004, the average electric power transmission and distribution losses, as a percentage of output, were 17%, according to Senelec figures. The World Bank on the other hand estimated higher losses at about 22% and 28.3GWh per year in September 2015 (World Bank, 2016). In both cases the majority of losses are in the distribution lines. Senelec was forecasting losses for 1,208 billion FCFA between 2015 and 2025, greater than $2 billion, or an average of $200 million per year (Senelec, 2018). On a positive note, Senelec has seen an improvement of continuity and quality of service with a reduction in the number of cumulative cut-off hours that fell from 124 hours in 2013 to 77 hours at the end of 2017. The variable cost of production went from 85.5 FCFA/kWh ($ 0.15/kWh) in 2013 to 55.01 FCFA/kWh ($0.095/kWh) in 2017[3] (LPDSE 2018-2022, n.d.).

The World Bank has been providing financial and technical support to Senelec to reinforce the national grid and ensure a better quality extension of the network. In parallel, the World Bank has been studying pathways for the integration of renewables in the grid, as well as the potential for storage in Senegal. One component of the support is also directed towards improving the financial stability of Senelec.

Despite tariffs being historically subsidised by the Government, electricity prices in Senegal are among the highest in the world, due the high cost of imported fuel oil. The domestic electricity price in Senegal in 2015 was $ 0.2/kWh, compared to $ 0.16/kWh in Morocco, $ 0.12/kWh in Ivory Coast, and $ 0.06/kWh in Nigeria and Algeria. The average energy price in Senegal has risen by 4.32% per year between 2004 and 2013, with the highest growth in the medium voltage lines (4.65% per year) (Senelec, 2018).

In line with decision N ° 2017-06 of the CRSE, as of 1 May 2017 electricity tariffs charged by the national utility SENELEC are set according to fixed guidelines (Table 14 and Table 15 presented in the Appendices). Electricity prices in 2016 averaged at $254/MWh in the commercial, $247/MWh in the industrial, $230/MWh for the retail sector, and $187/MWh in the residential sector. In contrast, the average kerosene price was $1.10/litre (BNEF, 2017).

Between 2012 and 2016, Senelec's electricity sales rose by an average of 6% per year, rising from 2,727GWh in 2015 to 2,889GWh in 2016. Of the 2,889GWh in 2016, only 406GWh were sold in rural areas. Rural areas on average account for 14% of Senelec electricity sales. In 2016, 44% of demand in rural and urban areas was driven by domestic lighting needs, 54% by professional use and 2% by public lighting (CRSE, n.d.).

Demand and peak demand for electricity are expected to grow by 207% and 163% respectively by 2030 compared to a 2016 baseline. This equates to an annual demand growth of 8.4%. Peak demand is forecasted to reach 1,621MW in 2030, and demand 6,500GWh. The main drivers of this growth will be refrigerants (19%), lighting (17%), leisure equipment (13%) and air conditioning (11%) (Senelec, 2018).

In 2009, the supply deficit was 137MW, and decreased to 66MW in 2013. Stakeholders affirm that one of Senelec's main problems is to meet peak demand in the evening. ANER, CRSE and Senelec are therefore all working together in urban areas to investigate, among other things, the potential for battery storage.

2 This network is mainly concentrated in the western and north-western parts of the country and provides power to the regions of Dakar, Thies, Louga, Diourbel, St. Louis, Matam, Kaolack, Fatick and Kaffrine. The Non Interconnected Network (RNI) covers the regional centres of Tambacounda and Boutoute (Ziguinchor) and nearly 26 isolated centres distributed between the regions of Kaolack, Tambacounda, Kolda, Ziguinchor, Kedougou and Sedhiou

3 Primary causes of this fall in the cost of production include: a more diversified energy mix, a higher penetration of renewables and better performing IPPs among others (LPDSE 2018-2022, n.d.).

Table 2. Key statistics for the electricity in Senegal, 2015 to 2017 (Senelec)

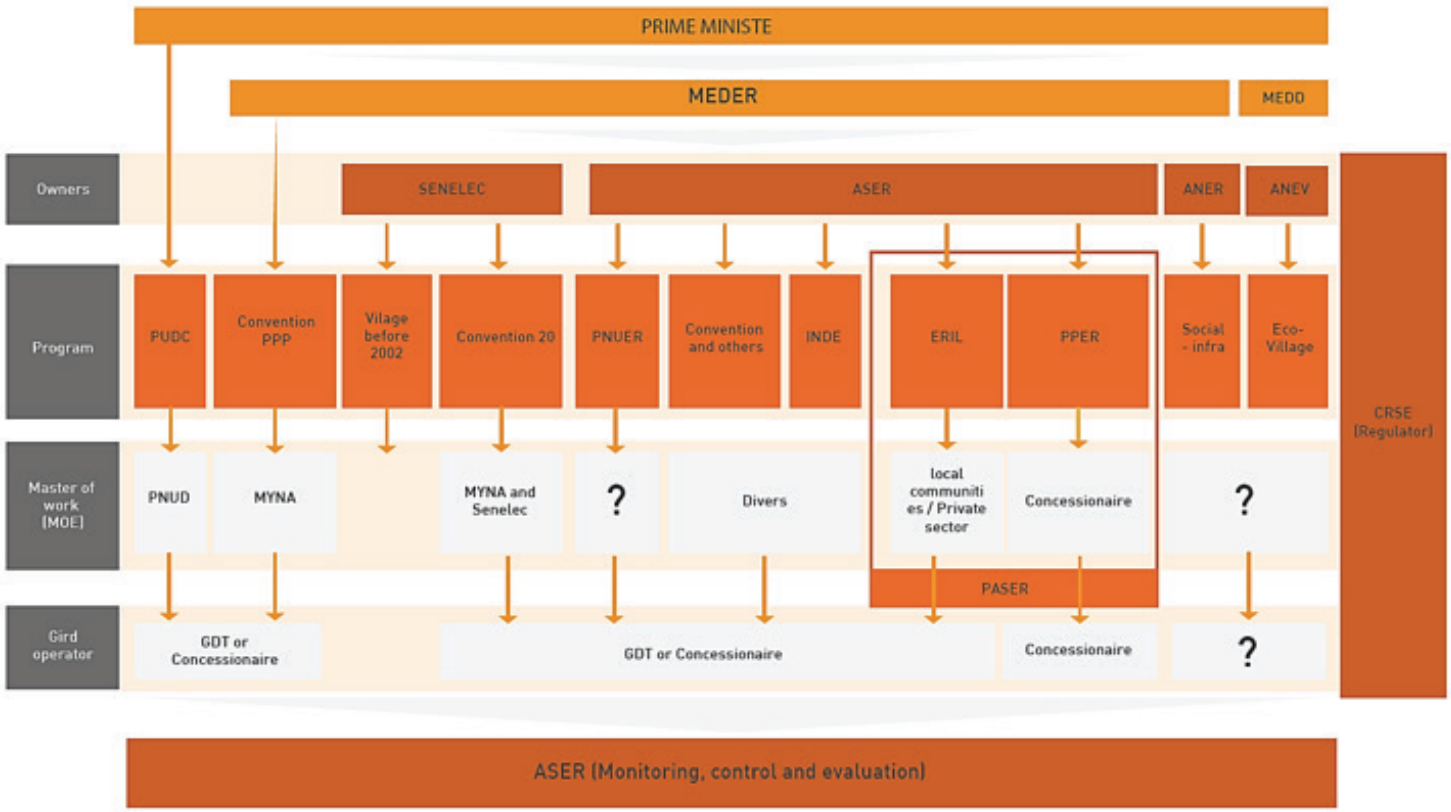
Key statistics	Unit	2015	2016	2017
Installed capacity	MW	887	951	1,024
Maximum peak capacity	MW	533	560	606
Total generation	GWh	3,438	3,599	3,921
Senelec generation	GWh	2,214	2,144	2,140
Energy purchase	GWh	1,223	1,454	1,781
Energy delivered to the network	GWh	3,383	3,545	3,868
Energy sales	GWh	2,752	2,899	3,179
Number of clients	U	1,121,962	1,199,155	1,332,075
Prepaid clients	U	79,301	193,718	373,673
Post-pay clients	U	1,042,661	1,005,437	958,402

2.4 OVERVIEW OF THE OFF-GRID SECTOR

2.4.1 ENERGY ACCESS POLICY AND PLANNING

Despite some co-ordination problems between organisations, Senegal has been making good progress in terms of rural electrification. At present, the national electrification rate is 64%, one of the highest in Sub-Saharan Africa (90% in urban areas and 43.5% in rural areas). This means that ~5.6 million people lacked access to grid electricity in 2016. The electrified population has grown at an annual compound rate of 29% since 2005. The largest growth occurred between 2005 and 2010 where the national rate of access grew by 54% (IEA, 2017). The number of electrified rural localities increased from 1,648 localities in 2012 to 3,336 in 2017, a doubling (102%) in five years. At the same time, the rural electrification rate has increased from 27% to more than 40%, an evolution of 60% (LPDSE 2018-2022, n.d.).

The current institutional framework in Senegal for rural electrification is complex and composed of many organisations and initiatives. The main public sector bodies involved in the sector are MEDER, the electrification agency ASER and the regulator CRSE.



Senegal is one of the first countries in West Africa to recognise the importance of providing access to electricity to rural area. This was made clear by Law 98-29 of April 14, 1998, that established the creation of ASER and the creation of CRSE. In 2002, Law 98-29 was amended to increase the transparency of tenders and to make them more attractive to the private sector. A strategy for improving access to electricity was defined in the LPDSE, which has since been updated every five years, with an increased focus on promoting renewables.

The Plan d'Action Sénégalais d'Electrification Rurale (Senegalese Rural Electrification Action Plan – PASER) was an ambitious 20-year programme (2002 to 2022) for the electrification of rural areas. PASER was structured around the **Programme Prioritaire de l'Électrification Rurale** (Priority Programme for Rural Electrification – PPER) which introduced the concept of concession areas in Senegal, and the **Projects d'Electrification Rurale d'Initiative Locale** (Local initiative rural electrification projects – ERILs).

In April 2015, the Government approved the Programme National d'Électrification Rurale (National Rural Electrification Programme – PNER) as the update to the PPER. PNER defines the strategy to achieve the objective of universal access by 2025 by setting intermediary objectives of access to electricity to 60% in 2017 (since pushed back to 2019) with a minimum of 30% access per department. The strategy is divided into three components:

1. The conclusion of ongoing programmes (e.g. PPER);
2. An emergency plan for 2015 to 2017 called Plan National d'Urgence d'Electrification Rurale (National Urgency Plan for Rural Electrification – PNUER); and
3. The Programme Complémentaire pour l'Accès Universel à l'Horizon 2025 (complementary plan for universal access to 2025), which included the four remaining concession zones (now Senelec).

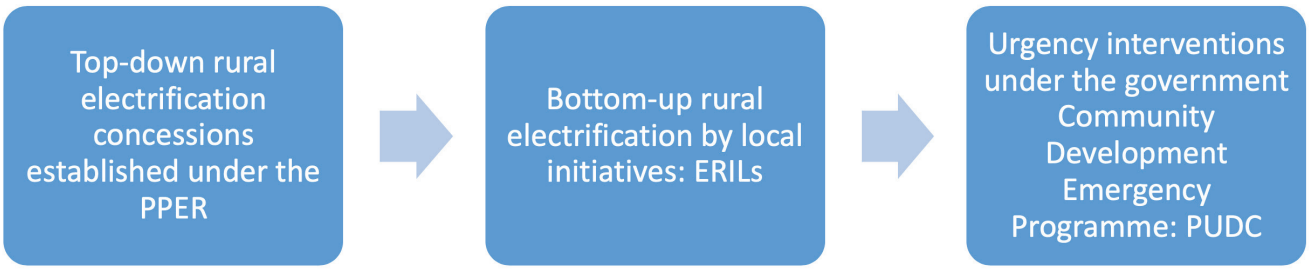
Despite a number of government strategy documents, there is no rural electrification roadmap at the moment looking at which villages to electrify, how, and in what timeframes. A target was set through the SEforALL plan to achieve universal access by 2025, yet it is still unsure how this will be achieved. ASER, in collaboration with a consultant, is currently developing a roadmap, which was expected to be available in Q1 2019 at the earliest.

Table 3. Evolution of the urban, rural and national electrification rate, 2012 to 2017 (LPDSE 2018-2022, n.d.)

	2012	2013	2014	2015	2016	2017
Urban electrification rate	88%	88%	89%	89%	91%	92%
Rural electrification rate	27%	29%	30%	30%	32%	40%
National electrification rate	58%	61%	62%	62%	64%	68%

Mini-grids in Senegal have historically been developed through three main programmes:

Figure 9. The mini-grids development framework in Senegal

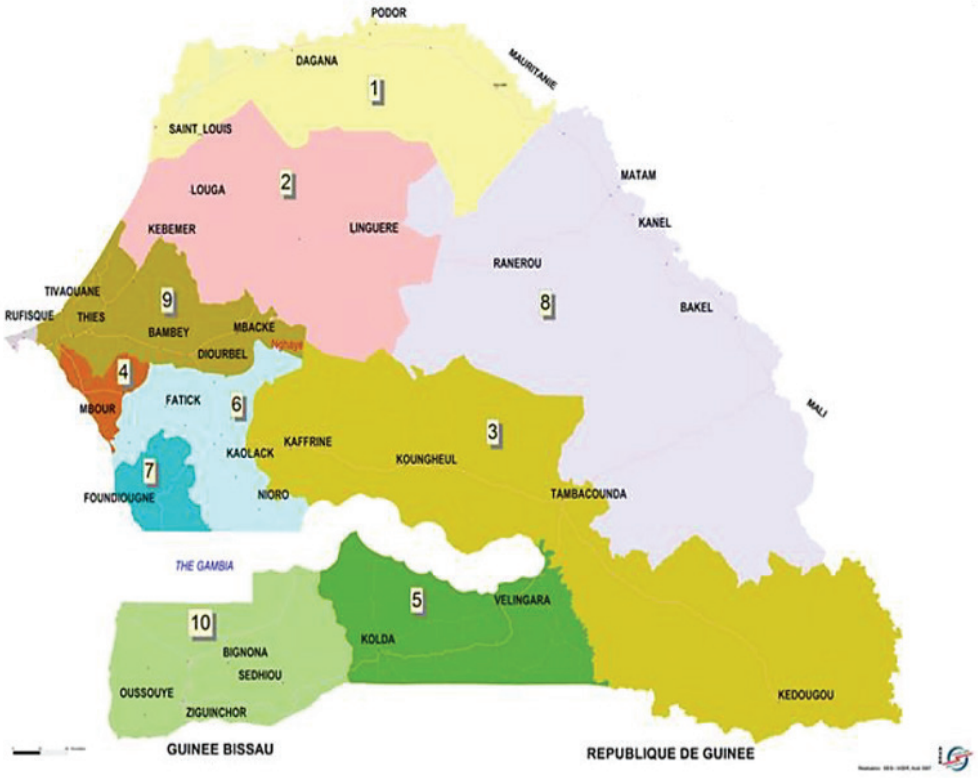


The following paragraphs will in turn elaborate on the above programmes.

1. PPER: Programme Prioritaire de l'Électrification Rurale/Rural Electrification Priority Programme

The top-down model divided national territory was divided into 10 concession areas, called Concessions d'Electrification Rurale (Rural Electrification Concessions – CER) (Figure 10). It was established in the law 98/29 but its implementation did not start until 2005. The objective was to encourage private sector investments in rural electrification. In March 2016, six out of the 10 areas had been attributed through international tenders, with the Government announcing in 2018 that the remaining four concession were being assigned to Senelec (following a four-week public consultation period). At the time of writing no concessionary contract had been signed between the Government and Senelec, and the committed number of electrified villages was yet to be defined. Senelec has not yet defined a plan for the electrification of these concessions. In the short-term, Senelec is expected to identify grid extension opportunities in-house and subcontract any mini-grid and SHS opportunities to third-party operators.

Figure 10. Senegal is divided into 10 territorial concessions for electrification



Concessions came with set targets on the number of households that will need to be electrified within the first three years of operation. However, results did not meet expectations. At the end of 2014, only 173 villages (7%) out of 2,343 planned and only 1,730 (2%) subscribers out of 106,601 were electrified under the programme (MDER, 2015). The Government has blamed the lack of connections on the price difference of approximately 25% charged between rural and urban tariffs. Through the planned harmonisation of tariffs, the Government is expecting connection levels to pick up. It is unclear whether penalties for not meeting the set electrification targets are being considered.

The CER is awarded for a 25-year contract, and operators can electrify rural populations through a choice of grid extension works, mini-grids and standalone systems. Tariffs for each of the CER were set by CRSE based on the concessionary business plan.

Table 4. Overview of the six concession zones with electrification targets and financial subsidies received (PNUER)

Intervention zone	Concessionaire	Financial subsidies (billion FCFA)	Villages to connect to the grid	Villages to electrify through PV	Households to connect to electricity
1. Dagana – Podor - Saint Louis	Comasel (ONE Maroc)	18.80	156	142	19,574
2. Louga – Linguere - Kebemer	Comasel (ONE Maroc)	9.20	254	118	11,826
3. Kaffrine – Tambacounda - Kedougou	ERA (EDF France)	7.92	109	71	18,001
4. Mbour	STEG (Tunisie) – COSELEC (Senegal)	7.45	111	-	9,700
5. Kolda - Velingara	ENCO (Maroc – Senegal)	8.00	7	900	20,500
6. Kaolack – Nioro – Fatick - Gossas	ENCO (Maroc-Senegal)	11.42	225	250	27,000
TOTAL		62.79[4] ($11m)	862	1,481	106,601

Table 5. Concessionaires are lagging behind targets for the electrification of the zones, state of play as of February 2017 (MEDER)

Intervention zone	Entry into force	Infrastructure network[5] (% or target met)	Solar installations[6] (% of target met)	Households connected (% of target met)
1. Dagana – Podor - Saint Louis	2011	95%	68%	22%
2. Louga – Linguere - Kebemer	2012	85%	108%	42%
3. Kaffrine – Tambacounda - Kedougou	2014	35%	136%	15%
4. Mbour	2015	18%	0%	0%
5. Kolda - Velingara	2015	0%	0%	0%
6. Kaolack – Nioro – Fatick - Gossas	2014	0%	0%	0%

2. ERILs: Projets d'Electrification Rurale d'Initiative Locale/Rural electrification by local initiatives

In those areas that did not yet have a top-down concession, ASER encouraged spontaneous village-level concessions by communities, consumer groups or private operators (World Bank, 2015). ERILs are therefore bottom-up rural electrification initiatives in local areas in which no electrification is planned by a concessionaire in the next three years. Similar to CER, ERILs are also technology neutral and can cover grid extension, mini-grids and standalone systems. The implementation of such projects is supported by ASER (support for studies and contribution of grants) and must be licensed by CRSE. There are two types of ERILs: with and without private sector participation. ERILs with private sector participation will usually require the private sector to invest 25% of the cost of the project with ASER covering the rest with government budget or donor funds. ERILs without private sector participation are usually covered 100% by either donors or the Government. The private sector, following a competitive tendering process, is put in charge of the installation of the systems/equipment and/or of the operation of the scheme. There are more than 3,000 households in 285 villages in Senegal benefitting from ERILs, showing that these local initiatives have been the main historical contributor to the mini-grids market in Senegal (ECREEE, 2017).

4 Of the 62.79 billion FCFA (~$11 million), 49% were mobilised by private operators, and the remainder collected through government subsidies.
5 Medium and low voltage network, includes grid extension and mini-grids
6 Standalone systems or solar PV mini-grids

The term ERIL should not be confused with the concept of 'Gestionnaire Delegué Transitoire' (Transitional Delegated Managers – GDTs), as in some instances the private sector receives a delegated power to operate schemes that have been set up in their entirety by the Government or donors, and that therefore are not the result of a 'local initiative'.

GDTs concessions were granted for 25 years and included a commitment of the concessionaire to transfer it to the PPER concessionaire being granted a concession including this region upon his request (World Bank, 2015).

The ERIL framework has many unclear elements. Firstly, projects must be capped to 200 households in order to be defined as ERILs. The logic behind this cap is unclear, but the Government has always considered ERILs as small-scale concessions in areas that will not benefit from a short-term electricity service[7]. According to interviewees, several ERIL developed by auto-producers exceed the cap on size, yet it is unclear whether this has any repercussions according to Senegalese law[8]. While ASER is supposed to play a management role over ERILs, the majority of these schemes have been operating without licences or tariff reviews since their inception. According to CRSE only one ERIL has a signed contract[9] and an official licence to operate. However, according to government figures, there are five more auto-producers that have electrified ~44 localities (groups of villages) under the ERIL designation since 2004.

ERIL concessions are not well documented. According to a World Bank report they seem to include:

Table 6. ERIL concessions in Senegal (World Bank, 2015)

Project/operator	Description
COSEER, SUD SOLAR and ENERGIE-R	COSEER could not start its projects due to a number of requirements from ASER, in particular on its relocation. SUD SOLAR is established in Casamance and operates a mini-grid with 21 hybrid power stations in the Sedhiou region. It serves 457 users. Level 4 Subscribers (professional users mainly) represent on average 20% of its subscribers (but over 30% in one third of villages).
ERSEN-1	Rural Electrification Senegal Project: Funded by KFW, GIZ and the Dutch government.
ERSEN-2	Second phase of the ERSEN project. Details unknown.
PASES	Project for access to electricity services for small communities in the region of Sedhiou (Projet d'accès aux services électriques des localités de petites tailles de la Région de Sédhiou): A project financed by the European Union. Details unknown.

Once a PPER concession is awarded, it is possible for a private developer to obtain an ERIL concession in the same geographic area, provided it meets certain conditions. ERILs require PPER concessionaire's approval and must be outside of the PPER's three-year expansion plan. However, PPER concessionaire's plans are not publicly available and are either ill-defined, dynamic or not consistently followed making it difficult for EIRLs to plan around PPERs. If a PPER concession is awarded, ASER can also bring in GDTs to operate rural electrification projects (World Bank, 2015).

3. PUDC: Programme D'urgence de Développement Communautaire/Community Development Emergency Programme

This model covers government programmes that are established to accelerate access to electricity, in a quest to meet the universal access by 2025 target. The Programme D'urgence de Développement Communautaire (Community Development Emergency Programme – PUDC) is the structure established by the Government to execute most of these urgent programmes. The PUDC was launched in 2015 with the main aim to fight against inequality between urban centres and villages in rural areas. PUDC acts across four different areas: improvement to road access, irrigation and water, equipment to reduce the physical effort of women in rural areas, and rural electrification projects.

7 The average number of connections per mini-grid in Senegal are 125 (IBRD, 2017).
8 Most successful mini-grids serve 300+ customers so it is understandable that operators exceed the 200 households cap on size currently imposed
9 Sine Moussa Abdou project, one out of six mini-grids originally operated by ENERSA.

During its first phase the PUDC electrified 420 villages, with a mix of 102 solar mini-grids and grid extensions. Villages were selected according to their distance from the main grid (>10km) and based on a comparative assessment of investment costs. Of the 102 mini-grids it is estimated that around 62 are currently operational. It is unclear why the other 40 are not operational. All the rural electrification projects done by PUDC are then transferred to ASER in the first instance, and then to the concessionaire in charge of the area where the project has been developed with a set of requirements such as starting to exploit the village immediately. ASER will either get in touch with GDTs or will transfer the mini-grids to the concessionaires of the zones. Due to this frequent change in ownership to date it is unclear how many of these 62 mini-grids actually have connections in place[10]. It is also unclear whether these mini-grids are being monitored or not. The first phase of the PUDC amounted to 123 billion FCFA (~$21 million), 100% from government money. Phase 1 received technical support from UNDP and is said to have facilitated the connection to electricity for ~20,800 households (not solely via mini-grids) (BOS, n.d.). It is unclear how Phase 1 of the PUDC has performed against target across the four areas of intervention.

The second phase should be around 300 billion FCFA (~$52 million), with 106 billion FCFA (approximately $18 million) already secured from the AfDB, the BID and the Abu Dhabi Fund. A total of more than 600 mini-grids are expected to be implemented under initiatives such as the PUDC and with funding from donors of the likes of the Islamic Development Bank (IsDB), the Abu Dhabi Development Fund, KFW, and the EU. During Phase 1, the PUDC procured a high performance GIS that will be enhanced under the project. Technical partnership agreements will be concluded between the PUDC and various technical structures (Senelec, ASER, etc.) (AfDB, 2018).

Despite being key, the PUDC may not represent a strategic plan for future electrification because of its urgency design. The President, Macky Sall, launched the PUDC to respond to the needs of the communities on a demand basis. There is therefore a need for close co-ordination between PUDC and ASER who has the formal mandate for rural electrification. Thus far, the collaboration/co-ordination has been done through a technical committee led by the Ministry in charge of energy on which the ASER sits too.

Private sector organisations presence in the mini-grid sector remains scarce. Generally speaking there is limited opportunity for the private sector to shape the PUDC, as mini-grids are developed by the PUDC and handed over to ASER, who only then identifies operators to take over the connection aspects of the mini-grid and start exploitation of the assets and provision of electricity. The private sector has therefore limited ability to get involved ex-ante under the PUDC framework. The current and future ownership structure of mini-grids is rather unclear as operators do not invest in mini-grid creation but are held responsible for managing them.

At present, we estimate that ~163 mini-grids are in operation across the country. Of these, 121 are thought to be hybrid diesel-solar PV mini-grids, 37 exclusively powered by solar PV, four entirely diesel-powered and one hybrid diesel-PV-wind. Official ASER figure state that the agency has injected 110 billion FCFA (~$17 million) in the rural electrification sector since 2012. This investment translates into 156,000 households or the equivalent of 2,235 villages connected to the grid since 2012.

Grid extensions are usually done in the West Coast where the Grid of Senelec is the most developed. Grid extension is usually used for larger populated villages, whereas villages with lower density inhabitant (<500 inhabitants) and located at more than 10km from the grid, are usually electrified by mini-girds or solar home systems (SHS).

2.4.2 LICENCING

The electricity sector is governed by Law 98-29, and the main entity responsible for providing the licence is the Ministry of Energy and Oil, after having received advice from the regulator CRSE. PPER concession licences are awarded for a 25-year period. Licences are independent from the chosen generation technology and allow the

10 PUDC covers the initial infrastructure works and not the connection aspect which is taken over by ASER. Operators receive fully functioning schemes and are required to start exploiting these immediately, sometimes despite having an electrification strategy in place. The operators will be the only ones responsible for investing in replacement kit and batteries for instance, as the Government will not support them financially.

concessionaire to distribute the electricity. Mini-grid operators need two licences, one to generate and one to distribute, which can be issued within the same ministerial act. In contrary to other countries, Senegal does not differentiate licences according to power output of the installation. Auto-production exists in Senegal yet does not apply to mini-grids.

In addition to the licences provided by the Ministry, the promotors of ERIL need pre-authorisation to operate from the concessionaire of the zone in which the project would be located, if the project is located within 10km of the main grid. This is because the concessionaire has the exclusivity of distribution within its concession area. The pre-authorisation is free of charge and is just a procedure to oblige the ERIL to inform the concessionaire about the project and ensure that it does not cover a village that is already included in the business plan of the concessionaire (within the next three years from the authorisation request). If the ERIL project is not part of the business plan of the concessionaire and once the authorisation is granted, the concessionaire no longer has the right to stop the ERIL promoter executing the project. As is the case for other mini-grids, ERILs are supposed to be governed by two licences from the Ministry, one for generation, and one for operation and distribution. In reality however, we have seen that ERILs have operated without licences or tariff reviews since their inception over 10 years ago.

2.4.3 MINI-GRID TARIFFS

As there is no specific law or regulations on mini grids, there is no specific tariff for mini grids, and these have historically been decided on a case-by-case basis. Existing mini-grids operated by concessionaires have therefore until now applied different tariffs from one concessionaire to the other. CRSE is in charge of tariff setting for ERILs, who usually charge the same price as that of concessionaires in the zone. CRSE is currently investigating how mini-grid regulation can be incorporated into existing regulations.

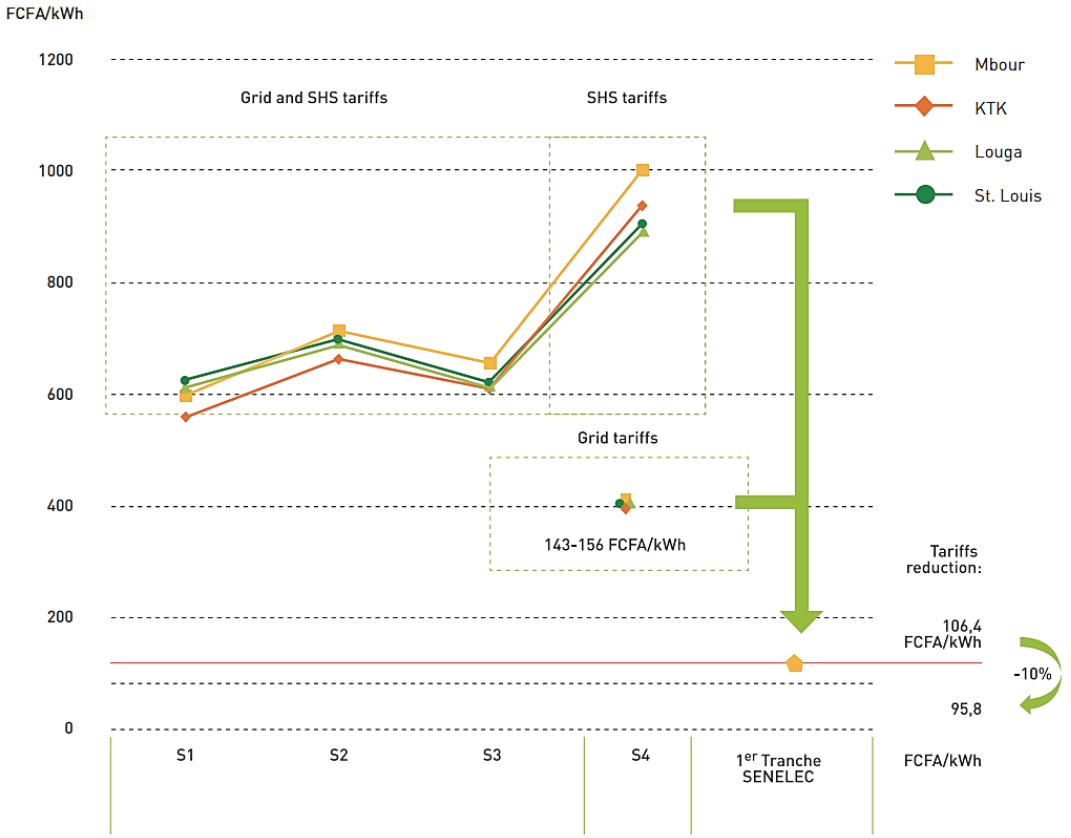
The tariffs, service standards and also their duration are defined in the concession specifications (Cahier de charges de la concession). The tariffs databases are subject to a five-year and/or extraordinary revision if a significant change in the financial conditions was observed; an unforeseeable event beyond the control of the concessionaire or over-costs which made the tariffs inappropriate (World Bank, 2015).

The main challenge faced by the concessionaires of rural zones comes from the large electricity tariff differences between regions, suppliers and in particular with tariffs charged by Senelec (the latter being up to 20-30% cheaper). The Government has even frozen Senelec's tariffs for multiple years, prior to agreeing a further 10% reduction in 2018. This price difference has frustration among end-users, and is seen as one of the main obstacles faced by the concessionaires limiting their ability to meet their connection targets. Linked to this is the fact that concessionaires charge a fixed tariff for their services to all types of consumers, regardless of the level of services, i.e. the level of consumption. Customers with the service levels S1, S2 and S3 and also S4 using solar panels currently pay a flat monthly fee. Flat fee tariffs can be up to seven times more expensive on a kWh basis than variable tariffs. Variable tariffs based on kWh are also 20 to 30% higher in concession areas.

To overcome tariff inconsistencies across the country, the Government is harmonising all tariffs (private and national) and aligning them to those charged by Senelec, therefore subsidising all concessions. The Government has suggested a harmonisation based on tariffs charged by Senelec (which in 2018 were further reduced by 10%). An analysis conducted by CRSE is ongoing to lay out the procedure for the applicability of the tariff harmonisation. To ensure a smooth transition CRSE has started engaging all the concessionaires of the six zones to review their contracts and agree on new terms which will include the subsidy that the Government will pay. CRSE had, as of September 2018, reached an agreement with two concessionaries and their contract should have been amended soon after. Once CRSE has concluded the process with all concessionaries they will start a similar exercise with the ERIL mini-grids operators. The harmonisation, which effectively acts as a drastic tariff reduction for mini-grid customers, will likely increase electricity consumption in mini-grids following the price elasticity effect. This will at the end require larger mini-grid generation and distribution assets. It is unclear how ASER is planning to react to this effect, and what the role of private operators will be in meeting this increased demand.

The multi-tier framework developed by World Bank under the SEforAll initiative definition of access can be used to establish the minimum intended level of access for Senegal rural areas. The PASER established four levels of service[11] (S1, S2, S3 and S4). Excluding SHS tariffs and taking the average service levels S3 as a baseline, tariffs charged in concession zones are approximately 600 FCFA/kWh, or $1.04/kWh. **With the harmonisation of tariffs we expect these to be lowered to as much as 95.8 FCFA/kWh, or $0.17/kWh**.

Figure 11. Comparison of different tariffs in Senegal, Concessions and Senelec (World Bank Group, 2018)



All new mini-grids promoters will have to develop business plans that take into account the harmonisation of the tariff and will include the amount of subsidy needed from the Government. It is important to note that a preferential tariff[12] exists for concessionaires that get their electricity from Senelec's national grid in order to support grid extension. Although it has not occurred yet, mini-grids operators that decide to connect their assets to the main grid could benefit from the preferential tariff.

2.4.4 SUBSIDIES AND INCENTIVES

In Senegal, PPER and ERIL concessions benefit from block subsidies paid by government or donors on the capital cost of project roll out. Two types of subsidies are common: co-funding and full funding. Co-funding usually covers up to 75% of the Capex of a mini grid project, while the remaining cost would usually be covered by the promoter of the mini grid. Few ERILs initiated by the local communities in partnership with entrepreneurs have benefited from this type of grant. The full funding is usually a grant of 100% of the capex. Subsidies are determined on a competitive public tender process and only cover operations and maintenance costs. In this case, the mini-grid is usually promoted directly by the Government

11 The level of service S1 corresponds to Tier 1 (power below 50W) which is considered a very low level of access normally recommended for the poorest households, with very low energy consumption – limited to five light points and possibly phone charging. Levels of service S2 and S3 correspond to Tier 2 (power capacity below 200W) which also represents a low level of access allowing the use of a lighting system, recharge of mobile phone batteries and, potentially, a fan or television. S4 and Grid based electrification corresponds normally to Tier 3 and above – depending on quality of service and cost

12 They buy electricity from Senelec at the tariff price reduced by 20% (T- 20%)

through programmes such as the PUDC, or by development partners such as GIZ. The private sector only gets involved at the procurement stage, where after a bidding process a private company is selected to install and/or operate and maintain the mini grid. Tariffs have historically been high because they were not based on an informed business model, as operators are simply being handed over mini-grids for operation, especially under the PUDC framework. It is important to stress that if the application to install and operate a mini-grid was spontaneous, then the operator will not receive subsidies on the initial investments but only on the tariff levels following harmonisation of the tariffs.[13]

Rural electrification funding comes mainly from the Government national budget. In 2006 (decree n°2006-247), a Fonds d'Electrification Rurale (Rural Electrification Fund – FER) was created to provide resources for a variety of instruments to be deployed across the sector including subsidies, loans and guarantees to rural electrification operators. The fund was going to be fed by a variety of sources including a fee on electricity sales, donors, and government budget. The REF was designed to be an independent agency that would work in collaboration with ASER. It was to be supervised by an independent 'Loans and Grants Committee'. While the decree was issued the fund was never established, and ASER ended up, to some extent, playing the role of the REF. Funds allocated to ASER have exclusively been integrated into ASER's accounts and none of the instruments specified were established, as ASER does not, officially, have the mandate to operate as a fund agency. ASER is hoping that in the upcoming laws on rural electrification, their ability to manage the FER will be made official.

The dependency of the available national budget made it difficult for ASER to properly plan or execute planned activities. Up to now, there are mini-grid operators (mainly ERILs) that are yet to receive the promised co-funding from the Government. The creation and operationalisation of an independent REF (within or outside ASER) with clear sources of income would allow for strategic planning to increase access to electricity, and would ensure that government engagements are honoured. An adequate procedure for recovery of funds should be put in place.

With the harmonisation of the electricity tariff, a new model of subsidy is being promoted. By the end of 2016, the Government had begun to consider actions to enable concessionaires to provide electricity at prices similar to those of Senelec (IBRD, 2017). The Government will now be subsidising the cost of electricity by providing a subsidy to the electricity tariff. The concern of most stakeholders involved in the sector is the ability of the Government to honour its engagement as subsidies will rise significantly. The harmonisation and tariff reduction decisions will represent a total of ~168 billion FCFA (~$29 million) operating deficit in the rural electrification sector between 2018 and 2025, a deficit that will require offsets (World Bank Group, 2017). To reduce the amount of subsidies, the Government plans to promote fully granted mini-grids which would minimise or even eliminate the need to provide additional subsidies to the operators for them to be able to apply the harmonised tariff[14].

There are also grants available from donors and development partners for mini-grids. Programmes from GIZ and the EU have provided substantial, and as much as all of the funding for micro-grid construction under various initiatives with differing objectives. GIZ has promoted the installation of 97 mini grids, and the EU has recently promoted, through ECREEE, the installation of 40 additional mini grids that should be made operational in early 2019. The national fund FONGIP is also starting to enter the energy market, having for instance financed a national biogas programme. To accelerate its involvement in the market FONGIP is advocating for a line of guarantee and a line of financing specific to mini-girds to be put in place, though debt won't replace the need for subsidies.

Import duty reductions and VAT reductions exist for rural electrification assets, though these are not standardised across the whole energy market. Rules governing access to tax and customs subsidy are complex and often involve multiple conventions and agreements that are not widely available to the public. Tax exclusion agreements include the following:

- Government-ASER agreement n ° 003 of 05/04/2014 – This agreement sets the fiscal rules for the rural electrification sector including tax and customs exemptions schemes on capital expenditures.

13 Though this would appear far less sustainable, it is unclear how faithfully the Government pays these recurring regular subsidies to the companies

14 A one-off upfront payment could be more beneficial to the market than recurring subsidies

- Renewable Energy Law Article 8 - Provides broad and vague exemptions from taxes for renewable energy incentives. This law is largely unimplemented.

- General Tax Code (Investment code and incentive scheme) - The code provides customs duties and fiscal incentives to new business and expanding ones including customs exemption, suspended VAT and a reduced corporate tax.

- General Tax Code (point 5 of Annex I to Book II) – This section outlines the VAT exemptions applicable to electricity consumption.

2.4.5 POWER PURCHASE AGREEMENTS

There are no standardised PPAs in the off-grid sector in Senegal. Despite there being no specific policy and regulatory framework for PPA for mini-grids, there is an intrinsic PPA regulation between Senelec and the concessionaires. The regulation obliges Senelec to sell the electricity to the concessionaires at the medium voltage tariffs minus 20%. The concessionaires on the other hand will still need to get an IPP licence from CRSE and directly negotiate with Senelec to agree the tariff.

CRSE is about to publish a regulation on Feed-In-tariffs (FiTs), which was mainly designed for rooftop stand-alone solar systems in the context of production for self-consumption, but that could be applied to mini-grids. Under this new FiT scheme, which went out for consultation in June 2018, operators will be able to inject excess generation into the main grid. Table 8 below shows feed-in-tariffs for each category of Senelec's clients. At present, operators are only allowed to inject 20% of the generation into the grid without becoming a producer. However, given capacity constraints, stakeholder affirms that Senelec unofficially drops the limit to 10%. So far, mini-grids have been located far from the grid, yet with over 600 mini-grids in the pipeline (with secured funding from the likes of AfDB, BID and Saudi Funds as part of the PUDC), it is important that the above is quickly addressed.

Table 7. Proposed surplus feed-in-tariffs

Client type	Medium Senelec tariff FCFA ($)	Feed-in-tariff proposed FCFA ($)
Low voltage		
Domestic – low voltage	99.02 (0.17)	75 (0.13)
Domestic – medium voltage	109.86 (0.19)	70 (0.12)
Domestic – high voltage	91.56 (0.16)	60 (0.10)
Business – low voltage	136.60 (0.24)	65 (0.11)
Business – medium voltage	145.44 (0.25)	60 (0.10)
Business – high voltage	111.56 (0.19)	50 (0.09)
Medium voltage		
General tariff – PV	93.02 (0.16)	50 (0.09)
General tariff – biogas	93.02 (0.16)	50 (0.09)

Source: (CRSE, 2018)

2.4.6 ARRIVAL OF THE GRID

There are no real clear rules on arrival of the main grid and the impact this can have on existing mini-grids in the sector. This is because at present there is no transparent grid extension plan. Senelec has until now focused its efforts on densifying its grid reach and improving the quality of the service, without being involved in rural electrification. The allocation of the four remaining concession zones puts this approach under scrutiny and a new strategy is being awaited, though it is speculated that Senelec will find some GDTs to operate mini-grids, and will focus its attention to grid extensions plans instead.

Once the grid arrives, the operators can decide to keep the asset or abandon it. For large scale solar stations, there was an obligation on Senelec to buy the generation of power from the operators. This should be considered for mini-grids, too. It is unclear what happens with ERILs, though these can only be proposed in areas far away from the grid, i.e. where the grid is not expected to reach within the next three years.

2.4.7 TECHNICAL RULES

Technical standards are defined in each tender. Standards at conception stage have historically been the responsibility of ASER. **Donors such as the GIZ often impose stricter standards than government ones**. For instance, under its EnDev programme[15] the GIZ requires a minimum service level of eight hours per day.

Distribution in the concessions is done through a variety of technological approaches. ASER based its strategy on "technology neutrality", leaving the private operators free to decide on the choice of technology, within the constraints of the technical standards defined by ASER. Concessionaires, however, should respect minimum service standards. In practice, however, this was mostly true for ERILs, as in the current more centralised process put in place by the PUDC, the operation of mini-grids is delegated to operators who receive the full scheme after it has already been built. There is therefore limited opportunity for operators to get involved in the design of the system.

Table 8. Minimum service levels for rural electrification

Type of supply	Standards
Villages supplied by MV networks	Access of 24 hours a day
Villages supplied by mini-grids	Electricity access of a minimum of six hours per day (7pm to 1am)
Solar home systems	Same as for mini-grids

The technologies used on the PPER concessions are a mix of technological approaches yet initially mostly included SHS and grid extension rather than mini-grids (World Bank, 2015).

2.4.8 MOBILE SERVICES

Mobile penetration in Senegal is high with ~105 penetration rates and roughly 74% of the population owning a mobile phone (ARTP, 2018). These numbers diverge in rural areas where only 64% of the population owns a phone. From 7.5 million in 2010, the country now has more than 15 million subscriptions. Mobile network coverage in Senegal varies by provider and service level. Few providers in Senegal have extensive 4G networks and despite expansion of 3G networks, services in remote rural areas are still dependent on 2G networks. Overall, 2G networks are reasonably pervasive covering most population centres.

Mobile money penetration in Senegal is extremely low, with only 8% of the population with access to mobile money services as of 2016. No updated data is available, but to put this in contrast, Kenya and Tanzania have rates of mobile money adoption of 69% and 62%, respectively. Rural-urban differences further highlight access challenges with only 9% of rural populations having access (compared to 22% in urban areas). Senegal has a financial inclusion rate of just 15% compared with 20% in Benin, 37% in Nigeria, and 69% in Kenya. Senegal has two primary mobile money providers - Orange Money and Tigo Cash - operated by the sector's dominant Mobile Network Operators (MNOs).

COMASEL and SCL Energie Solutions use pre-paid meters for their grid-connected clients. PERACOD and ERA do not use pre-paid meters for their grid connected clients. No private operator uses pre-paid meters for use in solar home systems (Legendre, 2015). Donors such as the GIZ are only now starting to consider Pay as you go business models when designing their mini-grids, having historically done on-site revenue collection.

15 The EnDev Senegal project focuses on rural electrification. Based on an assessment of the ability and willingness to pay for electricity, EnDev identified interventions to serve different demands of households and social institutions. Electricity is provided by village grids (PV-diesel hybrid) or by individual SHS (in smaller villages) based on technical and economic criteria (70% is subsidised by EnDev while the remainder is contributed by the operator and the municipality concerned (EnDev, 2019).

2.4.9 BARRIERS AND POTENTIAL INTERVENTIONS FOR MINI-GRID DEPLOYMENT

Concessionaires have been faced with contractual, financial and technical challenges that have limited their ability to increase access and meet their objectives. To better understand the obstacles faced by concessionaires, CRSE was asked by the Government to conduct an audit of all the concessions. The results of the audit (technical, financial, economic and juridical) has now been shared with each concessionaire and was expected be signed off by end of 2018. The audits will allow the Government to better understand the challenges and provide an appropriate remedy.

There is a need to improve the legal and regulatory framework on mini-grids. Most of the mini-grids established under ERILs do not have a concessionary contract in place with the Government. E.g. of the six ERIL recognised by the state, only one has signed a contract with the Government and received a licence to generate. The capacity of CRSE to process applications remains uncertain. Operators are not being incentivised to apply for ERILs and are therefore wary to make any major investments in the correct operation of the mini-grid. This is one of the main reason many of the mini-grids are no longer operational.

The existing financial framework is not conducive to private investment in the energy environment. The majority of the existing mini-grids in Senegal today are 100% grant-based. The few exceptions have included a 25% private investment and 75% grant. The involvement of the commercial financial institutions is therefore not needed at present, yet concerns persist on the ability of the government to continuously fund these projects, or to raise funds from international donors. The REF was never made functional. ASER took on the responsibility of financing mini-grids but was never able to operationalise the REF. It will be essential that the fund is made operational to reassure the private sector that the Government will have the means to honour its engagement when co-founding a rural electrification project. It will also allow the ASER to better plan their interventions. There has been some limited self-financing but it is largely done through personal, collateralised loans. Local banks have expressed little willingness to lend to ERIL developers citing numerous reasons including: lack of established revenue; lack of creditworthy buyers and no guarantees; lack of established presence; and unclear business plans. The principal problem is that business plans are not able to show clear profitability when the tariff issue is not entirely solved.

There is also a need to improve the co-ordination of the different actors in the mini-grid sector. Despite ASER being on the technical committee of the PUDC, it seems that efforts to electrify rural villages by these two main players are not always aligned yet occur in isolation from each other. There have also been cases where villages were selected to benefit from mini-grid systems under a project led by ASER that had to be cancelled because Senelec expanded the grid to the same villages. To avoid this situation, especially with players like Senelec or programmes such as the PUDC, it is important that ASER is consistently involved in a very early stage of the projects (before the selection of the locations and the technology).

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 Senegal. 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 tariffs . 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

Senegal has publicly available, though limited, GIS data on many sectors through its BaseGeo platform (http://www.basegeo.gouv.sn/). Currently, energy data in this platform is limited to high voltage lines and some basic information on hydrocarbons. The primary tool driving decision making is ASER's GIS system, which in 2015 was integrated with Senelec's Information system.

Another former source of information was Senegal's Energy Information System (Système d'Informations Energétiques du Sénégal – SIE-Sénégal). This tool provided statistics on Senegal's power sector and is widely cited in reports and studies, including on the regulator's webpage. The site (http://www.sie-energie.gouv.sn/), is however inactive and no longer used.

There are also several external sources of GIS data relevant to rural electrification. Of particular relevance is ECREEE's ECOWAS observatory for Renewable Energy and Energy Efficiency (ECOWREX). ECOWREX offers detailed GIS information on electricity infrastructure, climate and weather data, transport data, population distribution, electricity demand, and other elements. Integrated with ASER data, this could provide a powerful tool for prospective developers.

3.2 ASSESSING MINI-GRID POTENTIAL

3.2.1 METHODOLOGY

The first step in understanding mini-grid potential in Senegal 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, with household density greater than 50 households per km^2
- Standalone system (SHS) areas: defined as areas 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 area . 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 km^2.

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).
2. 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).
3. Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SE4ALL 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 SE4ALL 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.
4. Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SE4ALL 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.

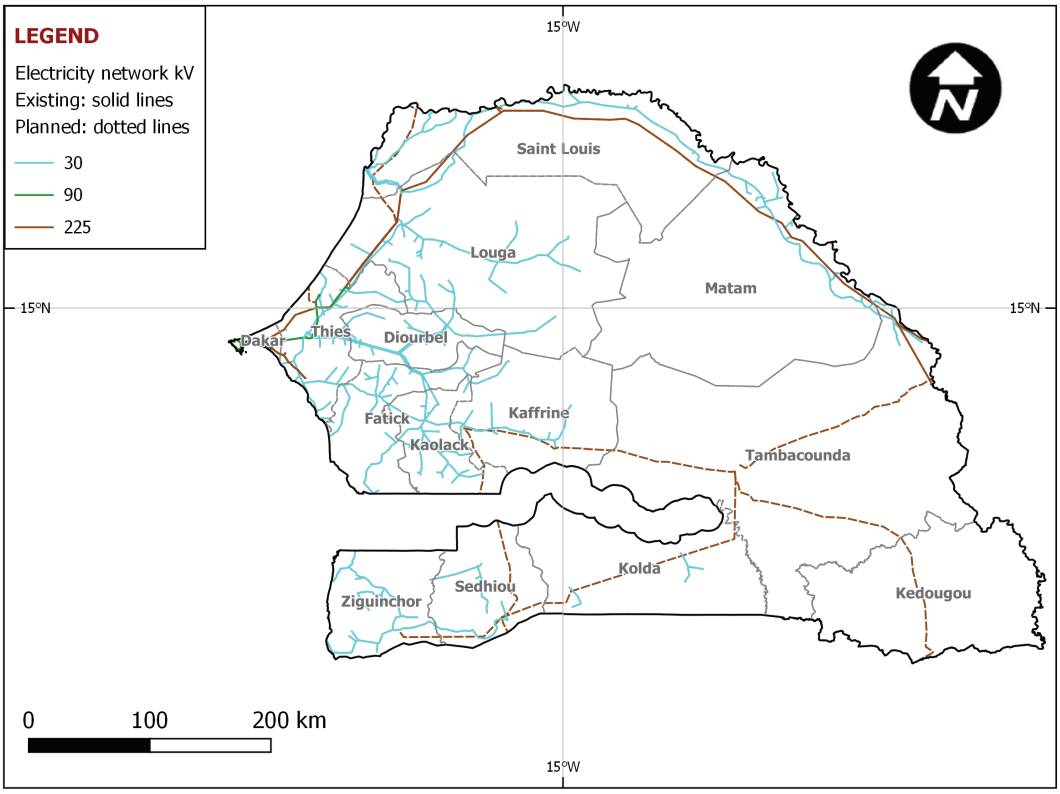
3.2.2 RESULTS

Transmission grid coverage in Senegal is non-homogenous by regions and relatively limited in general. The current HV network consists of an international 225kV link connecting the Manantali hydro power plant in Mali to Dakar through the northern border with Mauritania. This axis is extended to the Touba and Kahone substations. This HV network also includes the 90kV and 225kV voltages used to supply the urban areas of Dakar, Thiès and Mbour. The MV network is divided in two distinct networks. The interconnected network extends over most of the north and western area of Senegal by connecting the main towns and villages to the HV network. For the southern regions, there are several MV autonomous mini-grids in Ziguinchor, Kolda, Tambacounda and Velingara that constitute the non-interconnected network (World Bank Group, 2017).

In terms of planned HV network, there is a large 225kV interconnection project with neighbouring countries within the framework of the Organisation pour la mise en valeur du fleuve Sénégal (Senegal River Development Organizations – OMVS) and the OMVG passing through Tambacounda. For the MV level, the on-going PNUER is building a series of 'backbone' MV lines called 'dorsales' to bring the interconnected grid closer to rural areas.

By inferring the presence of MV and LV transmission lines using night lights, and overlaying population density (Figure 13) onto the resultant map, we can identify those areas best served by mini-grids (Figure 14).

Figure 12. Existing electricity grid with planned network up to 2025 (dotted lines) (Western African Pool)



The spread between urban and rural population in Senegal is relatively even. According to 2013 projections, the urban population was forecast to reach seven million in 2017, and the rural population 8.1 million. The regions with the highest percentage of the national population are Dakar (23.1%), followed by Thies (13.1%) and Diourbel (11.1%) (ANSD, 2018). The remaining regions are relatively homogenous in terms of inhabitants. Figure 13 below shows a graphical view of the population density per region.

Figure 13. Population density in Senegal, with main cities, 2017 (ANSD, 2018)

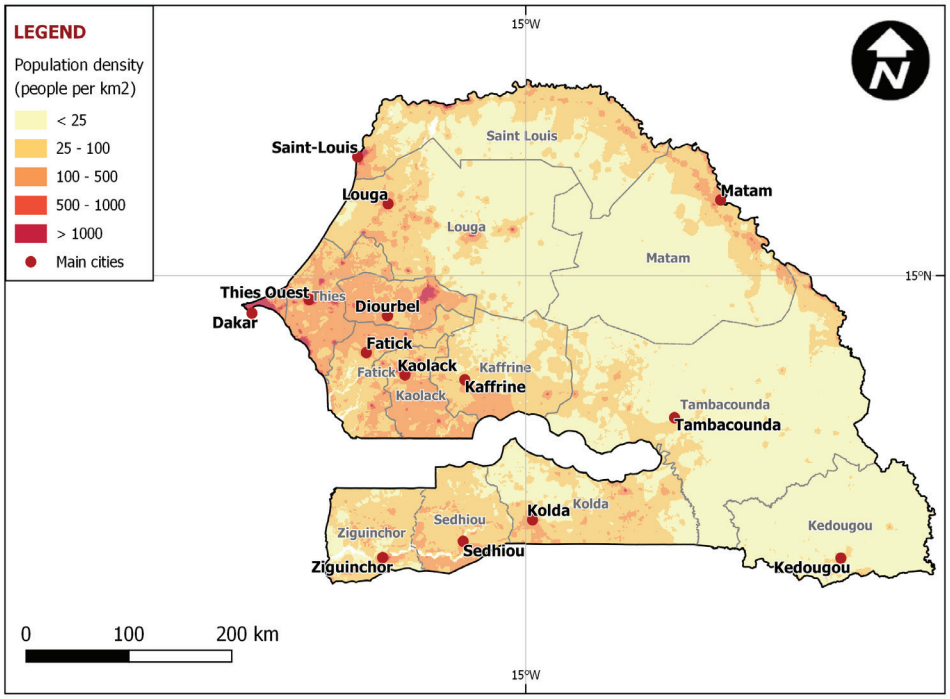
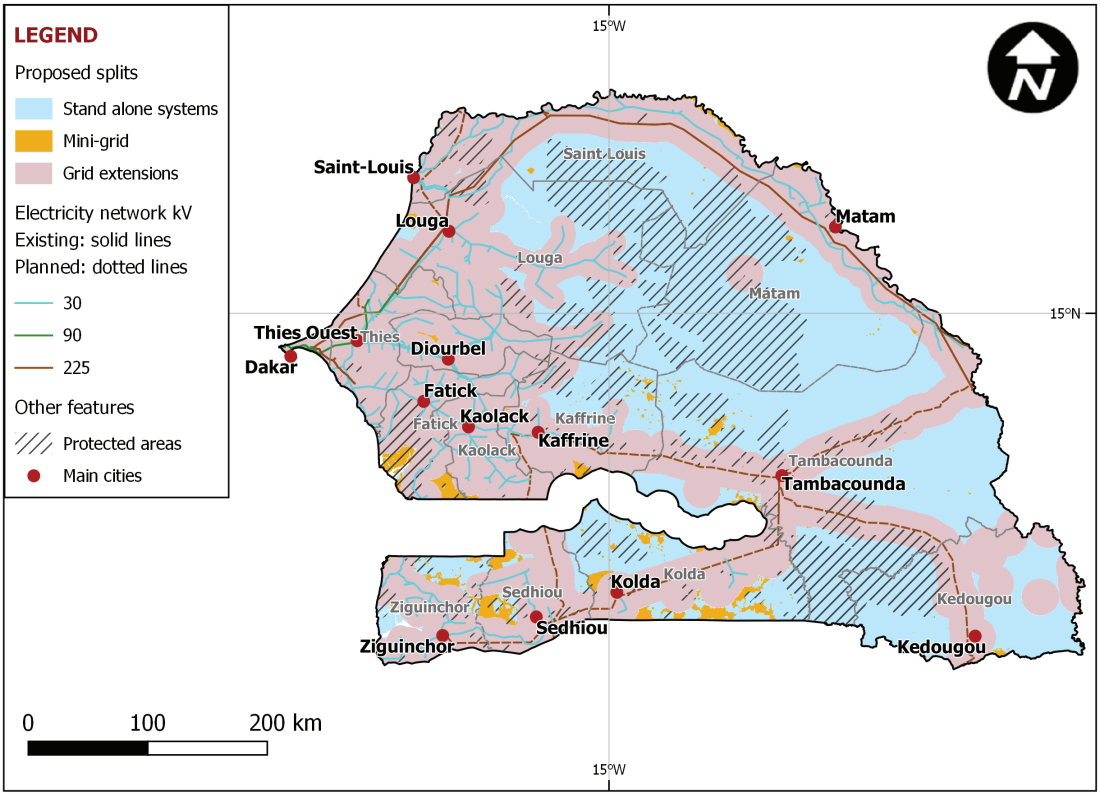


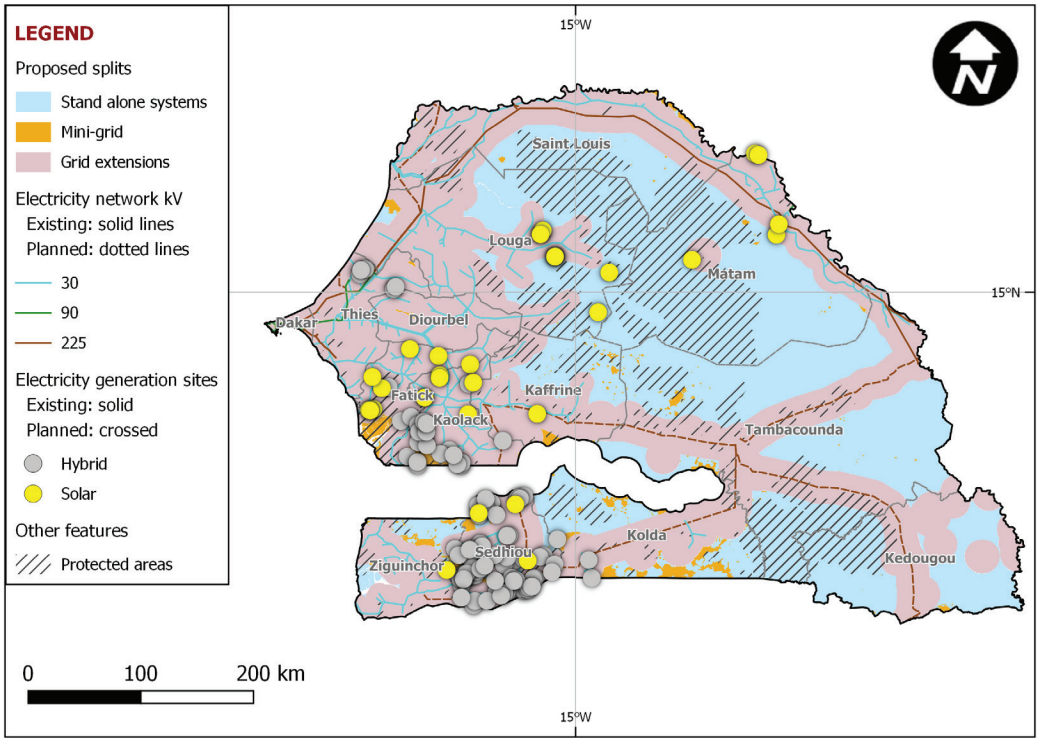
Figure 14. Regions best served by grid extension, mini-grid and standalone systems, shown with major and minor population centres (Carbon Trust analysis)



Our analysis estimates that 1.1 million people (7% of the non-electrified population) will be best served by mini-grid solutions in Senegal. The highest potential region is Kolda, with an estimated market size of $22 million. A further 1.6 million people (11% of the non-electrified population) will be best served by solar home systems (SHS) and 7.5 million people (50% of the non-electrified population) will be best served by grid extension, based on proximity to the existing grid. These estimates of mini-grid potential are based on the current grid coverage only.

Based on intended grid expansion to 2025, our analysis estimates that 651,000 people would be best served by mini-grid solutions, corresponding to 4% of the non-electrified population. This 40% reduction in market size reflects a number of planned extensions as provided by the Western Power Pool (WEPP), which takes the total population living within 15km of the grid to 13 million people. This difference with current government plans to build ~600 mini-grids could be explained by the distance to the main grid as historically the Government in Senegal has selected villages for electrification through mini-grids according to their distance from the main grid of 10km or more. The results of this analysis is shown graphically in Figure 13 including planned renewable energy sites.

Figure 15. Regions best served by grid extension, mini-grid and standalone systems, shown with existing and planned renewable energy sites (dotted lines are planned grid extensions up to 2025) (ECOWREX data portal, Carbon Trust analysis)



Population sizes best served by either grid extension, mini-grid or SHS are shown by regions in Table 9.

Table 9. Suitable electrification solutions by state in Senegal (Carbon Trust analysis)

State	Current grid network					Planned grid network to 2025			
	Electrification rate	Population (thousands)			Mini-Grid Market ($,m)	Population (thousands)			Mini-Grid Market ($,m)
		< 15km of grid	Mini-Grid	SHS		Grid extension	Mini-Grid	SHS	
Dakar	86%	489	-	-	-	489	-	-	-
Diourbel	14%	1,445	41	1	3.5	1,445	41	1	3.5
Fatick	47%	305	98	10	8.4	305	98	10	8.4
Kaffrine	6%	222	219	135	18.7	369	103	105	8.8
Kaolack	8%	836	108	-	9.2	889	55	-	4.7
Kedougou	5%	-	20	129	1.7	33	7	101	0.6
Kolda	2%	211	258	215	22.0	398	136	151	11.6
Louga	8%	731	38	143	3.2	746	25	142	2.1
Matam	23%	295	11	216	0.9	295	11	216	0.9
Saint Louis	19%	643	52	158	4.4	674	33	146	2.8
Sedhiou	4%	303	111	87	9.5	404	63	34	5.4
Tambacounda	4%	105	76	471	6.5	343	26	283	2.2
Thies	16%	1,557	23	-	2.0	1,557	23	-	2.0
Ziguinchor	23%	377	30	55	2.6	382	39	51	2.5
Total		**7,518**	**1,086**	**1,622**	**92.6**	**8,328**	**651**	**1,239**	**55.5**

In terms of potential revenue, the size of the market based on 1.1 million potential customers varies according to the four electricity expenditure scenarios described in section 3.2.1 Methodology:

1. Existing rural household expenditure on electricity from the World Bank Global Consumption Database: in Senegal 94.5% of the rural population falls under the 'lowest' consumption segment, and 5.5% under the 'low' consumption segment. According to the World Bank Global Consumption Database the per capita annual spend on electricity in Senegal is $5.97.

2. Existing rural household expenditure on electricity based on other reports/literature: this assumes a national average per capita annual spend on electricity of $66.38. This expenditure is derived from a 2014 national survey which found that 5.6% of rural households' annual budgets were spent on expenses related to paying gas and electricity bills, other fuels and heating.[16] This is an average of 78,947 FCFA per year per household in rural areas (~ $136.5), or 7,894 FCFA per person per year[17] (~$13.64).

3. Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SE4ALL 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 based on forward-looking household electricity consumption of 2.2kWh per day, represents annual per capita electricity demand of 100kWh (eight people per household). With the harmonisation of tariffs which is expected to be fully operation in April 2019, we expect tariffs to be lowered to as much as 95.8 FCFA/kWh, or $0.17/kWh.

4. Potential rural household expenditure on electricity, estimated based on a bottom-up calculation of what would be required to deliver SE4ALL 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 100kWh per capita, a tariff of $0.4/kWh gives an average annual electricity expenditure of $40 per capita: an overall annual mini-grid market size of $43.5 million given a mini-grid population of 1.1 million.

A summary of these four market size estimates is shown in Table 10 .

Table 10. 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	$5.97	$6.4m	$3.8m
2 Other Reports	$13.64	$14.8m	$8.8m
3 'Bottom-up' + existing tariff	$17.06	$18.5m	$11.1m
4 'Bottom-up' + theoretical tariff	$40.15	$43.5m	$26.1m

16 The survey also found that 1.49% of households' annual budgets were spent on wood, charcoal and candles.
17 The National Bureau of Statistics states that the average household is eight people, with an average of seven in urban areas and 10 in rural areas (statistics released in 2016 based on a 2013 census) (ANSD, 2016). We used the rural average of 10 people per household to calculate the per capita annual spend on electricity.

Scenario (1) yield underestimated results because the high household size is diluting the household spend and market size. Scenario (2) is based on a 2014 national survey which only provides indicative household energy spend, yet it is useful as it separates out rural and urban energy spend. Scenario (3) is based on national tariffs in Senegal (post harmonisation) and on demand levels observed elsewhere in SSA, and has been selected as the more likely estimate of the mini-grid market size in Senegal.

In summary, this report estimates an annual mini-grid market size of $18.5 million in Senegal, based on an average tariff of $0.17/kWh, and average household demand per day of 2.2kWh. This implies per capita annual electricity expenditure of $17.06 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 **57.5% 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).

3.3 RENEWABLE ENERGY POTENTIAL FOR MINI-GRIDS

3.3.1 HYDRO

Studies carried out in the mid-1980s show that the hydroelectric resources specific to Senegal alone are small. The relatively flat relief of the country is not favourable to the deployment of this form of energy, with the exception of the East of the country, near Kédougou. Senegal does also not have any small hydropower (SHP) plants on its territory.

However, Senegal shares hydropower capacity with its neighbours, as part of the OMVS and the OMVG framework a potential estimated at nearly 1,400MW, of which to date around 260MW can be exploited (MDER, 2015). The main hydropower plant, the Manantali Plant, is on the Senegal River near the border with Mali. This plant was developed within the OMVS framework. The hydropower plant has a capacity of 200MW, generating ~740GWh per year (UNDP, 2016). The 128MW Sambangalou project currently under construction in Senegal is set to be connected to the recently completed 402MW Kaleta project in Guinea. This follows an agreement between members of the OMVG (IHA, 2017).

3.3.2 BIOMASS

Senegal has a significant biomass deposit estimated at 331.3 million m^3 (MDER, 2015). Biomass resources, such as agricultural waste, and agribusiness by-products, have potential uses in on-grid and off-grid electricity generation. The estimated generating potential is 2,900GWh (RECP, 2015).

Currently, more than half of Senegal's energy consumption is biomass, putting considerable pressure on forests, with the demand for traditional fuels driving forest losses of 0.5% annually, or some 40,000ha of forest. In 2012 IRENA reported the potential for off-grid electricity generation and grid-distributed for agricultural by-products and agribusiness. Alternatively, Senegal also benefits from a major potential for biofuel production in the southern part of the country. Agricultural by-products include ~3.3 million dry tonnes of agricultural residues and bio-fuel production could potentially come from the presence of diverse pant species (plant oil, sunflower, cotton, cattails etc.) (IRENA, 2012).

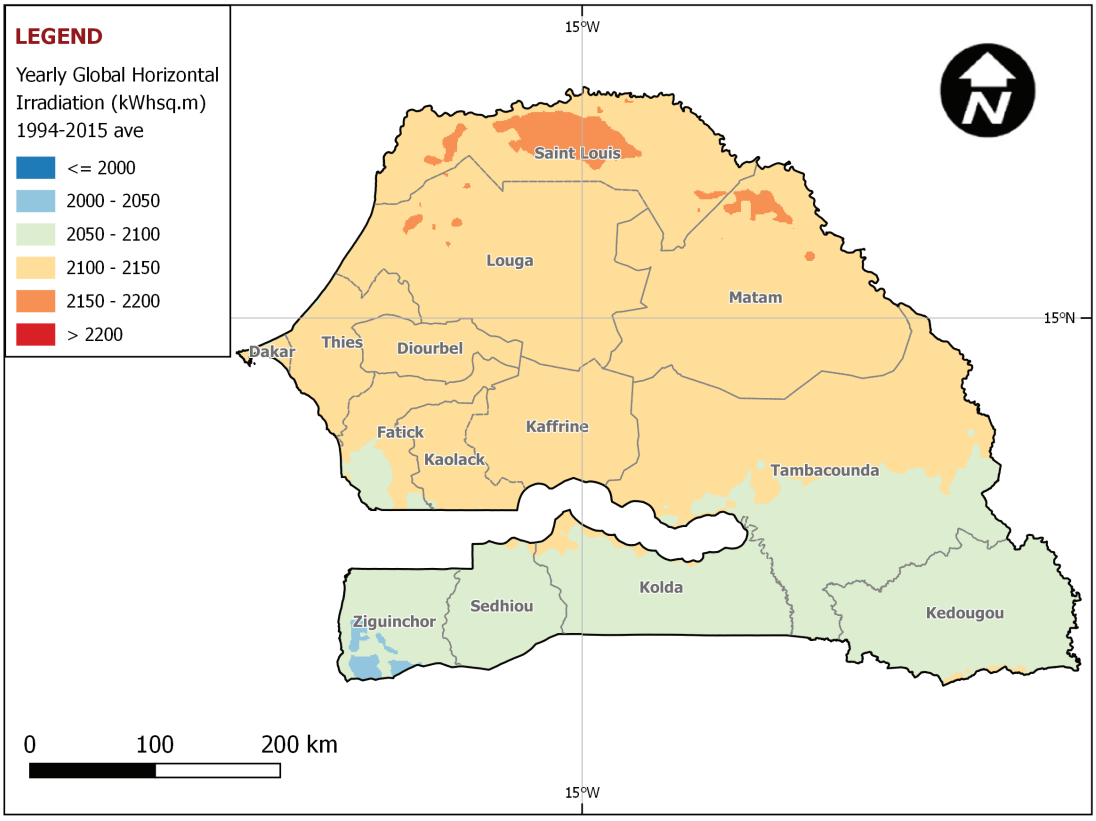
3.3.4 SOLAR

With 3,000 hours of sunshine a year and an average daily irradiation energy of 5.8 kWh/m^2/day, Senegal has significant solar potential (MDER, 2015). The highest global horizontal irradiance is found in Dakar and Thies. However, Dakar also has a low solar potential because of highly populated areas. Tambacounda region has the highest land availability for solar PV (Nogoye Diaw et al. , 2017).

Table 11. Solar radiation and potential for each region (Nogoye Diaw et al. , 2017)

Regions	Total area (km²)	Available area for PV (km²)	3% of available area (km²)[18]	Solar PV Plant (MV)
Dakar	6,640	332	9.96	498
Diourbel	20,257	7,085	212.55	10,627.5
Fatick	27,987	2,563	76.89	3,844.5
Kaffrine	42,863	13,919	417.57	20,878.5
Kaolack	566	33	0.99	49.5
Kedougou	7,354	2,401	72.03	3,601.5
Kolda	24,659	1,965	58.95	2,947.5
Louga	11,314	154	4.62	231
Matam	6,848	168	5.04	252
Saint Louis	7,351	1,268	38.04	1,902
Sedhiou	16,950	8,239	247.17	12,358.5
Tambacounda	13,804	4,256	127.68	6,384
Thies	4,860	0.8	0.024	1.2
Ziguinchor	5,407	229	6.87	343.5
Total	**1,96,860**	**42,613**	**1,278.39**	**63,919.5**

Figure 16. Yearly Global Horizontal Irradiatoin (kWh/sq.m) 1994 to 2015 ave



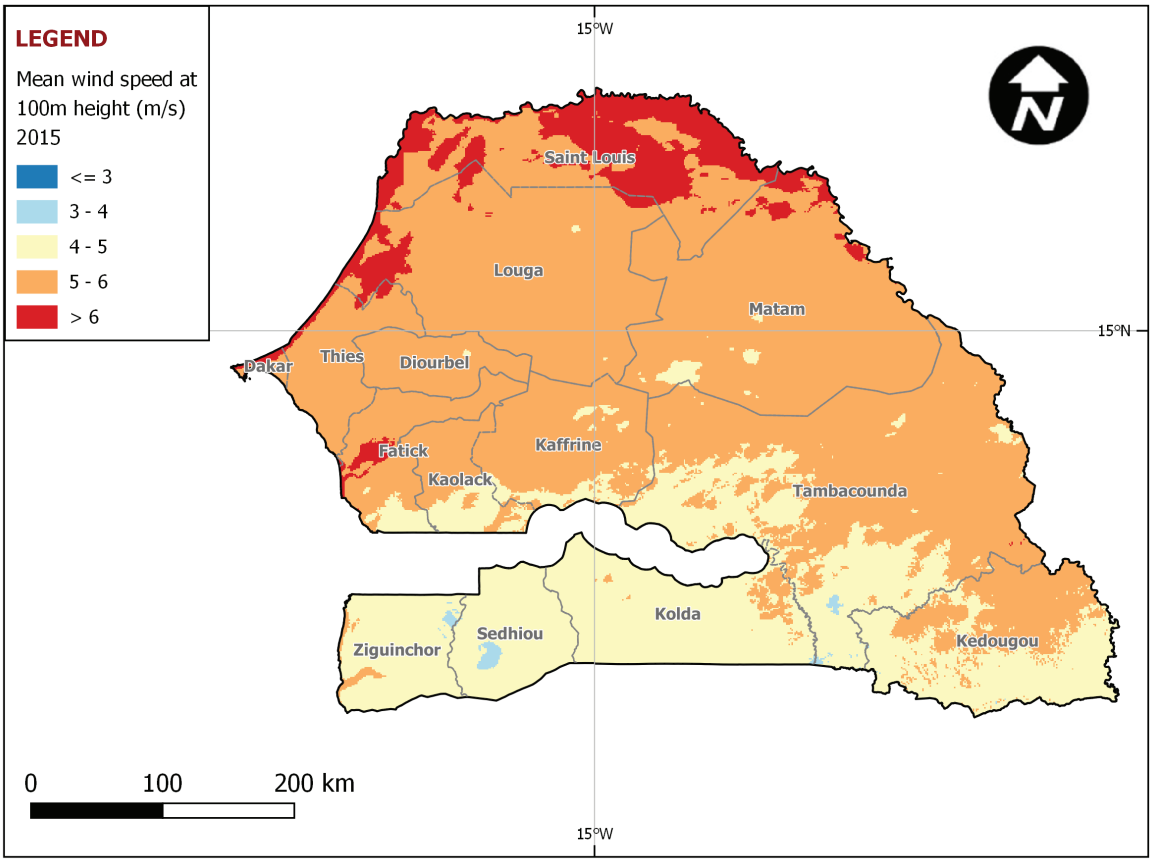
18 Solar energy resource exploitation requires a shadow free area to tap the amount of solar energy available in a specific place.

3.3.5 WIND

There is an interesting wind potential along Senegal's Northern Coastline, particularly in the 50km wide coastal strip from Dakar to Saint-Louis, where the average annual wind speed is around 6m/s (MDER, 2015). The Southern part of the country has only a moderate potential for wind.

In August 2018, the 158.7MW Taiba N'Diaye wind farm successfully reached financial close. The wind farm is majority owned by renewable power generation company Lekela, and received technical, environmental and social advice from Mott MacDonald. At the end of its construction (forecast for 2020), the wind farm will consist of 46 Vestas wind turbine generators. An on-site substation will boost the voltage of the electricity generated by the scheme from 33kV to 225kV via a transformer, while the adjacent Tobène substation will act as the grid connection point. Once operational, it is expected that the wind farm will provide over 450,000MWh of energy per annum for over two million people. As expressed by Mott MacDonald's project director, "the Taiba wind farm is a transformative project that will form a significant portion of the Senegalese power generation mix once built and bring much needed affordable electricity to the country" (Mott McDonald, 2018).

Figure 17. Mean wind speed at 100m height (m/s). 2015



4. DIRECTORY

4.1 ENERGY SECTOR POLICIES AND REGULATORY FRAMEWORKS DIRECTORY

Law 98-29 of April 14, 1998: Established the creation of ASER and the creation of CRSE. In 2002, Law 98-29 was amended to increase the transparency of tenders and to make them more attractive to the private sector.

Plan Sénégal Emergent (Emerging Senegal Plan – PSE): The PSE, adopted by the government in November 2012, constitutes the main document on social and economic policy in the medium and long-term (2035).

Lettre de Politique de Développement du Secteur de l'Energie (Policy for the development of the energy sector - LPDSE). The LPDSE is also a strategy for improving access to electricity. The New LPDSE (2019 to 2023) will soon be validated. Under the LPDSE, Senegal is developing a number of additional key policies, in particular a policy on Feed-in-Tariffs (FiTs), and the harmonisation of tariffs. The targets for the integration of renewables into the grid have increased to 30% by 2025 (against current levels of ~20%).

Plan d'Action Sénégalais d'Electrification Rurale (Senegalese Rural Electrification Action Plan – PASER): ambitious 20-year programme (2002 to 2022) for the electrification of rural areas. PASER was structured around the Programme Prioritaire de l'Électrification Rurale (Priority Programme for Rural Electrification – PPER) which introduced the concept of concession areas in Senegal, and the Projects d'Electrification Rurale d'Initiative Locale (Local initiative rural electrification projects – ERILs).

Programme National d'Électrification Rurale (National Rural Electrification Programme – PNER): New rural electrification strategy document. PNER defines the strategy to achieve the objective of universal access by 2025 by setting intermediary objectives of access to electricity to 60% in 2017 (then pushed back to 2019) with a minimum of 30% access per department. The strategy is divided into three components: the conclusion of ongoing programmes (PPER); an emergency plan for 2015 to 2017 called **Plan National d'Urgence d'Electrification Rurale** (National Urgency Plan for Rural Electrification – PNUER); and t**he Programme Complémentaire pour l'Accès Universel à l'Horizon 2025** (complementary plan for universal access to 2025), which included the four remaining concession zones to be allocated.

A full repository of regulations and other energy sector documents can be found on the NERC website.

4.3 DATA SOURCES DIRECTORY

This methodology was developed during the first phase of this project, the Green Mini-Grids Market Development Programme - Market Intelligence business line, which is also available via the African Development Bank. The two methodology papers are published on the AfDB's Green Mini-Grid Help Desk.

This analysis, the results of which are provided in Section 3, considers the potential for mini-grids by segmenting the countries into two areas: grid and off-grid areas. This split is based on the distance of 15km from the power network. We have used the planned power network for up to 2025. The GIS sources used in this analysis are detailed below.

1. 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 Senegal

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

2. Clean Energy Mini-grids

File name: cemgs_30072018

Source age: 2018

File type: ESRI Shapefile, points; GEOJSON

Description: A shapefile of off-grid power plants in Senegal

Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: ECOWAS observatory for Renewable Energy and Energy Efficiency (ECOWREX) database

Link: http://www.ecowrex.org/mapView/index.php?lang=eng&mclayers=layerCEMG#

3. Woldpop Population Density

File name: SEN_pph_v2b_2015_UNadj.tif

Source age: 2015

File type: Raster

Description: 2015 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: http://www.worldpop.org.uk/data/data_sources/

4. Administrative Layers (National and Region Boundaries; Main cities)

File name: sen_admbnda_adm0_1m_gov_ocha_04082017.shp; sen_admbnda_adm1_1m_gov_ocha_04082017.shp; sen_plpp_gov_ocha_09082017.shp

Source age: 2017

File type: ESRI Shapefile, polygons and points

Description: Shapefiles of State and Local Government Area boundaries, main cities

Projected co-ordinate system: WGS_1984 (EPSG: 4326)

Source: Humanitarian Data Exchange

Link: https://data.humdata.org/dataset/senegal-administrative-boundaries and https://data.humdata.org/dataset/senegal-settlements

5. Wind

File name: gwa__gwa_ws_100m_mean.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

6. Solar

File name: GHI.tif

Source age: 2015

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/senegal

4.3 STAKEHOLDER DIRECTORY

4.4.1 GOVERNMENT AND AGENCIES

Ministre de l'Energie et du Développement des Energies Renouvelables/Ministry of Energy and Development of Renewable Energies (MEDER)

Contact: **Email:** http://www.energie.gouv.sn/contact

Telephone:

Link: www.energie.gouv.sn

Brief description: Under the authority of the Prime Minister, the Minister of Energy and Development of Renewable Energies prepares and implements the policy defined by the Head of State in terms of energy production and distribution, promotion of renewable energies. It develops, in particular, plans and programmes of energy saving and development of alternative energies likely to provide the national economy with a substantial reduction in the weight of conventional energies such as oil, gas and coal.

Agence Sénégalaise D'Electrification Rurale/Senegalese Agency for Rural Electrification (ASER)

Contact: **Email**: aser@aser.sn

Telephone: +221 33 849 47 17

Link: www.aser.sn

Brief description: The Senegalese Agency for Rural Electrification (ASER) was created in 1998 by Law 98-29 governing the electricity sector. ASER is an autonomous unit of the Department of Energy. The main task is to conduct and to support development programmes aimed at rural electrification. The organisation provides technical and financial support to businesses and individuals. ASER finances the off-grid sector through grants, involves the private sector through PPPs and the voluntary sector and local communities through ERILs.

Commission de Régulation du Secteur de l'Electricité/ Electricity Regulator (CRSE)

Contact: **Email:** crse@crse.sn

Telephone: +221 33 849 04 59

Link: www.crse.sn

Brief description: The Electricity Regulator (CRSE) was created in 1998 by Law 98-29. It is in charge of reviewing licence or concession applications and ensuring compliance with ToRs, determining the structure and composition of the tariffs, and ensuring compliance with technical standards. CRSE is also responsible for ensuring compliance with competition in the sector, and submitting to the Minister of Energy decrees concerning in particular: the rights and obligations of companies, third party access to the network and the relations between companies and their customers.

Agence pour l'Economie et la Maîtrise de l'Energie/National Agency for Energy Efficiency (AEME)

Contact: **Email**: https://www.facebook.com/aeme.officielle/

Telephone: +221 33 823 26 55

Link: www.aeme.sn

Brief description: AEME is a public law institution with financial and administrative autonomy. Technically, it depends on the Ministry of Petroleum and Energy, while the Ministry of Economy and Finance provides financial supervision. AEME's role is to participate in the implementation of policies in the fields of energy, the environment and sustainable development, propose strategies for the good functioning of the energy sector, and conduct and evaluate the implementation of energy saving and EE programmes, etc.

Agence nationale des énergies renouvelables/National Agency for Renewable Energies (ANER)

Contact: **Email**: infos@aner.sn

Telephone: +221 33 865 66 88

Link: www.aner.sn

Brief description: The missions of ANER are defined in the article 2 of the Decree 2013-684 of May 17th, 2013, on its creation, its organisation and its functioning. This article stipulates that ANER's mission is to promote the use of renewable energies, including bioenergy, in all sectors of activity in Senegal. ANER participates in the definition and formulation of energy policy, in particular in renewable energies, carries out prospective and strategic studies for the development of renewable energies, identifies and exploits innovative financing mechanisms for the development of renewable energy, including Carbon Finance, and develops bilateral and multilateral co-operation in the field of renewable energies.

Senelec

Contact: **Email:** http://www.senelec.sn/contact/

Telephone: +221 33 839 30 30

Link: www.senelec.sn

Brief description: Senelec is the national electricity company of Senegal. Senelec was established in 1983 after the nationalisation and merging of Électricité du Sénégal and Société sénégalaise de distribution d'électricité. Senelec has historically worked in the on-grid market, yet has recently received in concession four zones for rural electrification. Working with private sector mini-grid installers and operators Senelec will now work in the grid extension and mini-grids sphere.

Fonds de Garantie des investissements Prioritaires/Priority Investments Guarantee Fund (Fongip)

Contact: **Email:** http://www.fongip.sn/nous-contacter/

Telephone: +221 33 859 19 19

Link: www.fongip.sn

Brief description: Fongip was set up to act alongside other public entities in the financial ecosystem to mobilise public and private financial resources for SMEs by providing greater assurance to financial institutions. It is an innovative response to social demand, which enables to mitigate risks associated with the granting of loans to SMEs; complement the financial institutions' intervention mechanism for SMEs; and make interest rates currently applied by financial institutions more attractive to SMEs.

4.4.2 MINI-GRID PRACTITIONERS AND PRODUCT DEVELOPERS

Conseil patronal des énergies renouvelables/Council of the Renewable Energy Private Sector (COPERES)

Brief description: COPERES has been created in 1995 to federate all the activities of the private sector along the value chain (technicians, service providers, lawyers, equipment providers, etc). It acts as a cluster for RE in Senegal, gathering all the RE actors in Senegal (public, private, non-governmental) to improve participation of the private sector in the decision-making process. COPERES has a unit that looks specifically at rural electrification and it includes a number of mini-grid operators in the Senegalese market. COPERES has four types of members: those operating large power stations (IPPs), ERILs, distributors and installers, and consultants and engineers. As SENELEC will be looking for operators to work in their four new concessions, COPERES could be a sub-contractor to them and install the mini-grids.

4.4.3 BILATERAL AND MULTILATERAL DONOR ORGANISATIONS

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Contact: **Email**: giz-senegal@giz.de

Telephone: +221 33 889 96 00

Link: https://www.giz.de/en/worldwide/339.html

Brief description: GIZ supports Senegal in the priority area of renewable energies and energy efficiency. GIZ works in rural electrification through the EnDev Senegal project. Specific activities for the electrification of rural areas include developing the technical package (mini-grids), identifying and selecting target communities, sensitising and mobilising

communities, tendering and supervising hardware installation, and supporting the tender and selection of the private operator. EnDev further provides the private operators with business and technical training, rehabilitates existing but non-operational systems, as well as training personnel for operation and maintenance and business procedures.

World Bank

Contact: **Email**: mademba@worldbank.org

Telephone: +221 33 859 41 00

Link: http://www.worldbank.org/en/country/senegal

Brief description: One of the three focus points of the World Bank's assistance to Senegal is rural and urban synergies. The WB is actively supporting the national utility Senelec to improve its operations. The long-term focus of the WB in Senegal is driving the transition from coal to natural gas. As of the end of January 2018, the active portfolio for Senegal comprised 20 national IDA investment projects, totalling $1.43 billion (43% disbursed), and 10 regional IDA operations with $384.74 million in commitments (34.15% disbursed).

Agence Française de Développement (AFD)

Contact: **Email**: afddakar@afd.fr

Telephone: +221 33 823 40 10

Link: https://www.afd.fr/en/page-region-pays/senegal

Brief description: AFD has been a partner of the country since 1947 and is a key correspondent for the Senegalese 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 Senegal, the AFD has mainly been focusing on facilitating access to essential services, developing urban transport and focusing on the country's agricultural potential.

United Nations Development Programme (UNDP)

Contact: **Email**: registry.sn@undp.org

Telephone: +221 33 859 67 67

Link: http://www.sn.undp.org/

Brief description: In support of the implementation of the Senegal Emergent Plan, UNDP in Senegal aims to support the Government's efforts to achieve the Sustainable Development Goals. UNDP provided technical support to Phase 1 of the Emergency Community Development Program (PUDC) which aims to contribute to improving the access of rural populations to basic social services through the establishment of socioeconomic infrastructures.

Islamic Development Bank (IsDB)

Contact: **Email**: RODK@isdb.org

Telephone: +221 33 889 11 44

Link: https://www.isdb.org/country/senegal

Brief description: The IsDB are global leaders in Islamic finance, providing long-term sustainable and ethical financing structures to underpin project investments. The IsDB is also committed to supporting the management and reform of public procurement systems in member countries. The IsDB has also been subsidising mini-grids in Senegal.

USAID (USAID)

Contact: **Email**: usaid-senegal@usaid.gov

Telephone: +221 33 879 4000

Link: https://www.usaid.gov/senegal

Brief description: USAID's Power Africa is supporting Senegal's power sector through financial, technical and advisory assistance. Currently USAID is working with the Ministry of Energy to assess Senegal's rural electrification efforts to date and identify recommendations to accelerate access gains. It also provides transaction advisory assistance to private sector off-grid companies and rural concession holders to strengthen their business models and expand services.

Table 12. Low voltage power supply, (Senelec)

Tariff categories	Price of energy in FCFA/kWh			Fixed monthly prime in FCFA/kW
	1st slice	2nd slice	3rd slice	
Domestic				
Small domestic power	90.5 ($0.16)	101.64	112.65	
Medium domestic power	96.02	102.44	112.02	
Commercial				
Small commercial power	128.85	135.68	147.68	
Medium commercial power	129.81	136,53	149.24	
Prepaid				
Small domestic power	90.47	101.64	101.64	
Medium domestic power	96.02	102.44	102.44	
Small commercial power	128.85	135.68	135.68	
Medium commercial power	129.81	136.53	136.53	
Large power usage	Off-peak[19]	Peak		
Domestic large power usage	86.30	120.81		869.21
Commercial large power usage	103.36	165.38		2,607.63
Public lighting	118.16			3,007.21

19 Off-peak is from 00:00 to 19:00, and from 23:00 to 00:00; peak is from 19:00 to 23:00

Table 13. Medium and high voltage power supply, (Senelec)

Tariff categories	Price of energy in FCFA/kWh		Fixed monthly prime in FCFA/kW
	Off-peak	Peak	
Medium voltage			
Short usage tariff	118,51	183,48	907,32
General tariff	85,29	136,46	3 861,89
Long usage tariff	70,07	112,12	9 321,26
Rural electrification concessionaires	91,35		
High voltage			
General tariff	55,69	80,20	9 461,23
Emergency tariff	74,16	106,78	4 206,24

REFERENCES

AfDB, 2018. Project Appraisal Report: Emergency Community Development Programme Support Project (PA-PUDC), s.l.: s.n.

ANSD, 2016. Recensement General de la Population et de l'Habitat, de l'Agriculture et de l'Elevage (RGPHAE). [Online]
Available at: http://www.ansd.sn/ressources/publications/Rapport%20analyse_ATLAS-RGPHAE_13_Mars_2017_VF_last.pdf
[Accessed 19 October 2018].

ANSD, 2018. [Online]
Available at: http://www.ansd.sn/
[Accessed 18 October 2018].

ANSD, 2018. La Population du Senegal en 2017. [Online]
Available at: http://www.ansd.sn/ressources/publications/Rapport_population_2017_05042018.pdf
[Accessed 19 October 2018].

ARTP, 2018. RAPPORT TRIMESTRIEL SUR LE MARCHE DES TELECOMMUNICATIONS, s.l.: s.n.

BNEF, 2017. Climatescope 2017. [Online]
Available at: http://global-climatescope.org/en/country/senegal/#/enabling-framework
[Accessed 18 October 2018].

BOS, n.d. [Online]
Available at: http://senegal-emergent.com/fr/programme-durgence-de-developpement-communautaire-pudc
[Accessed 19 February 2019].

CRSE, 2018. DOCUMENT DE CONSULTATION PUBLIQUE RELATIF A LA DETERMINATION DU TARIF D'ACHAT DU SURPLUS D'ENERGIE ELECTRIQUE D'ORIGINE RENOUVELABLE RESULTANT D'UNE PRODUCTION POUR CONSOMMATION PROPRE, s.l.: s.n.

CRSE, n.d. Les ventes de Senelec. [Online]
Available at: http://www.crse.sn/les-ventes
[Accessed 22 October 2018].

ECREEE, Final Diagnostic - Senegal Off-Grid. 2017, s.l.: s.n.

EnDev, 2019. Energising Development - Senegal. [Online]
Available at: https://endev.info/content/Senegal
[Accessed 20 March 2019].

FT, 2018. Senegal's journey from blackouts to gas and green energy. [Online]
Available at: https://www.ft.com/content/d6432b72-2ea8-11e8-97ec-4bd3494d5f14
[Accessed 18 October 2018].

IBRD, 2017. Rural Electrification Concessions in Africa: What Does Experience Tell Us?, s.l.: World Bank Group.

IEA, 2018. Global energy data. [Online]
Available at: https://www.iea.org/statistics/?country=SENEGAL&year=2016&category=Key%20indicators&indicator=undefined&mode=chart&categoryBrowse=false&dataTable=INDICATORS&showDataTable=false
[Accessed 18 October 2018].

IEA, I. E. A., 2017. Energy Access Database. [Online]
Available at: http://www.iea.org/energyaccess/database/

IHA, 2017. Hydropower status report 2017, s.l.: s.n.

IRENA, 2012. Senegal renewables readiness assessment , s.l.: s.n.

Legendre, B., 2015. Organisational, technical and financial audit of ASER's programs, evaluation of intervention strategies and recommendations for optimisation, s.l.: s.n.

LPDSE 2018-2022, n.d. Diagnostic et Propositions Strategiques, s.l.: MPE.

MDER, 2015. Plan d'Actions National des Energies Renouvelables (PANER), s.l.: MDER.

MEDER, 2017. Expérience du Sénégal sur les Concessions d'Electrification Rurale. [Online]
Available at: http://www.ecreee.org/sites/default/files/editor/expeience_senegal_sur_les_concessions.pptx.pdf
[Accessed 22 October 2018].

MEF, 2012. Cartographie des services sociaux de base, s.l.: s.n.

Mott McDonald, 2018. Taiba N'Diaye wind farm successfully reaches financial close, Senegal. [Online]
Available at: https://www.mottmac.com/releases/taiba-ndiaye-wind-farm-successfully-reaches-financial-close-senegal
[Accessed 29 October 2018].

Nogoye Diaw et al, 2017. Estimation of Solar Potential in Senegal Using GIS Application. International Journal of Advanced Research in Education & Technology (IJARET), 4(1), pp. 59-63.

RECP, 2015. Africa-EU RECP. [Online]
Available at: https://www.africa-eu-renewables.org/market-information/madagascar/energy-sector/

Senelec, 2018. Nos metiers. [Online]
Available at: http://www.senelec.sn/production/
[Accessed 18 October 2018].

Senelec, 2018. Plan Yeesal Senelec 2020, s.l.: s.n.

UNDP, 2016. World Small Hydropower Development Report 2016 - Senegal, s.l.: s.n.

World Bank Group, 2017. Electrification Rurale du Senegal SE4ALL - Programme d'Action et Prospectus d'Investissement, s.l.: s.n.

World Bank Group, 2018. Senegal's SE4ALL Rural Electrifictaion (ESMAP), s.l.: s.n.

World Bank, 2015. Evaluation of Rural Electrification Concessions in sub-Saharan Africa. Detailed Case Study: Senegal, s.l.: s.n.

World Bank, 2015. Evaluation of Rural Electrification Concessions in Sub-Saharan Africa. Detailed Case Study: Senegal, s.l.: s.n.

World Bank, 2016 . Senegal - Electricity Sector Support Project: additional financing , s.l.: s.n.

World Bank, 2017. Climate Change Knowledge Portal. [Online]
Available at: http://sdwebx.worldbank.org/climateportal/index.cfm?page=country_historical_climate&ThisCCode=NGA

World Bank, 2018. Senegal Overview. [Online]
Available at: https://data.worldbank.org/country/senegal
[Accessed 18 October 2018].

World Bank, 2018. Senegal: World Bank Supports 10,000 People Affected by Climate Change. [Online]
Available at: https://www.worldbank.org/en/news/press-release/2018/06/07/senegal-world-bank-supports-10000-people-affected-by-climate-change
[Accessed 23 October 2018].

World Bank, n.d. [Online]
Available at: http://datatopics.worldbank.org/consumption/sector/Energy

World Bank, n.d. The World Bank in Senegal. [Online]
Available at: https://www.worldbank.org/en/country/senegal/overview
[Accessed 18 October 2018].

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